3. Planning Step 3: Quantify Existing & Future Needs/Demands

Chapter 3 quantifies and summarizes the existing and future needs and demands for water in the Upper Deschutes Basin. Much of this analysis was completed in 2019 as part of the Upper Deschutes Basin Study. The Basin Study evaluated hydrologic information and utilized water resources modeling to help quantify water supply shortages for the "three legs of the stool," agricultural, municipal, and instream and out-of-stream (i.e., wetlands) ecological water demands. As used in the Basin Study and in this Plan, the term *shortage* indicates a difference between a modeled water supply objective and the modeled water deliveries (Bureau of Reclamation and Oregon Water Resources Department 2019). **Note that the Basin Study included the Crooked River and Whychus Creek, and thus covered a broader geography than that of Phase I of this Plan. However, the relativity of shortage statistics between uses remains true for the Upper Deschutes Basin planning area as defined under this Plan.** The Crooked River and Whychus Creek will be the focus of future place-based planning efforts in the broader Deschutes River basin.

For the Basin Study, observed hydrologic data were used in hydrologic and water resources modeling to evaluate instream and agricultural water supply shortages for conditions representative of the current situation in the basin. Projected needs for municipal and quasi-municipal water suppliers were developed based on analyses of future demand and available supplies. Ecological shortages relative to instream flows were also informed by flow-habitat and temperature assessments.

The Basin Study Working Group (BSWG) determined that integrated solutions involving multiple tools are needed to address water needs for the three legs of the stool required to support achievable and sustainable water management in the Upper Deschutes River Basin. The three legs of the stool refer to the three major instream and out-of-stream demands for water in the Basin: agricultural needs, municipal/quasi-municipal needs, and instream/ecological needs. These three categories of water needs are described below:

- Instream water needs for ecological objectives are affected by low and altered streamflows that result from storage of water and diversions for agricultural uses, and, to a lesser degree, from groundwater pumping for municipal, industrial, and commercial uses. Species of concern relative to ecological objectives of this Plan include redband trout throughout the Upper Deschutes Basin and the Oregon Spotted Frog (OSF) in the Upper Deschutes River, Little Deschutes River, and Crescent Creek. Locations of the Deschutes River, Tumalo Creek, and other waterways in the study area (outlined in red) are shown in Figure 1~~Figure 1~~.

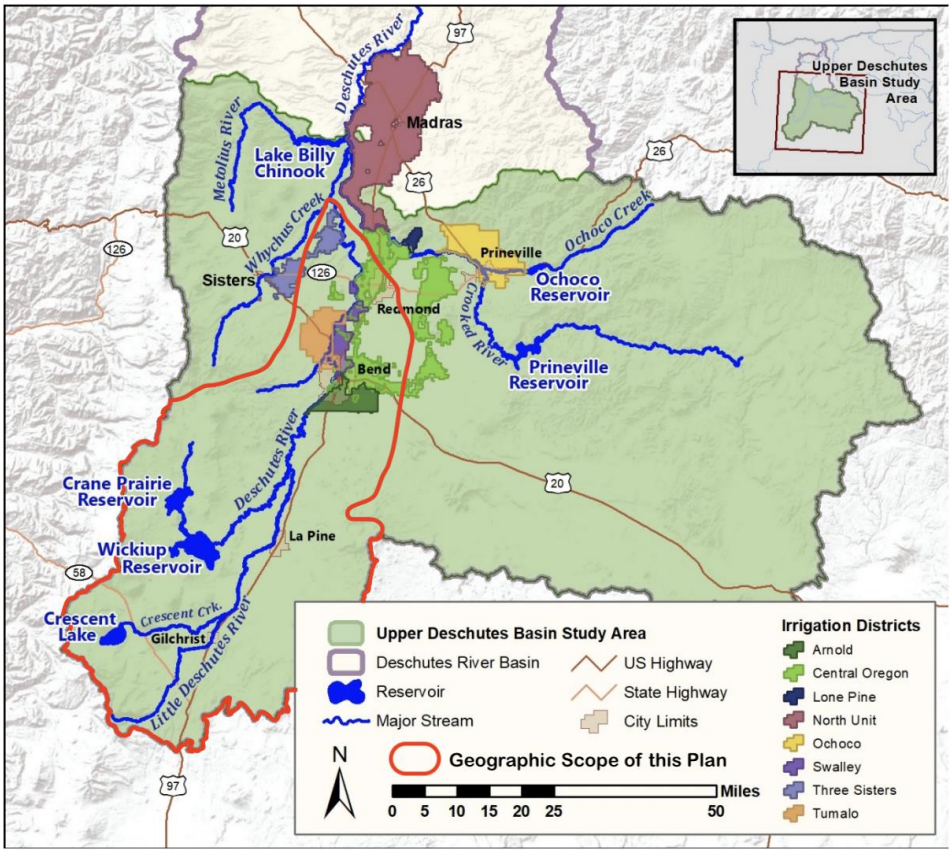
- Agricultural water uses include diversions from rivers and streams by eight irrigation districts in the basin. The broader geography covered by the Basin Study covers the six irrigation districts described in Section **Error! Reference source not found.**~~2.1.7~~ plus two districts that are outside the geographic scope of this Plan. Water stored in reservoirs during winter months is released during irrigation season for use by some of these irrigation districts. Districts with junior water rights, such as NUID, are relatively less

