Preliminary Investigative Report for the Swalley Irrigation District Irrigation Modernization Project

Prepared by Farmers Conservation Alliance

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Acronyms

cfs	cubic feet per second
DO	dissolved oxygen
EA	Environmental Assessment
EFU	Exclusive Farm Use
FCA	Farmers Conservation Alliance
HDPE	high-density polyethylene
HUC	Hydrologic Unit Code
LCDC	Land Conservation and Development Commission
mg/L	milligram per liter
MUA	Multiple Use Agricultural
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
PIR	Preliminary Investigative Report
RM	River Mile
SHPO	State Historic and Preservation Office
SID or District	Swalley Irrigation District
UDWC	Upper Deschutes Watershed Council
UGB	Urban Growth Boundary
URB	Urban Reserve Boundary
U.S./US	United States
USFWS	United States Fish and Wildlife Service
VIC	Variable Infiltration Capacity
Watershed 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 (US). Within the Deschutes Basin, irrigated agriculture (the primary out-of-stream water use in the area) relies on infrastructure that is over 100-years-old to store, divert, and deliver water to produce food, other crops, and water for other uses as well as drive local economies across the region. Irrigation canals have become a public health safety risk and require increasing maintenance due to the age of the existing system. This contributes to water supply insecurity for out-of-stream users and limits stream flow, affecting water quality and instream habitat in the Deschutes River and its tributaries. The aging infrastructure also affects the financial stability of the Swalley Irrigation District (herein referred to as SID or the District), as SID must embark on finding increased funding for maintenance activities.

A portion of the water diverted through SID's canal and laterals[1] currently seeps into the area's porous, volcanic soil prior to reaching farms. Less water would need to be diverted if the distribution system could be made more efficient. Improving aging irrigation infrastructure offers an opportunity to enhance aquatic species habitat, reduce public safety risks, support and maintain existing agricultural land use through enhanced water supply reliability, and provide financial stability to irrigation districts in the Deschutes Basin, including SID.

The District operates and maintains approximately 28 miles of main canal and laterals, including some segments that are already piped. The District proposes to modernize its infrastructure by converting up to 19 miles of open canal, lateral, and aging pipe to buried pipe.

Piping would result in pressurized water deliveries, help to alleviate local and watershed-scale water quality, instream flow and habitat issues, and provide financial and operational benefits to the District and its patrons. Specific details regarding the District's proposed project are available in its System Improvement Plan (SIP; SID 2017) and are further described in Section 7.3.1.

2 Consultation and Participation with Local Partners, Agencies and Tribes

This Preliminary Investigative Report (PIR) was prepared to provide sponsors, local partners, and agencies with information to evaluate further planning, implement the goals and objectives, and aid in securing funding for the SID Irrigation Modernization Project (herein referred to as the "project"). This project development process is designed to work collaboratively with partners, agencies, tribes, and 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, and during the development of the PIR, project sponsors conducted initial consultation with natural resource agencies and stakeholders. SID and its partners will conduct further comprehensive public scoping prior to the preparation of the Watershed Plan-Environmental Assessment (Watershed Plan-EA) as described in the scope of the Environmental Assessment (see Section 4).

1 "Laterals" refer to canals that branch off from the Main Canal.

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:

- Deschutes Basin Board of Control

Supporting sponsors for the project are:

- Swalley Irrigation District (SID)
- National Resource and Conservation Service (NRCS)

Local partners are area entities that have land ownership or a shared resource within the District. Local partners for the project include:

- City of Bend
- Bend Parks and Recreation
- Deschutes County

Agencies that are involved with the project include the following state and federal resource agencies:

- 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. Bureau of Land Management

Tribes consulted regarding the project include:

- Confederated Tribes of Warm Springs

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

- Upper Deschutes Watershed Council
- Deschutes River Conservancy
- WaterWatch of Oregon
- Trout Unlimited
- Coalition for the Deschutes
- Interested public

2.2 Permits and Compliance

It is anticipated that this project will utilize NRCS federal dollars for funding. Therefore, it will require a Watershed 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 (managed by SHPO), Section 7 of the Endangered Species Act (managed by NOAA Fisheries and USFWS),

and Sections 404 and 401 of the Clean Water Act (managed by ODSL and Army Corps of Engineers).

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 other potential impacts as a result of the project will be outlined, designed, and completed following consultation with the corresponding agencies.

3 Purpose and Need for Action

The project area is defined as the canal and laterals to be piped and associated rights of way and/or easements. The project area is located in four subwatersheds: Deschutes Junction, Laidlaw Butte-Deschutes River, Overturf Butte-Deschutes River, and Cline Falls-Deschutes River (Table 3-1), which cover a total of 133,324 acres, as defined by Section 500.3 of the Watershed Planning Manual (NRCS 2014). These four subwatersheds comprise the SID Watershed Planning Area and are located within the Upper Deschutes watershed (Hydrologic Unit Code [HUC] 17070301).

Table 3-1. SID Watershed Planning Area

12-digit Hydrologic Unit Code	Name	Area (acres)
170703010801	Deschutes Junction	47,337
170703010802	Laidlaw Butte-Deschutes River	42,749
170703010406	Overturf Butte-Deschutes River	31,374
170703010803	Cline Falls-Deschutes River	11,864
	Total	133,324

The District currently provides irrigation water to approximately 4,305 acres using one primary diversion and 15 single farm diversions on the Deschutes River, a tributary to the Columbia River in the western US. During peak irrigation season, the District may divert up to 87 cubic feet per second (cfs) of water from the Deschutes River.

The purposes of this project are to:

- Enhance habitat for aquatic species by creating instream water rights through Oregon's Allocation of Conserved Water Program and increasing stream flow in the Deschutes River
- Reduce risks to public safety from open irrigation canal and laterals
- Support and maintain existing agricultural uses through enhanced water supply reliability
- Provide financial security to SID through reduced operation and maintenance costs
- Conserve energy by reducing the need for irrigation pumping

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

- Improved habitat conditions
- Reduced risks to human health and safety
- Increased water supply reliability
- Increased financial security and reduced operation and maintenance costs for SID

3.1 Watershed Problems and Resource Concerns

3.1.1 Habitat Conditions

The middle Deschutes River, defined as the reach from North Canal Diversion Dam at River Mile (RM) 165 to Lake Billy Chinook at RM 120, is listed as a temperature impaired waterway under Section 303(d) of the Clean Water Act because it does not meet State of Oregon water temperature standards for salmon and trout. Water management along the entire length of the Deschutes River affects its temperatures. Additionally, reduced habitat associated with low stream flows increases competition between populations, which often favors non-native brown trout over native redband trout. Reduced habitat availability can concentrate fish populations and increase susceptibility to predators and disease.

The Deschutes River and its tributaries support sensitive species including steelhead trout (*Oncorhynchus mykiss*), redband trout (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), as well as many other fish, bird, and wildlife species. Stream flow in the Deschutes River often limits habitat for many of these species, particularly during the summer months. Returning up to 16 cfs of water to the Deschutes River would benefit the river ecosystem by increasing the quantity and value of aquatic habitat, potentially reducing water temperatures, and improving water quality. This project would provide an opportunity to measurably improve habitat along 45 miles of the Deschutes River from SID's diversion at North Canal Dam (RM 165) to Lake Billy Chinook (RM 120).

3.1.2 Risks to Human Health and Safety

Canals pose a risk to public safety. There have been two recent drowning deaths in adjacent districts' canals (DEA 2005). The District's location in a partly-urbanized area heightens the potential for an accident, as the canals wind through urban areas, rural residences, private lands, and irrigated fields.

Barriers at the top of bank of the canals are not installed as they would prevent access for necessary maintenance. During the summer, water depths in the District's canal and laterals range between 2 to 6 feet, with velocities up to 5 cubic feet per second (cfs) 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 have an even higher risk of drowning in a canal with these attributes. If a person or animal falls into a canal, they could have serious difficulty gaining hold on the banks in order to climb out due to the volume and speed of the moving water.

Deschutes County was the fastest growing county in Oregon in 2015 based on the Oregon Population Report (PSU 2015); these public safety risks will continue to grow as urbanization expands into previously-rural areas such as SID's service area.

3.1.3 Water Supply Reliability

Conserving water is a key goal of the District and has already invested in multiple large piping projects to meet this goal. The District's remaining antiquated canal infrastructure loses water to seepage and other conveyance inefficiencies. Details of water losses and demands can be found in the District's SIP (SID 2016; Appendix). Water losses due to inefficient conveyance systems prevent the District from delivering to its patrons the full rate and duty associated with each water right.

The District's previous aggressive conservation efforts have inadvertently created some water user supply issues; during the 30 percent and 50 percent seasons, patrons' full allotments of water do not reach their deliveries due to remaining inefficiency infrastructure. The District can no longer consistently deliver a sufficient water supply to patrons during these spring and fall shoulder

seasons. The District seeks to conserve additional water in a way that would not exacerbate current water user supply issues within the shoulder seasons, nor cause further supply issues for water users within any season.

3.1.3.1 District Diversions

SID can divert its full water right from the Deschutes River if needed every year. SID's 1899 water rights are some of the most senior on the upper Deschutes River, so the District has priority over most other water users on the river. SID's permitted water allocation is always available at its diversion on the Deschutes River; it does not rely upon, nor does it hold rights to, stored water in the upstream reservoirs.

3.1.3.2 Patron Deliveries

Every year between April 1 and April 30, SID's early season rate starts at 30 percent of its mid-summer rate, increases to 50 percent of its mid-summer rate on May 1, and increases to its full mid-summer rate on May 15. SID's rate decreases to 50 percent again from September 15 to September 30, and to 30 percent again from October 1 through the end of October. The District's open canal and laterals do not pass water as efficiently as a fully piped system would, especially at the reduced rates allowed early and late in the irrigation season. Not enough water makes it through some of SID's laterals to meet patrons' needs at these reduced rates. Consequently, some patrons do not receive adequate deliveries early and late in the irrigation season (i.e., during the shoulder seasons).

3.1.3.3 Other Water Users

In some years, there is not enough water in the Deschutes River and its tributaries at appropriate times to meet water needs for irrigation districts and their patrons. Arnold Irrigation District, Central Oregon Irrigation District, Lone Pine Irrigation District, and North Unit Irrigation District are all junior in priority to SID, therefore their needs may not be met by the Deschutes River during low flow times.