Formatted: Highlight

secure in their water supply. Figure 1~~Figure 1~~ illustrates the locations of irrigation districts, reservoirs, and other key features of the study area.

- Municipal and quasi-municipal water users largely rely on groundwater sources. Since 1995, new water rights for groundwater use in the basin require mitigation credits per the Deschutes Basin Groundwater Mitigation Program (OAR 690-505). Mitigation credits can be generated by transferring water from out-of-stream use to instream flow in the Middle Deschutes to offset each acre-foot of additional groundwater pumping from any new permit. The locations of key cities in the study area are shown in Figure 1~~Figure 1~~.

Figure 1. Map of the Upper Deschutes Basin Study Area. The geographic scope (Planning Area) of this Plan is outlined in red.



The Basin Study defined the following three broad objectives for water management in the Upper Deschutes Basin to meet the needs of each of the three legs of the stool (Bureau of Reclamation and Oregon Water Resources Department 2019):

Formatted: Highlight

Formatted: Highlight

- Increased streamflows and improved water quality for the benefit of fish, wildlife, and people.
- A reliable and affordable water supply to sustain agriculture.
- A safe, affordable, and high-quality water supply for municipal and quasi-municipal water users.

Significant elements of the Basin Study and other analyses, which quantify existing and future water demands/needs in the Upper Deschutes Basin, are described in this Chapter.

3.1 Instream/Ecological Functions

Instream demands for water exist to support ecological objectives for the protection or enhancement of instream and adjacent aquatic habitats (i.e., wetlands and groundwater-dependent ecosystems) for critical species of concern. Species of concern relative to ecological objectives of this Plan include redband trout and mountain whitefish throughout the Upper Deschutes Basin and the Oregon Spotted Frog (OSF) in the Upper Deschutes River, Little Deschutes River, and Crescent Creek. Ecological objectives are affected by low and altered streamflows that result from the storage of water and diversions for agricultural uses, and, to a lesser degree, from groundwater pumping for municipal, industrial, and commercial uses. Unnaturally low winter flows limit overwintering habitat and survival and access to spawning habitat for trout and whitefish species. Low flows in winter cause OSF habitat in adjacent wetlands to become disconnected from the river channel, stranding frogs. In the summer, high flows cause scour which impacts aquatic habitat for both OSF and fish species.