The Deschutes River also experiences shortages every year. Reservoir operations lead to very low winter stream flows and high summer stream flows in the Deschutes River upstream from SID's diversion. The combined diversions of the six irrigation districts that divert water in or near the City of Bend lead to low spring, summer, and fall stream flows in the Deschutes River downstream from SID's diversion.

In order to protect habitat in the watershed, the irrigation districts are jointly developing a multi-species Habitat Conservation Plan under the federal Endangered Species Act that will be used to establish seasonal stream flow targets in areas of the Upper Deschutes Watershed with endangered species.

3.1.4 District Financial Security

Approximately 77 percent of SID's accounts are 6-acre or smaller parcels, yet they represent only 28 percent of the irrigated area of the District. Approximately 33 percent of the District has been urbanized within the city limits of Bend, Oregon. The development of smaller parcel sizes served with the original canal systems greatly increases the time and effort expended by SID to manage its water supply system. This results in increasing operation and maintenance costs. Urbanization also demands substantial infrastructure upgrades and related costs. Another consideration relative to

irrigation of smaller parcels is water use efficiency by the end user, which SID desires to improve through providing a pressurized system.

3.2 Watershed and Resource Opportunities

The following is a list of resource opportunities that would be realized through the implementation of the project. Quantification of these opportunities is provided in other sections of this report and in subsequent studies and reports, as appropriate.

- Improve stream flows and water quality within the Deschutes River from the North Canal Dam (RM 165) to Lake Billy Chinook (RM 120) [Middle Deschutes]
- Minimize the potential for injury and loss of life associated with the open SID canal and laterals.
- Provide a more reliable source of irrigation water to SID patrons.
- Reduce the maintenance required to deliver irrigation water to SID patrons.
- Maintain or reduce SID operating costs.
- Reduce energy costs by removing the need for individual pumps.

Stream flow benefits would be realized by allocating saved water instream and creating instream water rights through Oregon's Allocation of Conserved Water Program.

4 Scope of the Environmental Assessment

Natural Resources Conservation Service (NRCS) and SID 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, SID, and 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 Watershed 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

SID is located in central Oregon, in the northern half of Deschutes County, and is situated north of the City of Bend. It is generally confined by the Deschutes River and Highway 97 and falls within four subwatersheds that have a total area of 133,324 acres (Figure 5-1, Table 3-1). These four subwatersheds comprise the Watershed Planning Area.

The entire District is approximately 17,000 acres in area, and it contains 4,305 irrigable acres used by 662 patrons (SID 2010). The district is about 14 miles long (north to south) and 4 miles wide (east to west). The main point of diversion is at the North Canal Dam on the Deschutes River (RM 165). There are 15 direct withdrawals from the Deschutes River that irrigate 328 acres of the District. Existing District infrastructure includes approximately 12 miles of Main Canal and 16 miles of laterals, including existing piped segments.

The Watershed Planning Area is located within the Upper Deschutes watershed (4th field HUC: 17070301) and within Deschutes County (Figure 5-2). Within the Upper Deschutes watershed,

portions of the Deschutes River are referenced as the upper Deschutes River (from RM 226 to RM 165) and the middle Deschutes River (from RM 165 to RM 120). This reference point divides the river based on its hydrograph, which is driven by reservoir operations. Current reservoir management in the upper Deschutes River leads to low winter flows and high summer flows. When the high summer flows reach the North Canal Dam, they are diverted for use by several irrigation districts. This is further illustrated in Figure 5-3, which was developed by Central Oregon Irrigation District.

The 35-mile segment of the Deschutes River from Twin Bridges (RM 155) to the head of Lake Billy Chinook (RM 120) is a designated State Scenic Waterway under the Oregon Scenic Waterways Program. The 20-mile segment from Odin Falls (RM 140) to the upper end of Lake Billy Chinook (RM 120) is also a federally-designated National Wild and Scenic River.

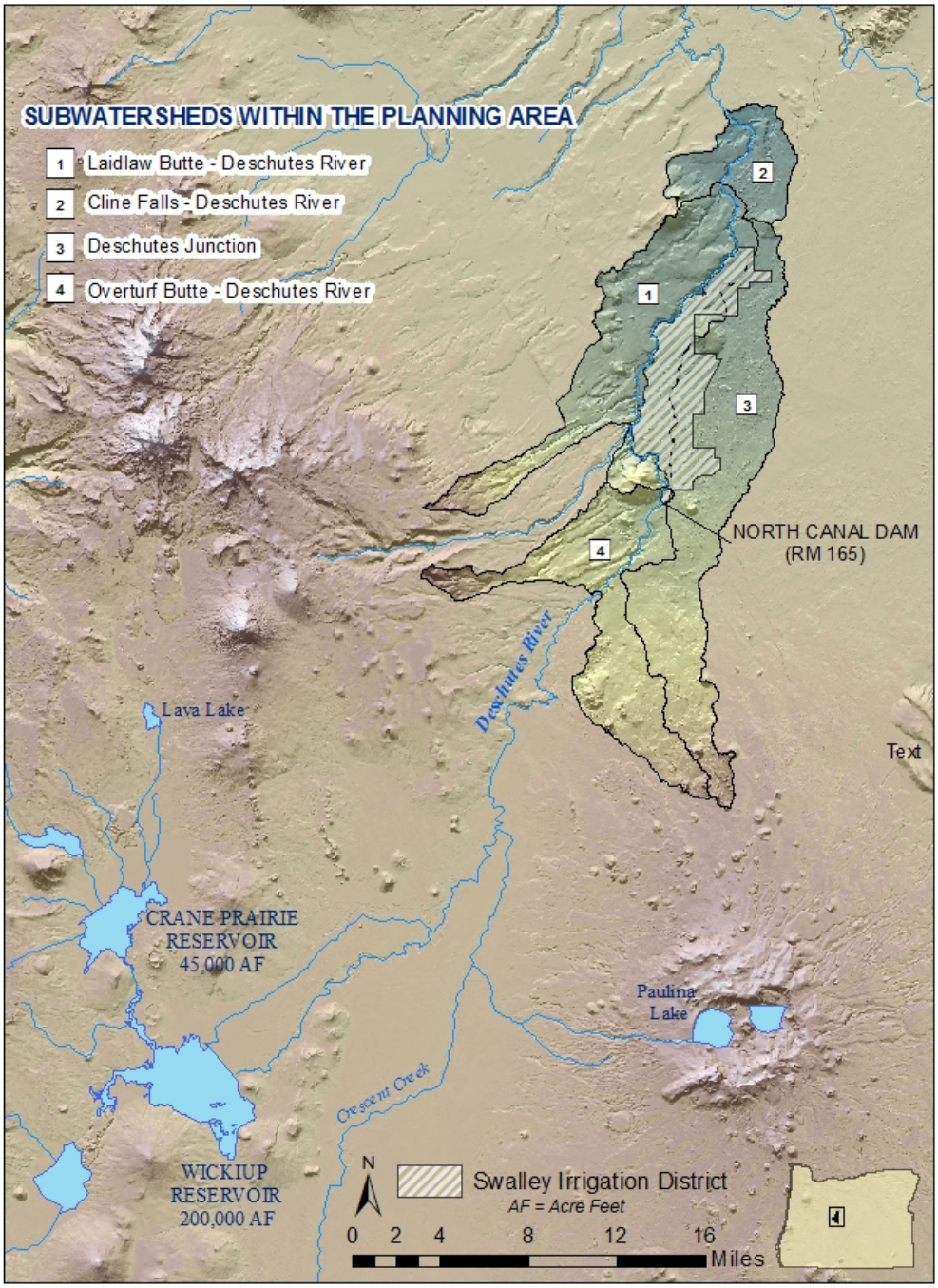

Figure 5-1 SID Watershed Planning Area

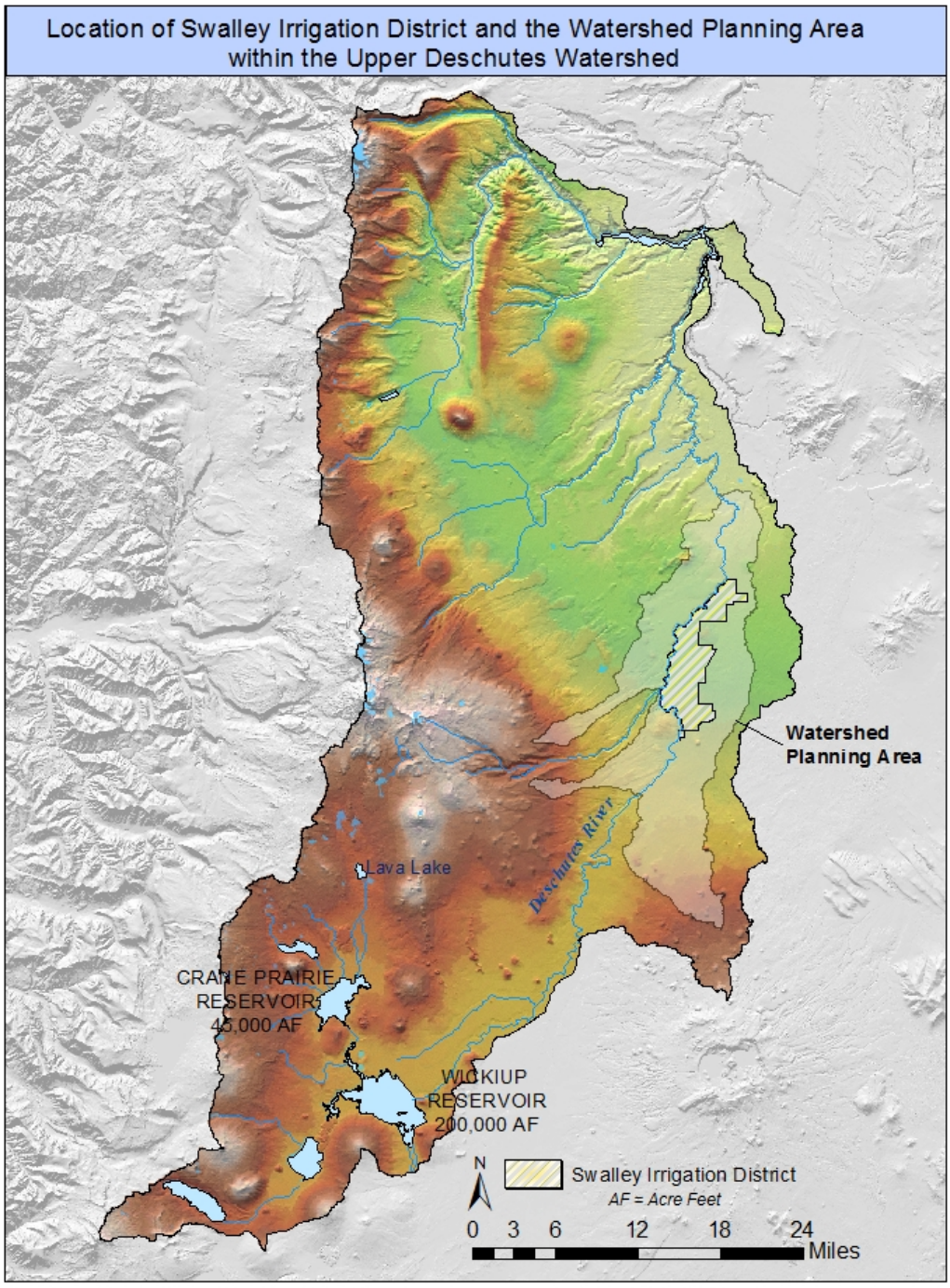

Figure 5-2. Location of Swalley Irrigation District and Watershed Planning Area within the Upper Deschutes watershed.

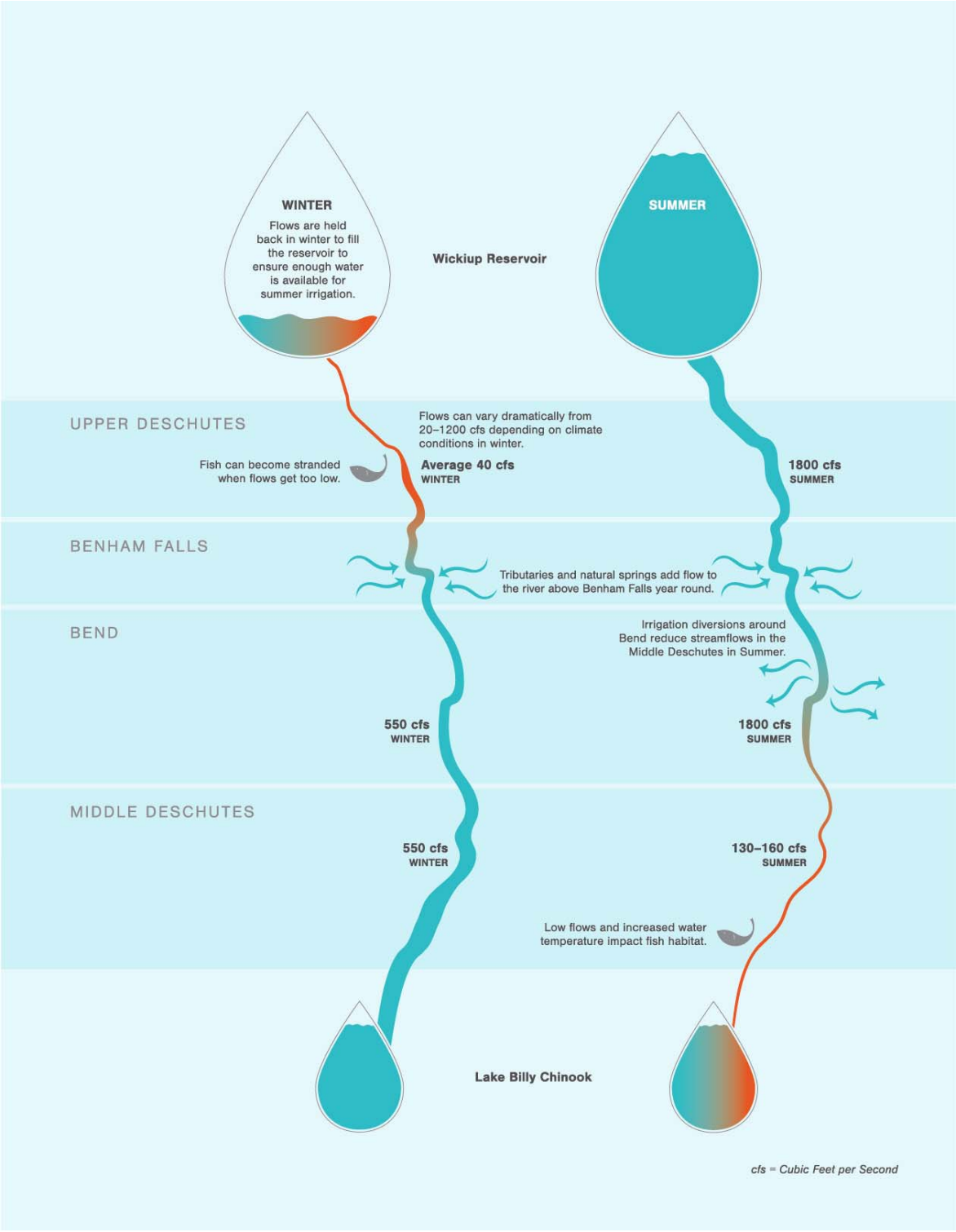

Figure 5-3 Deschutes Watershed Seasonal Flow Management
Source: Central Oregon Irrigation District

5.2 Current Infrastructure

The District cooperatively operates a shared intake structure with the North Unit Irrigation District and Central Oregon Irrigation District at the North Canal Dam on the Deschutes River. Flows coming in the shared intake structure split into the North Unit Irrigation District Primary Feed Canal, the Central Oregon Irrigation District Pilot Butte Canal, and SID's Main Canal Pipeline after passing through its automated fish screen and vertical slide gate. After water passes into SID's Main Canal Pipeline, it flows into a vaulted segment of steel pipe where it is metered. It then transitions into a high-density polyethylene (HDPE) pipe. The SID Main Canal Pipeline conveys water through HDPE pipe for approximately 5.1 miles to the north until it reaches SID's 0.75-megawatt Ponderosa Hydroelectric Power Plant. The Main Canal Pipeline diameters range from 54 inches to 48 inches. The pipe diameter is reduced as deliveries and laterals withdraw water from the system.

After the water is run through the hydroelectric facility, it continues another 7 miles to the terminus of the Main Canal delivery system in an open-channel earthen canal (Figure 5-4). Several laterals stemming from the Main Canal and pipeline have been piped, including portions of the NC-1 Lateral, the Kotzman Lateral, the Rogers Lateral, the Deschutes Lateral, and the Frakes Lateral. There are several laterals that branch off the Main Canal and pipeline that remain open, such as: the Elder Lateral, Riley Lateral and Sublateral, Rogers Lateral and Sublateral, Butte Lateral, and the Mickelson Lateral. There are also approximately 28 miles of private conveyance, including pipes and open canals, stemming off of the District's system. Patron turnouts from the District's Main Canal and laterals to these private conveyances are typically gate-regulated and weir-measured. The District field staff regulates flows to each system lateral and patron turnout. Direct deliveries from the river irrigate 328 acres in the District and are monitored and metered by the District.

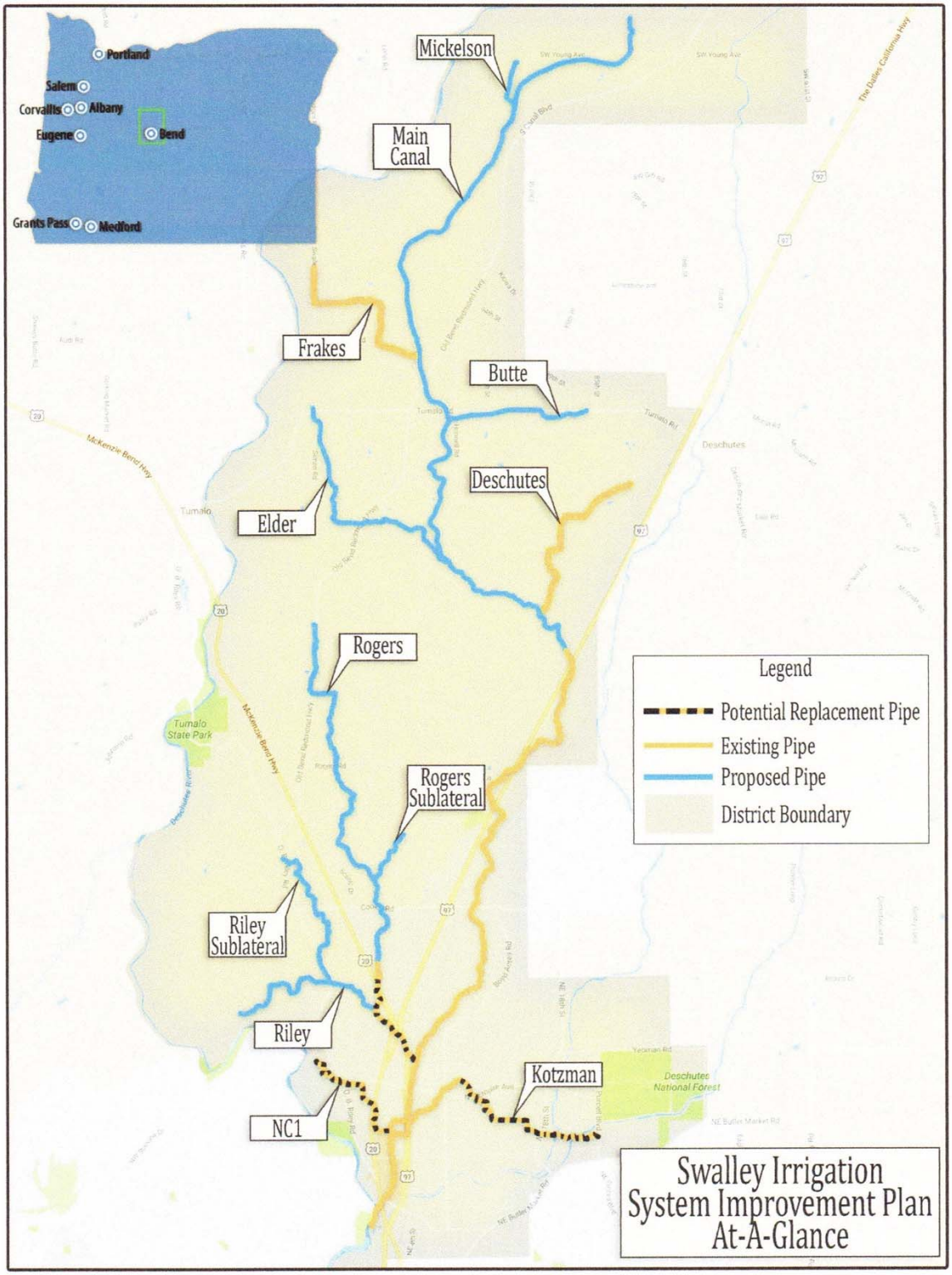

Figure 5-4. Swalley Irrigation District Source Existing Infrastructure and Planned Improvements: SID 2016.