Existing demands for the instream leg of the stool consist of existing instream water rights applied for by one of three State agencies (ODFW, ODEQ, and OPRD) and approved by the Oregon Water Resources Department (OWRD). These instream water rights provide only a starting point for understanding instream demands and do not represent the range of needs required to fully meet ecological objectives in the basin. Environmental specialists in the basin (i.e., ODFW) have worked to develop other approaches to assist in determining the true range of ecological water needs. Moreover, USFWS has documented flow needs of the Oregon Spotted Frog in their 2020 Biological Opinion on the Deschutes Basin Habitat Conservation Plan (HCP). While these efforts help provide a more robust understanding of water needs for the instream leg of the stool, some information gaps remain on the relationship between flow and habitat restoration for OSF needs and on the groundwater component of instream water demand. Efforts to understand the flow-habitat components of ecological water needs will need to consider the findings from US Fish and Wildlife Service's ongoing OSF Recovery Planning process. Similarly, the groundwater component of instream demand will need to consider the new groundwater allocation rules being developed by the Oregon Water Resources Department (OWRD). The outcomes from these processes are forthcoming at the time of writing of this Plan.

3.1.1 Existing Demands – Surface Water

Current demands for instream flow in the Upper Deschutes Basin include flow amounts protected by existing certificated instream water rights (ISWRs) and by the State Scenic Waterways (SWW) Act. Note that these demands do not reflect actual instream/ecological flow needs – Section 3.1.3 describes other sources of information (modeling efforts and both

regulatory and non-regulatory ecological flow targets) which have been developed to provide a better estimation of actual ecological water needs.

ISWRs are water rights that were applied for by ODFW and approved by OWRD for the instream beneficial use of fish and aquatic life under Oregon's Instream Water Rights Act of 1987. The purpose of ISWRs is to protect a baseline of instream flow against future appropriators to maintain water instream for the public beneficial use for which that right was applied (e.g., for the conservation, maintenance, and enhancement of aquatic and fish life, wildlife, and fish and wildlife habitat). These rights and applications specify certain flow amounts in cubic feet per second (cfs) for certain reaches of the mainstem Deschutes River and its tributaries during certain months of the year. Since ISWRs applied for by state agencies were established after the Instream Water Rights Act of 1987, they usually have more junior priority dates than other out-of-stream water rights on a given reach. Under the water rights administration system of prior appropriation, this means that other, higher priority rights will be satisfied first, so voluntary transactions with the senior water rights holders are required to meet certified ISWR flow amounts.

ODFW has applied for and received instream water rights to support aquatic life in 30 reaches of the Upper Deschutes Basin (Figure 2~~Figure 2~~). Of these, 29 of them are certificated water rights and one – for the reach on the mainstem Deschutes River from North Canal Dam to Round Butte Reservoir – has been protested. Certified instream water rights are summarized in the darker green rows and instream water right applications amounts are listed in the lighter green rows in Table 1~~Table 1~~. In its review process, OWRD often reduces the certificated flow amounts from the initial application amount, so certificated flow amounts listed below do not represent the species-dependent needs that were assessed and used to apply for the ISWR. Note that Table 1~~Table 1~~ includes instream water rights applied for by state agencies and converted minimum perennial streamflows but does not include instream transfers. Minimum perennial streamflow conversions are those with priority dates prior to 1987 (the first three certificated rights in Table 1~~Table 1~~), and instream transfers maintain the priority date of the original water right, which can date back to the 1800s.

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

Formatted: Font: (Default) Times New Roman

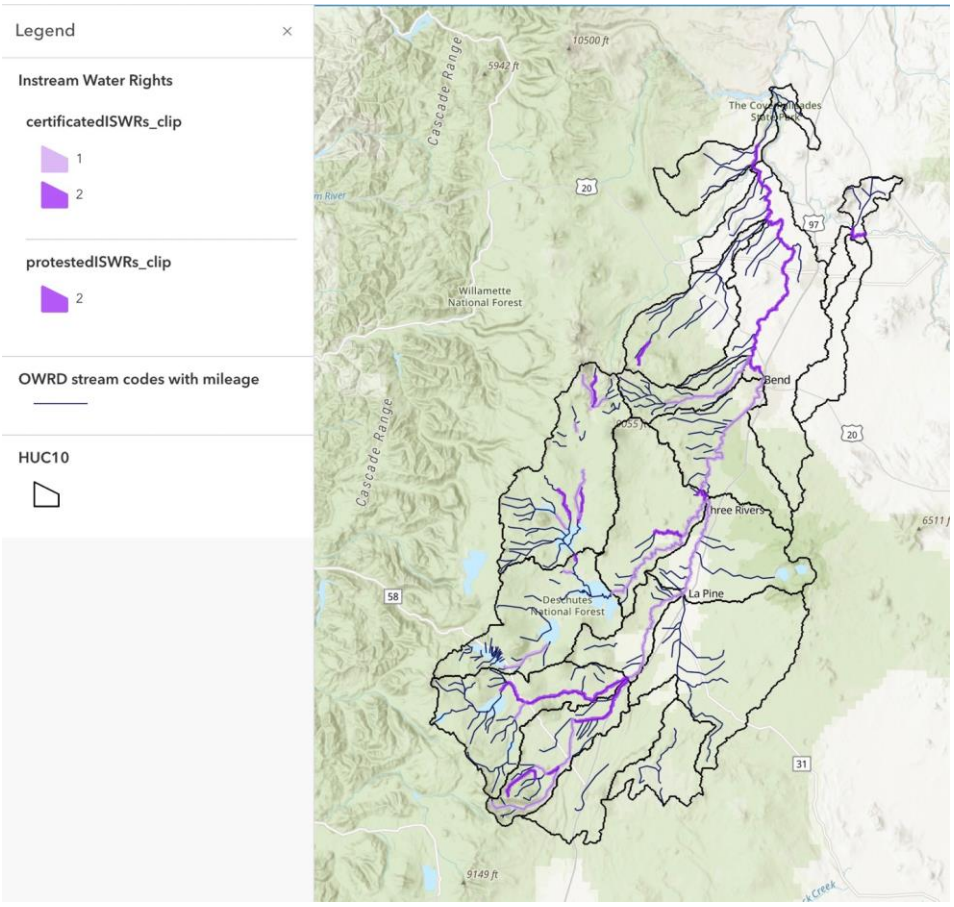
Formatted: Font: (Default) Times New Roman

Table 1. Summary of ISWR certificates and applications in the Upper Deschutes River. Darker green rows are certificated instream water rights and lighter green rows are instream water right application amounts.