5.3 Topography

The land within the District is slightly undulating. The main diversion at the North Canal Dam is at 3,558 feet above sea level. There is approximately 400 feet of elevation loss between the diversion at North Canal Dam and the end of the Main Canal.

5.4 Climate

The upper Deschutes Basin is located in the rain shadow of the Cascade Mountain range. Orographic processes result in large amount of precipitation in the Cascades Range with levels exceeding 200 inches per year, mostly as snow. Precipitation diminishes rapidly moving from west to east across the basin, with less than 10 inches per year received in the central part of the basin. The District's annual average precipitation is 10 to 12 inches; thus irrigation is essential to crop production, and SID irrigators rely on the Deschutes River in order to receive adequate water supplies for their crops. Summer high temperatures in the District range from 75 to 95 degrees Fahrenheit and winter lows range from 21 to 44 degrees Fahrenheit. The average growing season is approximately 70 to 100 days.

Recent yet consistent changes in climate show signs of future increased temperatures and changes in precipitation patterns. These will result in fundamental changes in the seasonal distribution of stream flow in the area and may have serious implications for natural resource managers and local farmers (Vano et al. 2015). Variable Infiltration Capacity (VIC) simulations show a substantial decrease in annual stream flow in response to increasing summer (April through September) warming. Winter (October through March) warming stimulates greater stream flow immediately, which partly compensates for a subsequent decrease in summer stream flow that happens because less water is available (Das et al. 2011). The probable result of climate change 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).

5.5 Geology and Soils

5.5.1 Geology

The project area is located within the Deschutes-Columbia Plateau, which is part of the larger Columbia Plateau. The Deschutes-Columbia Plateau was formed by periodic fissure eruptions of lava during the Miocene epoch, which filled a subsiding basin. The Deschutes Formation is a result of these basalt flows that erupted from vents and fissures. The permeability of the Deschutes Formation is variable within the Deschutes Basin. 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 is able to move through easily (Lite and Gannet 2012). This influences hydrology because 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.

SID is located at the interface of the Cascade Range and High Lava Plains physiographic provinces (Orr et al. 1992) and more specifically just east of the High Cascade subprovince. The High Cascades were primarily formed 2 to 4 million years ago during the Pliocene and Pleistocene Epochs and they changed the landscape of the Deschutes Basin. This volcanic activity resulted in complex assemblages of vents, lava flows, pyroclastic deposits, and volcanically-derived sedimentary deposits.

The peaks in the High Cascades that lie to the west of SID are: Jefferson, Three Fingered Jack, Washington, the Three Sisters, Broken Top, and Bachelor. Over the last 2 to 4 million years, erosion, sedimentation, and volcanic activity resulted in more layers of alluvium, ash, and andesite over areas of the Deschutes Formation. The geologic units found in the study area include: basaltic to andesitic lava from the Pliocene and Miocene epochs; areas of sand and gravel deposits; alluvium from the Pleistocene; and some small areas of tuff deposits (Sherrod et al. 2004).

5.5.2 Soils

The underlying material of the SID area is generally basalt and andesite, with areas of alluvium and volcanic ash deposits. Soil surface layers consist of sandy loam; the Deschutes sandy loam is the most common soil in the District (USDA National Resources Conservation Service 2002). The Deschutes sandy loam soils are moderately deep and well-drained. Much of the Deschutes sandy loam occurs in areas between mounds and ridges of outcropping lava, which are characteristic of the upland plains east of the Cascades. Deschutes sandy loam has a slightly developed profile, meaning the subsoil is slightly finer in texture and more compact than the surface soil and has a weakly developed structural aggregate. Sandy loams are very loose and are sensitive to lateral soil movement and erosion. Soil displacement of topsoil layers can adversely affect soil fertility and productivity. The sandy loam soils are shallow to moderately deep and are well-drained. This type of soil has high seepage rates for canal-conveyed water and for ponds. The low available water capacity (0.1 to 0.14 inch per inch) and high permeability (2 to 6 inches per hour) requires the careful management of sprinkler irrigation to avoid deep percolation losses while providing adequate soil moisture for crop use. Without adequate cover, these soils are also subject to wind erosion.

The parent materials for Deschutes sandy loam soils are primarily derived from ash, cinders, and pumice deposited from past volcanic eruptions. Pumice and ash tephras were expelled during eruptions like that of Mt. Mazama and the other High Cascade mountains. Deposits of ash, cinders, and pumice fell on previously developed soils. Almost all of the bedrock materials beneath soils are extrusive volcanic rocks (USDA 1990). Litter and duff on the soil surface is also found in variable depths throughout the District, primarily as a function of the aspect and plant association on which a given soil profile is located. Surface litter and duff is a primary component of the productivity of the soils present within the area. Underlying glacial or volcanic materials within the District affect the subsurface flow of water and can also influence the availability and content of nutrients within the soil profile.

5.6 Water Resources

5.6.1 Water Supply and Streamflow

The Deschutes River starts high in the Cascade Mountains. The headwaters of the Deschutes River begin as surface flow from Little Lava Lake when there is an abundance of water. During dry years its headwaters are the springs in Blue Pool. One of the Deschutes Basin's most unique traits is its geologic composition of porous volcanic rock and soil that allows surface water to infiltrate into the subsurface and recharge groundwater aquifers (Gannett et al. 2001). The Deschutes River has large springs throughout its reaches to Lake Billy Chinook. Before development of water resource projects, the river had a stable hydrologic regime in which natural daily, monthly, and even annual fluctuations in water flows were minimal, as the hydrograph was balanced by groundwater that entered the system as snowmelt or precipitation throughout the watershed (Gannet et al 2001). Reviews of historic annual hydrographs and flood peak records of the river show only a variance

factor of 1.5 between discharge during the months of greatest and least flow (O'Connor and Grant 2003).

Today, the operations of upstream reservoirs and diversions along the river by numerous irrigation districts have altered flow and water quality in the upper and middle Deschutes River. Under natural conditions, approximately 1,350 cfs would flow in the middle Deschutes River during summer months (Golden and Aylward 2006). However, from the 1960s through the 1990s, as a result of ongoing irrigation operations, stream flows were as low as 13 cfs in the Deschutes River below North Canal Dam (Golden and Aylward 2006).

In the late 1990s, collaborative work began between agencies, interest groups, irrigation districts, and the OWRD to engage in water conservation projects to protect and benefit the middle Deschutes River ecosystem. As a result, flows as high as 160 cfs now occur at times in the middle Deschutes. However, low stream flows still limit habitat conditions for aquatic species. In the late 1990s, ODFW applied for a year-round instream water right of 250 cfs to support fish populations in the middle Deschutes River. While this water right has not yet been granted, 250 cfs in the middle Deschutes River between North Canal Dam (RM 165) and Lake Billy Chinook (RM 120) is used as a target for meeting fish needs. Currently, in 2017, due to heavy demand during the April to October irrigation season, stream discharge within the middle Deschutes River still does not reach the 250 cfs target instream minimum flow, and diminished water quality is observed year-round. Figure 5-5 shows the 1982 to 2015 average monthly Deschutes River discharge above and below North Canal Dam. Summertime peaks upstream of the dam are due to storage releases from the reservoirs, while downstream reduced flows are due to irrigation diversions.

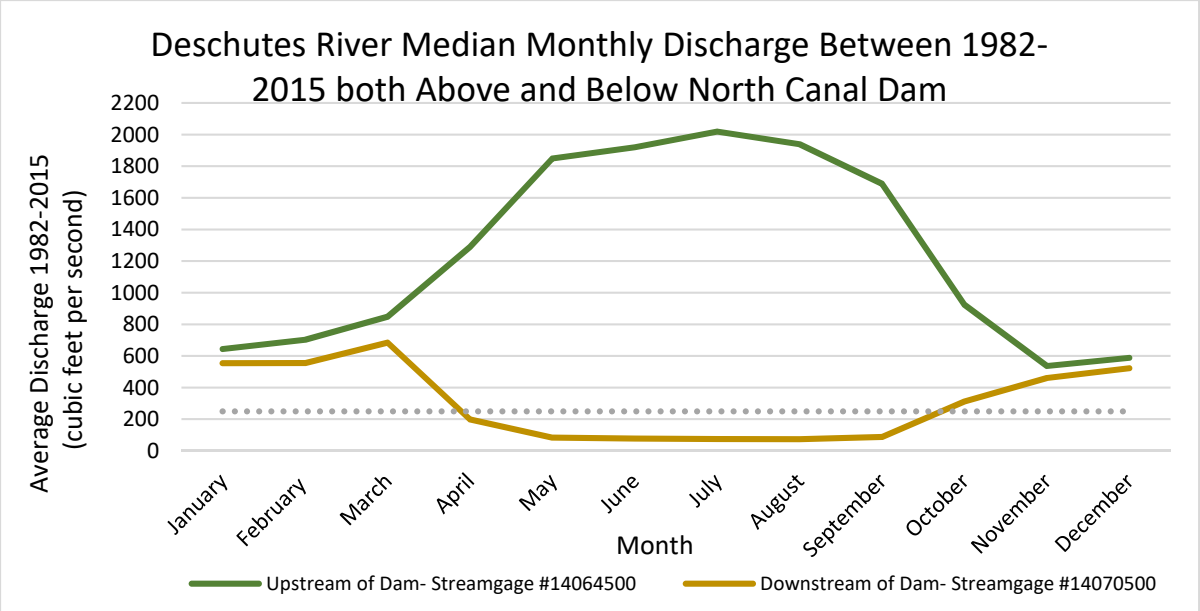

Figure 5-5. Deschutes River median monthly Discharge upstream and downstream of North Canal Dam (RM 165) between 1982-2015. Source: Oregon Water Resources Department 2016.