ISWR #	Stream Name	Reach	Priority Date	Certificate #	Flow Amounts and Timing (in cfs)											
					Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
MF-198	DESCHUTES R > COLUMBIA R	FROM THE LITTLE DESCHUTES RIVER TO THE CONFLUENCE OF SPRING RIVER	11/3/83	59777	400	400	400	400	400	400	400	400	400	400	400	400
MF-197	DESCHUTES R > COLUMBIA R	FROM SPRING RIVER TO THE NORTH CANAL DAM	11/3/83	59778	660	660	660	660	660	660	660	660	660	660	660	660
Application	DESCHUTES R > COLUMBIA R	FROM NORTH CANAL DAM TO ROUND BUTTE RESERVIOR	9/24/90	n/a	250	250	250	250	250	250	250	250	250	250	250	250
MF-199	DESCHUTES R > COLUMBIA R	FROM WICKIUP RESERVOIR TO THE CONFLUENCE OF THE LITTLE DESCHUTES RIVER	11/3/83	8/28/63	300	300	300	300	300	300	300	300	300	300	300	300
IS-70764	DESCHUTES R > COLUMBIA R	FROM CRANE PRAIRIE RESERVOIR TO WICKIUP RESERVOIR	10/11/90	7/2/00	130	130	130	130	130	130	130	130	130	130	130	130
Application	DESCHUTES R > COLUMBIA R	FROM CRANE PRAIRIE RESERVOIR TO WICKIUP RESERVOIR	10/11/90	n/a	130	130	130	130	130	130	130	130	130	130	130	130
IS-70763	DESCHUTES R > COLUMBIA R	FROM LITTLE LAVA LAKE TO CRANE PRAIRIE RESERVOIR	10/11/90	73232	60	60	94	96	100	60	60	60	100	100	100	100
Application	DESCHUTES R > COLUMBIA R	FROM LITTLE LAVA LAKE TO CRANE PRAIRIE RESERVOIR	10/11/90	n/a	60	60	100	100	100	60	60	60	100	100	100	100
IS-70752	TUMALO CR > DESCHUTES R	FROM SOUTH FK TUMALO CREEK TO THE MOUTH	10/11/90	73222	47	47	69	77	82	47	32	32	9/1-15: 32; 9/16-31: 47	65	47	47
Application	TUMALO CR > DESCHUTES R	FROM SOUTH FK TUMALO CREEK TO THE MOUTH	10/11/90	n/a	47	47	82	82	82	47	32	32	9/1-15: 32; 9/16-31: 47	87	47	47
IS-70757	LITTLE DESCHUTES R > DESCHUTES R	FROM CRESCENT CREEK TO THE MOUTH	10/11/90	73226	200	200	236	240	240	200	126	75	92	116	164	196
Application	LITTLE DESCHUTES R > DESCHUTES R	FROM CRESCENT CREEK TO THE MOUTH	10/11/90	n/a	200	200	240	240	240	200	135	135	135	135	240	240
IS-70758	LITTLE DESCHUTES R > DESCHUTES R	FROM UNNAMED TRIBUTARY (24.00S-8.00E-23-SW NE; River mile: 72.00) TO CRESCENT CREEK	10/11/90	73227	53	60	62	75	75	60	40	37	35	35	37	40
Application	LITTLE DESCHUTES R > DESCHUTES R	FROM UNNAMED TRIBUTARY (24.00S-8.00E-23-SW NE; River mile: 72.00) TO CRESCENT CREEK	10/11/90	n/a	60	60	75	75	75	60	40	40	40	40	75	75
IS-70759	LITTLE DESCHUTES R > DESCHUTES R	FROM THE HEADWATERS TO UNNAMED TRIBUTARY (24.00S-8.00E-	10/11/90	73228	34	34	45	62	68	34	34	34	33	33	35	38
Application	LITTLE DESCHUTES R > DESCHUTES R	FROM THE HEADWATERS TO UNNAMED TRIBUTARY (24.00S-8.00E-	10/11/90	n/a	34	34	68	68	68	34	34	34	34	68	68	68
IS-70765	CRESCENT CR > LITTLE DESCHUTES R	FROM CRESCENT LAKE TO THE MOUTH	10/11/90	73234	75	75	125	125	125	75	50	50	50	50	108	125
Application	CRESCENT CR > LITTLE DESCHUTES R	FROM CRESCENT LAKE TO THE MOUTH	10/11/90	n/a	75	75	125	125	125	75	50	50	50	50	125	125

***NOTE: this table does not include all ISWR certifications and applications in the DBWC Planning Area, there are additional ISWRs on smaller tributaries to Crescent Creek and the Little Deschutes River that are not included here. These rights can be seen on the reaches highlighted below in Figure 2.**

Figure 2. Map of reaches with ISWRs (certificated and protested) in the Upper Deschutes Basin (from ODFW spatial tool).



The Oregon Water Resources Commission (OWRC) has adopted SWW flow protections in addition to instream water rights. SWW flows are intended to protect the free-flowing character of waterways to maintain flow quantities necessary for recreation and fish and wildlife uses. SWW applications and amounts are summarized in **Error! Reference source not found.**~~Table 2~~. Given the one-to-one hydraulic connection between surface and groundwater, new appropriations of groundwater must also maintain SWW flows, which is the basis for the Deschutes Groundwater Mitigation Program.

Table 2. SWW flow applications and amounts in the Upper Deschutes Basin Planning Area.

SWW Application #	Stream Name	Reach	Flow Amounts and Timing (in cfs)											
			Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
SY90503A	DESCHUTES R > COLUMBIA R	FROM WICKIUP RESERVOIR TO THE CONFLUENCE OF THE LITTLE DESCHUTES RIVER	400	400	400	500	500	500	500	500	500	500	400	400
SY90504A	DESCHUTES R > COLUMBIA R	FROM SPRING RIVER TO THE NORTH CANAL DAM	660	660	1000	1000	1600	1600	1600	1600	1600	1000	660	660
SY90505A	DESCHUTES R > COLUMBIA R	ABOVE BUCKHORN CANYON	500	500	500	500	250	250	250	250	250	500	500	500

3.1.2 Existing Demands – Groundwater

While it has been well understood that groundwater provides significant contributions to surface water flow in the Upper Deschutes Basin, ongoing state groundwater allocation rulemaking is defining reasonably stable groundwater levels and assessments of potential interaction/impact of new groundwater permits on surface water. More information may be needed on water quality issues related to groundwater.

3.1.3 Future Needs – Surface Water

The instream/ecological need for surface water goes beyond what has been protected through existing ISWRs and SWW flows. Often, certified ISWR flow amounts do not reflect the actual amount that ODFW requested in its applications as the minimum necessary to support the beneficial use (i.e., management objective) applied for. This is because OWRD, through implementation of their instream rules for ISWRs, often reduces ODFW's biologically based instream water right application amounts to the 50th percentile flow. Thus, the flow amounts requested in ODFW applications provide a better baseline for determining instream flow needs than the certificated flow amounts. The DBWC Ecological Needs Technical Committee gathered information on application amounts by stream reach in the Upper Deschutes Basin, which are summarized in the light green rows in Table 1~~Table 1~~ above.

Formatted: Font: (Default) Times New Roman

Using ISWRs, or even application amounts, as a proxy for instream water needs has its limitations. Under ODFW instream rules (OAR 635-400; last modified in 1989), the amounts of instream flow that can be applied for must be limited to the "minimum quantity of water necessary to support the public use requested by an agency" (OAR 537.322(2)). It is important to note that the definition of "minimum" here does not mean the absolute minimum flow that can sustain a population, but rather the minimum necessary to serve the management objective of the applicant agency (from hearing transcripts/testimony from 1995 Legislative Hearing and Work Sessions for SB 674). As a result, application amounts have historically not been utilized to include the full range of flows needed for ecosystem health, including seasonally varying flows or temperature-based flows that provide important habitat formation and maintenance functions (Oregon Department of Fish and Wildlife 2023). As mentioned above, the ability to meet ISWRs – even those which are certified – is also limited by having junior priority dates relative to other water rights holders.

Commented [AE1]: How to properly cite this info

Due to the limitations on using ISWRs to estimate instream flow needs, ODFW has worked on developing other methods for better characterizing the range of instream flow needs. The result was the development of a **modified presumptive standard,** which provides a range of monthly flows to consider for planning purposes for areas where previous instream flow studies are not