Swalley Irrigation District operates with water right Certificate 74145. The District's only source of water is the Deschutes River with a priority date of September 1, 1899, and at a modified maximum rate of 87.217 cfs. These water rights are considered "natural flow" and do not depend on the use of any reservoir or pumping facilities. SID does not have any storage water rights. North Canal Dam

(RM 165), a spill-over diversion dam, provides the water surface elevations necessary for diversion into the SID, COID, and NUID water intake systems.

OWRD and USGS have a meter/gauge located on SID's Main Canal Pipeline intake downstream from the diversion point and fishscreen. The following charts illustrate the median withdrawal from the Deschutes River into SID's Main Canal Pipeline for the months of April (Figure 5-6) and August (Figure 5-7) between 1982 and 2015. The incremental installation of piping projects has resulted in a general decreasing trend in irrigation withdrawals since 1987. Troughs in the trend line below represent time periods when SID water conservation construction projects cut into the start of irrigation season and resulted in lower than normal measured withdrawals and/or time periods when new metering equipment was in the process of being installed.

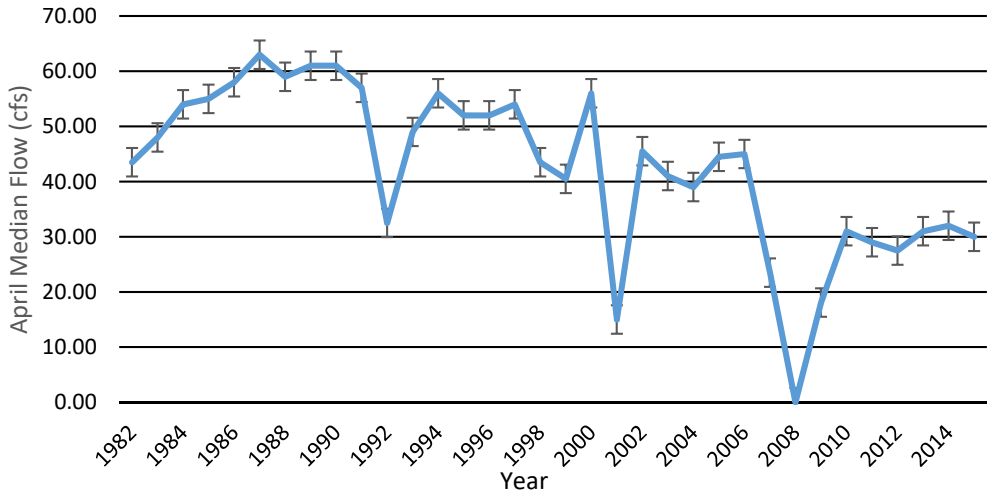

Figure 5-6. April median monthly withdrawal into the Swalley Irrigation District diversion (OWRD stream gauge #14070000). Source: Oregon Water Resources Department, 2016.

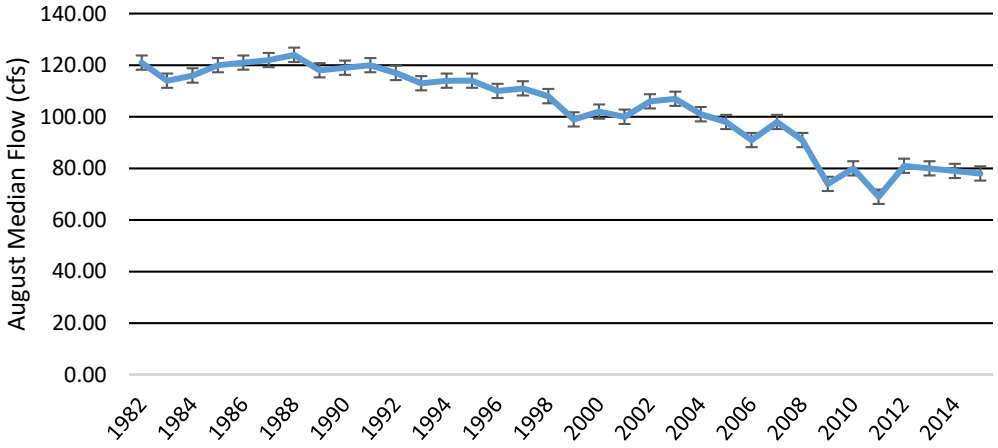

Figure 5-7. August median monthly withdrawal into the Swalley Irrigation District diversion (OWRD stream gauge #14070000). Source: Oregon Water Resources Department, 2016.

5.6.2 Ground Water

As discussed above, groundwater plays an important role in the hydrograph of the entire Deschutes watershed; groundwater in the upper watershed provides more than three quarters of the total stream flow for the entire watershed.

At upper elevations, most (approximately 70 percent) precipitation becomes groundwater, whereas precipitation at low elevations is largely lost to evapotranspiration, with only 5 percent infiltrating to the groundwater system (Manga 1997 and Gannett et al. 2003). 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 the Upper Deschutes watershed, and SID's service area in particular, often show seepage losses indicative of the area's permeable geology. A loss assessment study in 2016 measured up to 20.1 cfs of peak-season loss in SID's canals due to seepage (SID 2016).

5.6.3 Water Quality

Impacts of changes to the Deschutes River's hydrograph due to flow discussed in Section 5.2.1 include diminished water and habitat quality throughout the Deschutes River. Low flows can exacerbate temperature and dissolved oxygen (DO) problems. The Oregon Department of Environmental Quality (ODEQ) periodically prepares a list of all surface waters in the state considered impaired because they do not meet water quality standards under Section 303(d) of the Clean Water Act (33 USC 1251 et seq.). The Deschutes River in the study area is included on the most current list for temperature and pH year-round that affect fish habitat and recreation, and DO from January 1 through May 1 to protect trout spawning. It is also considered water quality limited, but not included on the 303(d) list, for flow modification that impairs fish habitat (ODEQ 2012).

5.6.3.1 Temperature

In the Deschutes River, elevated stream temperature affects native fish by exacerbating conditions that cause stress and disease, raise their metabolism, and reduce growth rates. Non-native fish often thrive in warmer waters, allowing them to outcompete and prey on native fish (Recsetar et al. 2012; Shea and Peterson 2007). Higher water temperatures also lower the DO potential. The temperature standard in the middle Deschutes River is 64 degrees Fahrenheit to protect salmon and trout rearing and migration life stages. This standard is frequently exceeded downstream from the North Canal Dam as well as in other reaches outside the study area (ODEQ 2012).

5.6.3.2 Dissolved Oxygen

Sufficient DO concentration is an important characteristic of habitat suitability for aquatic organisms. The Deschutes River is included on the State 303(d) list for not meeting the DO criterion from Wickiup Reservoir (RM 226) downstream to Lake Billy Chinook (RM 120) through the winter season of January 1 to May 15. During salmonid spawning until fry emergence, criteria apply in the Deschutes River from October 1 to June 30, which are not less than 11.0 milligrams per liter (mg/L) or 95 percent saturation; and not less than 9.0 mg/L or 95 percent saturation if intergravel DO is 8.0 mg/L or greater (ODEQ 2012).

5.6.3.3 pH

pH values in surface waters are generally determined by DO and temperature levels; both reduced DO availability and higher temperatures cause an increase in pH. pH extremes can affect the

solubility of nutrients, thereby changing the amount of nutrients available for plant growth. When pH is high, too many nutrients are available and plants grow at a higher than normal rate. This results in increased organic matter decomposing in the stream that further reduces DO. The pH standard in the Deschutes River is 6.5 to 8.5, this standard is frequently exceeded in the middle Deschutes River with higher, or more alkaline, pH values (ODEQ 2012).

5.7 Fish & Aquatic Species

SID's canal and laterals do not support resident or anadromous fish species. SID installed a v-notch fish screen on its primary diversion on the Deschutes River in 2004. The fish screen prevents fish from entering the District's canal.

As discussed in Section 5.2.1, historically, the Deschutes River had very consistent stream flows seasonally and annually. This created fish habitat with cold, clear water and consistent flows. Since the late 1800s, changes to Deschutes River stream flows, construction of fish passage barriers, and water management has created a very different aquatic environment with resulting changes to the fish species assemblages.

The species currently present in the middle Deschutes River are a reflection of the available habitat conditions. The ODFW, Oregon Watershed Enhancement Board, and the Upper Deschutes Watershed Council (UDWC) have been working to describe fish populations in the middle Deschutes River and interpret how fish are using aquatic habitat in relation to temperature and stream flow conditions (UDWC 2014). The data being collected as part of this ongoing study are improving the understanding of the native and non-native fish assemblages in the middle Deschutes and how they respond to changes in flow and water temperatures. Between 2012 and 2014, Carrasco and Moberly found fish assemblages in the middle Deschutes River to include: mountain whitefish (*Prosopium williamsoni*), redband trout (*Oncorhynchus mykiss*), brown bullhead (*Ameiurus nebulosus*), mottled sculpin (*Cottus bairdii*), brown trout (*Salmo trutta*), tui chub (*Gila bicolor*), and bridgelip sucker (*Catostomus columbianus*). Mountain whitefish, brown trout, and redband trout were found to be the dominant species (Carrasco and Moberly 2014). Mountain whitefish and redband trout are native to the middle Deschutes River. Brown trout were introduced to the Deschutes Basin by state and federal agencies in the early 1900s.

An isolated population of bull trout (*Salvelinus confluentus*) exists in the Metolius River and Lake Billy Chinook (ODFW 1996). The Metolius River is one of the three rivers that feed Lake Billy Chinook. Bull trout may utilize the Deschutes River downstream from Big Falls (RM 132).

Historically, Chinook salmon and summer steelhead were distributed in the Deschutes River up to the natural barriers of Steelhead Falls (RM 127.75) and Big Falls (RM 132), respectively. The construction of the Pelton Round Butte Dam complex on the Deschutes River eliminated anadromous populations upstream from the dams. Fisheries managers initiated efforts to reintroduce Chinook salmon and steelhead trout upstream from the Pelton Round Butte Project as part of a hydropower relicensing agreement in 2005.

Elevated water temperatures in the middle Deschutes River (see Section 5.2.3) negatively impact salmonid growth and survival (Recsetar et al. 2012). Availability of cold water for temperature sensitive fish species are of key importance when water temperatures rise above acceptable standards. Water temperatures out of the normal range for fish can increase physiologic stress, increase susceptibility to predators, and influence growth rates, feeding, metabolism, and development. Further data collection and temperature modelling efforts will aid in managing the additional habitat gained by increased stream flows.

5.8 Wildlife

Wildlife and their habitat within the SID boundary is relatively limited, as urbanization, commercial businesses, and transportation corridors have created fragmented, disturbed habitat, typically frequented by wildlife more tolerant of urban and agricultural land uses. Typical wildlife in the project area:

- mule deer (*Odocoileus hemionus*)
- coyote (*Canis latrans*)
- beaver (*Castor canadensis*)
- cottontail rabbits (*Sylvilagus* spp)
- pygmy rabbits (*Brachylagus idahoensis*)
- gray squirrels (*Sciurus griseus*)
- golden-mantled ground squirrels (*Spermophilus lateralis*)
- least chipmunk (*Tamias minimus*)
- opossum (*Brachylagus idahoensis*)
- raccoon (*Procyon lotor*)
- western small-footed Myotis (*Myotis ciliolabrum*)
- little brown bat (*Myotis lucifugus*).

Reptiles potentially present in the project area:

- western fence lizards (*Sceloporus occidentalis*)
- desert horned lizards (*Phrynosoma platyrhinos*)
- sagebrush lizards (*Sceloporus graciosus*)
- gopher snakes (*Pituophis catenifer*)
- western rattlesnake (*Crotalus viridus*).

Birds potentially present in the project area:

- osprey (*Pandion haliaetus*)
- turkey vulture (Cathartes aura)
- Canada goose (*Branta Canadensis*)
- bald eagle (*Haliaeetus leucocephalus*)
- red-tailed hawks (*Buteo jamaicensis*)
- Stellar's jay (*Cyanocitta stelleri*)
- spotted towhee (*Pipilo maculatus*)
- northern flicker (*Colaptes auratus*)
- rufous hummingbird (*Selasphorus rufus*)
- winter wren (*Troglodytes hiemalis*)
- red-breasted nuthatch (*Sitta canadensis*)
- and many others

5.9 Vegetation

SID lies in the high lava plains province and within the western juniper (*Juniperus occidentalis*) forest zone of Central Oregon (Johnson and O'Neil 2001). The dominant natural vegetation in the District

is western juniper (*Juniperus occidentalis*) with ponderosa pine (*Pinus ponderosa*). The understory is dominated by big sagebrush (*Artemisia tridentata*) and low sagebrush (*Artemisia arbuscula*) and relate to mesic microhabitats. Other shrubs and herbaceous plants found in the area include bitterbrush (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa sandbergii*), and cheatgrass (*Bromus tectorum*) (Johnson and O'Neil 2001).

Over the past 100 years, land use has changed much of the vegetation within the District. Urban development, roads, irrigated agriculture, land management, and livestock grazing are the primary causes of changes to the plant community. The introduction of cheat grass 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.

5.10 Threatened and Endangered Species

The Endangered Species Act (ESA; 16 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 the 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 risked the continued existence of federally-listed ESA species, nor results in the destruction or adverse modification of designated Critical Habitat.

The USFWS maintains a list of wildlife species protected under the ESA that may occur in Deschutes County (USFWS 2017). Federal species of concern are identified by the USFWS but do not receive protection under the ESA. These species have potentially declining populations and could require additional management or protection in the future. Although a number of listed species are known by USFWS to occur in Deschutes County: threatened yellow-billed cuckoo (*Coccyzus americanus*), northern spotted owl (*Strix occidentalis caurina*), Oregon spotted frog (*Rana pretiosa*), and bull trout (*Salvelinus confluentus*); endangered gray wolf (*Canis lupus*); and candidate whitebark pine (*Pinus albicaulis*); none of these species occur in areas that could be directly or indirectly affected by the project.

Fisheries managers have reintroduced summer steelhead, listed as threated under the ESA, to the Deschutes River and its tributaries upstream from the Pelton Round Butte Project. Reintroduced summer steelhead are considered to be a 10(j) non-essential, experimental population under the Endangered Species Act.

5.11 Wetlands

Wetlands are defined as "areas that are inundated or saturated by surface or ground water 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" (ACOE 1987).

Wetlands have the following general environmental characteristics (ACOE 1987):

- Vegetation that consists of macrophytes, typically adapted to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions.

- Soils that have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.
- Hydrological effects that inundates the area with permanently or periodically at mean water depths ≤6.6 feet, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

Wetlands in Oregon are managed under two laws: Section 404 of the Clean Water Act, which regulates dredge or fill of wetlands over which the Army Corps of Engineers has jurisdiction (or "jurisdictional wetlands"), and the Oregon Removal-Fill Law. Jurisdictional wetlands are not known to occur in the project area. National Wetland Inventory geographic information systems (GIS) data (USFWS 2016) does not describe wetland resources within the project area.

Wetland plants are sometimes found along the banks of open irrigation canals as the hydrology provided by the canals can create conditions where they can grow. Although canals may have hydrology and vegetation indicative of a wetland, the Oregon Removal-Fill Law provides several exemptions for specific agricultural activities in wetlands and other waters of the state. Per the Oregon Removal-Fill statue OR 141-085-0515(9), regardless of whether it was created in wetlands or uplands, an irrigation ditch is not jurisdictional under Oregon Removal-Fill permitting if it meets both of the following (Oregon Dept of State Lands 2013):

- The ditch is operated and maintained for the primary purpose of irrigation
- The ditch is dewatered for the non-irrigation season except for isolated puddles in low areas. "Dewatered" means that the source of the irrigation water is turned off or diverted from the irrigation ditch. A ditch that is dewatered during non-irrigation season may be used for temporary flows associated with stormwater collection, stock water runs, or fire suppression.

5.12 Land Use, Zoning, and Ownership

5.12.1 Land Use

The dominant land use in the project area is agriculture followed by urban uses, suburban uses, and fallow ground. The crops grown in the agricultural areas include pasture grass (32 percent), hay (30 percent), nursery plants (1 percent), and vineyards (Table 5-1). Farmers typically get two to three cuttings per year on hay and pasture grass. The urban/suburban areas use SID water to irrigate landscapes, turf, golf courses, parks, sporting fields, and a cemetery. The majority of SID patrons irrigate parcels smaller than six acres (Table 5-2). The District's relatively small average acreage per account reflects its urbanizing nature.

Table 5-1. Commonly grown crops within Swalley Irrigation District.

Crop	Acres	Percent of Total Area
Pasture Grass	1,365	32%
Hay	1,290	30%
Landscape	730	17%
Recreation/golf/parks/cemeteries	490	11%
Fallow	300	7%
Instream lease	60	1%
Nursery	40	1%
Vineyard	20	0%
Industrial	10	0%

Crop	Acres	Percent of Total Area
TOTAL	4,305	100%

Source: SID Field Survey 2016

Table 5-2. Parcel size within Swalley Irrigation District.

Parcel Size	Total Acreage Amount	Percent of Total Acreage in SID	Number of Patrons	Percent of Patrons
Small [0-6 acres]	1,219	28%	507	77%
Medium [6-11 acres]	648	15%	73	11%
Large [11+ acres]	2,438	57%	82	12%
TOTAL	4,305	100%	662	100%

Source: SID 2010

5.12.2 Zoning

The state of Oregon has 19 statewide planning goals that are directed by the Land Conservation and Development Commission (LCDC). These goals work in combination with state and local planning, zoning, and land-division ordinances. For example, Goal 3: Agricultural Lands (OAR 660-015-0000(3)) is designed "to preserve and maintain agricultural lands." This specifically utilizes local zoning to separate urban growth from agricultural lands. Bend's local planning efforts have been addressing this by creating an Urban Growth Boundary (UGB) and Urban Reserve Boundary (URB). These boundaries are set to control urban sprawl by mandating that the area inside the UGB be used for higher density urban development. This manages challenges posed by urban growth and the encroachment of cities upon agricultural and rural land. The UGB border identifies land that would be beneficial to urbanize. It generally represents and encompasses the space needed for potential growth for 20 years. It considers land needs for employment, housing, schools, and other urban infrastructure. The URB is land that is currently outside the existing UGB but is considered suitable for accommodating further urban development in longer-term city planning efforts.

SID supplies water to approximately 350 acres of irrigated land inside Bend's UGB and another 560 acres within Bend's URB (Table 5-3). This makes up approximately 21 percent of the total land served by SID. The remaining 3,395 irrigated acres are zoned Multiple Use Agricultural (MUA) or Exclusive Farm Use (EFU). The purpose of MUA and EFU zoned land is to preserve and maintain agricultural lands and to serve as a sanctuary for farm uses.

Table 5-3. Division of Swalley Irrigation District's land use according to zoning.

Land Use Type	Acres	Percent of Total Area
within Bend's Urban Growth Boundary	350	8%
within Bend's Urban Reserve Boundary	560	13%
Exclusive Farm Use and Multiple Use Agricultural	3,395	79%
TOTAL	4,305	100%

Source: Deschutes County Open Data 2017

5.12.3 Land Ownership

The majority of land within SID is privately owned. SID has documented easements and legal rights-of-way underlying all of its infrastructure. The majority of these legal easements and rights-of-ways are federally granted land patents from the late 1800s. The right-of-way easements for many of SID's canal and laterals were filed with the General Land Office in The Dalles, Oregon, in 1901 as

required by the 1891 Carey Land Act. In 1923, the General Land Office accepted and granted the easements to SID. According to the 1866 Homestead Act and the 1891 Desert Land Act, the easements set aside 50 feet from the marginal canal bank edge on each side for a total easement of 100 feet for the entire canal. Over the course of the last 100 years, there have been re-negotiations in specific areas with regards to SID's easements to make them more realistic for modern infrastructure, but they have continued to keep their easement coverage intact for the entire District. SID is engaged in continual efforts to re-map and re-survey its infrastructure and rights-of-way easements to track changes over time.

5.13 Cultural and Historic Properties

Under Section 106 of the National Historic Preservation Act of 1966 (NHPA), federal agencies must take into account the effects their projects may have on cultural resources that are listed on or eligible for listing on the National Register of Historic Places. Management of cultural resources and implementation of NHPA is delegated to SHPO offices in each state. The Swalley Ditch (Main Canal), Riley Lateral, and Rogers Lateral are all currently listed on the National Register for Historic Sites. This designation requires consultation with SHPO prior to any alterations to the canal and laterals. Cultural resource surveys will also be required prior to any ground or structural disturbance to ensure that there would be no impact to sites of cultural or historic value. Currently, the District has completed Section 106 requirements for all but the remaining 4.5 miles of its Main Canal.

In 2007, SID initiated a water conservation, fish passage, and energy conservation project. In 2009-2010 the first 5.1 miles of the Swalley Main Canal were replaced with pipe (Main Canal Pipeline). A hydroelectric facility was installed, and an agency-compliant fish screen was installed at the North Canal Dam. (A fish ladder was also constructed in 2017, one of the terms of allowance for being granted a hydroelectric in-conduit water right.) As a result, approximately 39 cfs were returned to the Deschutes River, and an annual average of 2.3 million kWh are now generated from the hydro facility. To mitigate loss of the historic Main Canal for this project, SID signed a Memorandum of Agreement (MOA) with SHPO in 2007, agreeing to leave the last 4.5 miles of the Main Canal in its current configuration. In October 2016, FCA and SID engaged in preliminary consultation with SHPO to discuss the previous MOA. In May 2017, the SHPO agreed that the 2007 MOA will need to be revised in order to pipe the remaining 4.5 miles of the Main Canal, but that all other canal segments and laterals in SID are covered by the existing MOA's mitigation terms and are Section 106 compliant. Refuse sites were found in the Main Canal project area during prior cultural resource surveys that were conducted for the previous Main Canal piping project, but nothing of significance was found in other locations surveyed. Further surveys will be completed in accordance with SHPO consultation requirements.

5.14 Recreation

There are very few recreational opportunities on and adjacent to SID facilities. Although maintenance roads adjacent to the canal and laterals are sometimes used by hikers, bikers, and runners, this use is not sanctioned by the District. The canal and laterals do not contain fish due to a functioning fish screen at North Canal Dam. Use of the canal and laterals to swim or float, and any other activities within the canal easement that are not a function of the District are strictly prohibited.

Areas that would be indirectly affected by the project due to increased flows include the Deschutes River from the North Canal Dam to Lake Billy Chinook. Part of this section of the Deschutes River is designated as a Wild and Scenic River. There are parks and campgrounds adjacent to the river.

The river and associated trails provide many types of recreation including: rafting, kayaking, floating, stand up paddle boarding, fishing, hiking, biking, and cross country skiing.

5.15 Socioeconomics

The project area falls wholly within Deschutes County and includes the communities of Bend, Redmond, and Tumalo. Generally, the project area has seen stable growth over the past 10 years (2005 to 2015). The county has grown by 19 percent between 2005 and 2015, while the state had a moderate growth rate of 8 percent during the same period of time. Table 5-4 shows population estimates for the state of Oregon; Deschutes County; and the nearby communities of Redmond, Bend, and Tumalo. The Oregon Office of Economic Analysis (OEA) estimates that Deschutes County could reach a population of 241,223 by 2040.

Table 5-4. Population characteristics, 2005 and 2015.

Area	Year 2005 Population (number of people)	Year 2015 Population (number of people)	Population Growth Rate 2005 to 2015	Year 2015 Population per Square Mile (number of people)
State				
Oregon	3,631,440	3,939,233	8%	40
County				
Deschutes	143,490	170,740	19%	56
Cities and Towns				
Redmond	20,010	27,450	37%	1,635
Bend	70,330	87,017	24%	2,615
Tumalo	393 (2010)	537	37%	314

Source: U.S. Census Bureau 2005 and 2015; U.S. Census Bureau 2010 data for Tumalo's population in 2005 was unavailable; population estimate shown is from 2010.

5.15.1 Area Employment, Income, and Agriculture

The economy within the project area is described by employment/unemployment numbers, employment by industry, income, and agricultural activity. There is a strong level of employment in the project area according to the U.S Census Bureau data for 2015. The unemployment rate for Deschutes County was 9.4 percent in 2015, which was just slightly higher than the state unemployment rate of 9.3 percent in 2015 (US Department of Labor 2016). As of 2015, there were approximately 74,599 paid employees in Deschutes County (U.S. Census Bureau 2015). Educational services, health care and social assistance provides the highest number of employment positions throughout the county (Table 5-5).

Table 5-5. Employment by industry and unemployment rates in the project area, 2015.

Employment Sectors	Oregon		Deschutes County	
	Number of People	Percent of Oregon Employment	Number of People	Percent of County Employment
Agriculture, forestry, fishing and hunting, and mining	60,424	3.4%	2,330	3.1%
Construction	99,157	5.5%	5,306	7.1%
Manufacturing	204,094	11.4%	6,403	8.6%
Wholesale trade	51,908	2.9%	1,358	1.8%
Retail Trade	215,805	12.1%	9,619	12.9%
Transportation, warehousing, and utilities	73,724	4.1%	2,013	2.7%
Information	33,058	1.8%	2,159	2.9%
Finance and insurance, real estate, rental, and leasing	102,145	5.7%	4,327	5.8%
Professional, scientific, management, and administrative and waste management services	190,080	10.6%	8,554	11.5%
Educational services, health care, and social assistance	413,562	23.1%	15,472	20.7%
Arts, entertainment, recreation, accommodation, and food services	176,909	9.9%	10,046	13.5%
Other services (except public administration)	88,177	4.9%	4,450	6.0%
Public administration	80,653	4.5%	2,562	3.4%
Total Employed- all sectors	1,789,696		74,599	
Unemployment rate		9.3%		9.4%

Source: U.S. Census Bureau 2015.

6 Technical Evaluations

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

- **Swalley Irrigation District System Improvement Plan.** Completed by SID and FCA in October 2016, this document describes the specific infrastructure requirements for modernization of SID's distribution system. This document is integral to the formulation of the proposed action and is attached to this PIR as an appendix.
- **Main Canal Lining Alternatives Downstream of Hydropower Plant to System Tail.** Completed in 2008 by BlackRock Consultants, this study evaluated the effectiveness and costs of lining SID's remaining sections of canal and laterals.

- **Swalley Irrigation District Hydropower Feasibility Report.** Completed by SID in December of 2007 and submitted to the Oregon Economic and Community Development Department prior to completing the design of the Ponderosa Hydropower Project.
- **Upper Deschutes Basin Study.** A collaborative effort between BOR 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 finished in 2018.
- **Deschutes Basin Multi-Species Habitat Conservation Plan.** The USFWS is currently working to complete a Habitat Conservation Plan (HCP) regarding potential effects on bull trout, middle Columbia River steelhead, Oregon spotted frog, and sockeye salmon, and Chinook salmon in Crook, Deschutes, Jefferson, Klamath, Sherman, and Wasco counties, Oregon.

7 Alternatives

7.1 Formulation Process

In order to determine the most viable alternatives to meet the project's purpose and need, NRCS and SID considered 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 current status of the District's previous improvements. Alternatives considered by SID during project development but proposed for elimination from detailed study due to lack of feasibility or lack of consistency with the project's purpose and need are discussed in Section 7.2. The Proposed Action Alternative is described in Section 7.3.1 and the No-Action Alternative is described in Section 7.3.2.

7.2 Alternatives Proposed for Elimination from Detailed Study

The following alternatives are suggested for elimination from the analysis due to not meeting all aspects of the purpose and need.

7.2.1 Exclusive Use of Groundwater for Irrigation

Exclusive use of groundwater has been considered in order to leave more surface water available in streams and rivers for habitat values. The exclusive use of groundwater would involve forgoing up to 29,855 acre feet per year (with a maximum rate of 87.217 cfs) of 1899 senior surface water rights and exclusively pumping groundwater to meet irrigation needs in the SID area. This alternative would likely require hundreds of wells that would each need a pump to draw water from the ground. The exclusive use of groundwater for irrigation is not a viable option for the following reason:

- This option would not increase the financial security and reduce the operation and maintenance costs. The power costs to the district to pump irrigation water from groundwater would exceed approximately $450,000 per year. This cost makes groundwater pumping economically infeasible compared to the annual costs (amortized construction plus operation and maintenance) of either piping or lining the existing canal and laterals.

7.2.2 Fallowing of Farm Fields

Fallowing of farm fields includes permanently or temporarily transferring water rights off of irrigated lands or not using water rights appurtenant to irrigated lands. Fallowing of farm fields would allow for less use of irrigation water and would therefore allow more water to be kept instream for habitat

uses. Fallowing of farm fields is not a viable option because it would not increase water supply reliability for the District.

7.2.3 On-Farm Efficiencies Only

The on-farm efficiencies only alternative includes only improving on-farm infrastructure (e.g., converting to center pivot irrigation or installing soil moisture sensors) and farm management practices (e.g., deficit irrigation). SID is responsible for delivering water to the traditional high point (or delivery point) of the land. The District's responsibility of moving 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 efficiencies only are not a viable option for the following reasons:

- The District is not able to implement on-farm efficiency upgrades because the on-farm infrastructure is owned by the individual land owner and is therefore a responsibility of the water user/patron.
- Health and safety. The human health and safety risk would remain unchanged, and drownings due to canals would remain a risk.
- This alternative would not increase the financial security and reduce operation and maintenance costs for the district.

7.2.4 Canal Lining

Canal lining involves the installation of an impervious system to cover the canal bottom and banks. Materials typically employed include geomembranes, rubber liners, shotcrete and/or similar materials. Canal lining increases canal capacity, improves command (velocity), makes the canal section stable, prevents bank erosion and breaches, assures economical water distribution, and reduces maintenance costs. Canal lining has a varying lifespan as short as 10 years and can require extensive maintenance to continue operating at high efficiency (Bureau of Reclamation 2002). Lined canals are vulnerable to tears or cracks in the lining substrate; when torn or cracked, leakage from lined canals is similar to that from unlined canals.

This alternative would require the reshaping of the current canals to a trapezoidal form, sub-grade preparation, installation of the liner, and applying a coating for protection. Canal lining is not a viable option for the following reasons:

- Health and safety. Canal lining does not meet the project's purpose and need of reducing risks to public safety as it leaves canals open and potentially accessible to the public.
- Financial Stability. Canal lining does not provide for pressurization, so it would not eliminate the need to pump water for on-farm applications and the associated energy use. Additionally, canal lining has a greater life-cycle cost than piping and pressurization. Over a 50-year life-cycle canal lining requires maintenance and replacement cycles that ultimately cause it to exceed the cost of piping over time.

7.3 Description of Alternatives Considered

7.3.1 Piping and Pressurization Alternative

The Piping and Pressurization Alternative is SID's Proposed Action and desired alternative. The District has determined through engineering analysis described in the District's SIP that this alternative is feasible and addresses the project's purpose and need. Under the Piping and

Pressurization Alternative, SID would replace the remaining 6.5 miles of its open Main Canal and 12.6 miles of open laterals with gravity or pumped-pressurized buried high-density polyethylene (HDPE) pipe (or polyvinyl chloride (PVC) pipe where needed for engineering reasons (Figure 5-2). Pipe diameters would range from 48 inches in the Main Canal down to 8 inches on smaller laterals.

The main construction tasks associated with this alternative include excavating trenches, pipe welding and placement, and backfill of the trenches. A full description including detailed pipe sizing, pipe materials, project alignment, water loss assessment, and hydraulic modeling of the system can be found in the SID SIP (SID 2016).

This alternative would provide the identified project purpose and need as follows:

1. Enhance habitat for aquatic species through increased stream flows in the Deschutes River. By increasing flows, the amount of habitat would increase and the water temperatures could decrease.
    - This alternative would improve stream flows and instream habitat. A piped and pressurized system would eliminate evaporation and seepage losses of up to 16 cfs. It reduces District water needs and provides opportunities for instream flow restoration, helping to insure the viability of anadromous and resident fish species.
    - This alternative would restore up to 16 cfs to the Deschutes River between North Canal Dam (RM 165) and Lake Billy Chinook (RM 120) from May 15 through September 15 through Oregon's Allocation of Conserved Water Program.
2. Reduce risks to public safety from the irrigation canals. Putting the diverted irrigation water into a pipe would ensure that the risk of drowning in the canals is eliminated.
    - This alternative would reduce risks to downstream life and property. Open, unlined canals have the potential to fail, causing flooding and risking downstream life and property. Even without canal failure, there is an ongoing risk of drowning. Piping canals eliminates these risks.
3. Support and maintain existing agricultural land uses through enhanced water supply reliability. The conserved water would provide irrigators with pressurized water when they need it and would also return more water instream.
    - This alternative would improve irrigation water supply reliability. Eliminating seepage and evaporative losses through a piped and pressurized system greatly increases conveyance efficiency. It allows the District's patrons to receive the water that they need when they need it by providing pressurized water, ensuring the sustainability of the District's agricultural water supply and other beneficial uses.
    - With a piped and pressurized system, patrons will be able to better manage their own water to meet their specific crop needs. Patrons will be able to adjust their deliveries up to or down from their full legal rate by opening or closing a valve on a pressurized pipe, similar to turning on and off a faucet in a kitchen sink. Rather than taking their full rate 24 hours a day, 7 days a week, patrons can adjust their deliveries to take only the water they need. The fully piped system will automatically backwater and leave any unneeded water in the river.
4. Provide financial stability to SID through reduced operation and maintenance costs and conserve energy through the reduction of irrigation pumping.
    - This alternative would reduce energy use and associated costs. A pressurized pipeline allows for the elimination of individual pumps and the conservation of

approximately 1.1 million kWh/year across the District and eliminate tens of thousands of dollars per year in individual pump maintenance and repairs.

- Modernization will change how SID invests in operations and maintenance. A fully piped system will eliminate the need to inspect, repair, and remove obstructions from open canals and laterals. Buried pipe requires extremely little maintenance and does not allow for obstructions such as tree limbs, leaves, garbage, or other types of debris from entering and clogging the District's system. Modernization will allow the District to focus on delivering precise amounts of water to its patrons when they need it rather than continually managing, maintaining, and repairing its aging delivery system.

7.3.2 No Action Alternative (Future without Project)

Under the No Action Alternative, SID would not install piping on its remaining open canal and laterals. Construction activities associated with the project would not occur, and the District would continue to operate and maintain its existing canal, lateral, and pipe system in its current condition. The need for the project would still exist, and the District would continue replacing open canal and laterals with buried pipes on a project-by-project basis as funding becomes available. After over 20 years of aggressive conservation efforts, the District has completed several water conservation and pressurized pipe projects. These include the installation of HDPE pipe in approximately 5.1 miles of its Main Canal and in several laterals stemming from its Main Canal. These completed projects have greatly benefitted fish and farmers. However, the primary system continues on in an open-channel earthen canal for an additional 6.5 miles beyond these piped sections to its terminus. An additional 12.6 miles of laterals remain open and unpiped. Lack of available funding and increased operation and maintenance costs associated with managing a mostly 117-year-old open conveyance system severely limits District progress towards modernizing its infrastructure.

Under this alternative, there would be no water savings from irrigation improvements. Instream flows would not be enhanced for fish and other wildlife. Energy use and cost would remain high. Without pressurized water, the current individual pumps would continue to require an estimated 2.45 million kWh/year. Agriculture in the area would decline due to continued inconsistent water supply and to increased production costs. Increased competition for water resources, regulation, and litigation would continue and hinder agricultural production within the District.

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

- Enhanced habitat for aquatic species: This alternative would not improve instream flows and instream habitat.
- Reduce risks to public safety from open irrigation canals: This alternative would not reduce risks to downstream life and property. Unlined canals would still have the potential to fail, causing flooding and risking downstream life and property. The No Action Alternative does not address safety and drowning risks associated with canals.
- Support and maintain existing agricultural uses through enhanced water supply reliability: This alternative maintains existing operations and infrastructure and would not improve irrigation water supply reliability.
- Provide financial security to SID through reduced operation and maintenance costs and conserve energy through the reduction of irrigation pumping: This alternative would continue existing energy use and associated costs. The use of individual pumps would require an energy use of over 2.45 million kWh/year across the district.

7.4 Economics

This section is a preliminary economic investigation of the benefits of the proposed project. Following the completion of the PIR, during the project's NEPA review, a National Economic Development analysis will be completed for the project. Preliminary estimates of project costs are approximately $15 million. Based on preliminary information, the benefits (including improved habitat conditions, improved public safety, district financial security, and the value of maintaining irrigated agriculture) total approximately $18 million. Descriptions of further analyses regarding each of the benefits resulting from the needs are provided below; the value of these benefits will be refined and recalculated following completion of the SID PIR. The alternative that maximizes the net economic benefit will be the preferred alternative.

Prior to irrigation development on the Deschutes River, the river was characterized by very constant, year-round stream flows (see Section 5.2). As a result of altered hydrology due to irrigation diversions, stream flow extremes, particularly low seasonal flows, have changed the hydrograph and associated aquatic habitat conditions in the Deschutes River. Returning water to the Deschutes River by decreasing irrigation withdrawals may improve these aquatic habitat conditions.

Three primary types of economic values to people living, visiting, or working along the Deschutes River that may result from increased stream flow in the Deschutes are expected: value of aquatic and riparian species and their habitats separate from recreation; recreation values; and aesthetic values. These three values will be fully analyzed as a part of the economic component of the project's NEPA review.

7.4.1 Human Health and Safety

Economic benefits include removal of the drowning risk from exposed canals. This analysis will include:

- Value of the risk of drowning death per exposed irrigation canal mile based on the recent history of drownings and the mileage of exposed canals within the District; and
- Value of increased public safety with a reduced risk of drowning deaths. These data are the 'value of a statistical life' (VSL) or the value of reducing mortality risks. The VSL is not the monetary value of any given life, but rather it is a measure of how much people are willing to pay to reduce their risk of death by a very small amount.[2] VSL is often estimated based on the wage premium paid to workers engaged in more hazardous work (controlling for other factors that affect wages). These two figures would be combined to provide an estimate of the public safety value of the proposed project.

7.4.2 Value of Maintaining Irrigated Acreage

Typically, economic analyses of the value of irrigation water focus on how the availability of water affects the net returns to farmers. The economic analyses focus on how farm profit changes, due to changes in acreage harvested or changes in crop yields, as irrigation water supplies change. This is appropriate for commercial farms with the objective of maximizing profits. SID estimates that

2 Using an example provided by the EPA: Imagine a group of 100,000 people were asked how much they would be willing to pay to reduce their individual risk of dying by 1 in 100,000 (0.001 percent, or one fewer death in the group). If the average response to this question was $100, than the group's value of avoiding the risk of one death (i.e. VSL) is $10 million ($100 per person × 100,000 people = $10 million).

approximately 62 percent of district acreage (2,655 acres) is in hay or pasture, while nearly all other acreage is in landscaping. The landscaping is either for private or public use such as sports facilities or parks, accounting for 1,220 acres or 28 percent of SID irrigated acreage. Approximately 300 acres are estimated to be fallowed.

Given that the vast majority of SID irrigation is used for non-commercial purposes, measuring the market-based profit potential of crops or animals produced per acre-foot of water is not an appropriate measure of value to SID patrons. Rather, it is appropriate to identify the value to SID patrons of access to irrigation water. This economic analysis will focus on the difference in price of lands with and without access to water located in SID and other irrigation districts within and close to the Bend Urban Growth Boundary. This analysis would provide the average value of the water rights appurtenant to the land, which on a per-acre-foot value basis may be higher than the incremental value of reducing irrigation on the same land by one or two acre-feet.

Conceptually, the average value of irrigation water rights is reflected in the additional price that people are willing to pay for a property with water rights, over and above what they would be willing to pay for an otherwise identical property without water rights. In practice, statistical analyses can be performed to estimate the relative effect of different property characteristics, including water rights, on sales price.

7.4.3 District Financial Security

The economic analysis of SID's financial security would quantify many factors to estimate the potential financial costs of operating the district. These factors would include: groundwater recharge costs, energy cost savings, carbon benefits, operation costs, and potential increases to hydropower generation. These costs and savings will be estimated to help determine the overall changes to long-term cost effectiveness of the proposed project.

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9 Appendix

Swalley Irrigation District System Improvement Plan