available. ODFW encourages using ISWRs where they exist in conjunction with the modified presumptive standard to more fully understand and better characterize the full range of instream flow needs. The presumptive standard proposed by Richter et al. (2011), is based on a summary of case studies of four rivers that found that recommendations for flow protection typically resulted in a range of allowable cumulative depletion of 6% to 20% of normal to low flows (Richter et al. 2011). The modified presumptive standard used by ODFW in the Deschutes Basin is defined as a range from 80% of the natural (pre-diversion) median streamflow to the median flow to maintain a moderate-to-high level of ecological function (Table 3~~Table 3~~) (Oregon Department of Fish and Wildlife 2023). Natural, or unregulated, median streamflow used as the basis for the modified presumptive standard was modeled by the Bureau of Reclamation using the Riverware software program. Riverware Unregulated Flows (RUF) were determined for many reaches in the Upper Deschutes Basin and are conceptually similar to OWRD's Water Availability Analysis (WAA) Natural Flows calculations. However, the locations at which they are calculated do not always align – RUF estimates are calculated at stream gages and Natural Flows estimates can be calculated at any point along a reach. In reaches where there are neither RUF nor WAA estimates available, stream gage data may be available instead.

Formatted: Font: (Default) Times New Roman, Highlight

Table 3. Summary of modified presumptive standard and unregulated flows calculated for various reaches in the Upper Deschutes Basin.

Stream name	Reach Description	Target flow type	Flow Amount (cfs)																							
			January		February		March		April		May		June		July		August		September		October		November		December	
			Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End	Beg.	End
DESCHUTES R > COLUMBIA R	FROM NORTH CANAL DAM TO ROUND BUTTE RESERVIOR	80% of Median RUF	876	835	832	835	878	943	988	1052	1173	1206	1191	1130	1104	1116	1129	1168	1138	1146	1064	1024	926	903	878	842
		Median of RUF	1094	1043	1040	1043	1098	1178	1235	1314	1466	1508	1489	1412	1380	1395	1411	1460	1422	1432	1330	1280	1157	1129	1098	1052
		OWRD WAA	1250	1250	1270	1270	1270	1270	1430	1430	1530	1530	1610	1610	1280	1280	1250	1250	1280	1280	1310	1310	1250	1250	1270	1270
DESCHUTES R > COLUMBIA R	FROM THE LITTLE DESCHUTES RIVER TO THE CONFLUENCE OF SPRING RIVER	80% of Median RUF	617	586	584	579	629	682	721	807	935	970	952	907	913	929	933	985	955	930	848	781	682	661	638	597
		Median of RUF	772	733	730	723	787	853	901	1009	1169	1213	1189	1134	1142	1161	1166	1232	1194	1163	1059	976	853	826	798	746
		OWRD-WAA	1040	1040	1060	1060	1060	1060	1190	1190	1280	1280	1340	1340	1070	1070	1040	1040	1070	1070	1090	1090	1040	1040	1060	1060
DESCHUTES R > COLUMBIA R	FROM SPRING RIVER TO THE NORTH CANAL DAM	80% of Median RUF	866	828	829	835	881	932	972	1033	1136	1202	1182	1127	1090	1104	1111	1151	1123	1147	1094	1022	910	894	867	831
		Median of RUF	1082	1035	1036	1044	1102	1165	1215	1291	1420	1502	1478	1409	1363	1380	1389	1439	1404	1433	1368	1278	1138	1118	1083	1039
		OWRD WAA 50% Flow	1344	1344	1366	1366	1366	1366	1538	1538	1645	1645	1731	1731	1376	1376	1344	1344	1376	1376	1409	1409	1344	1344	1366	1366
DESCHUTES R > COLUMBIA R	FROM WICKIUP RESERVOIR TO THE CONFLUENCE OF THE LITTLE DESCHUTES RIVER	80% of Median RUF	438	411	412	396	411	414	438	480	545	621	647	663	718	771	795	836	817	772	706	623	532	497	468	447
		Median of RUF	548	514	515	495	514	518	547	600	681	776	809	828	897	963	993	1045	1021	966	882	779	665	621	585	559
DESCHUTES R > COLUMBIA R	FROM CRANE PRAIRIE RESERVOIR TO WICKIUP RESERVOIR	80% of Median RUF	173	164	172	173	171	179	205	220	259	277	284	259	249	242	250	253	231	231	209	208	186	186	185	169
		Median of RUF	217	205	215	216	214	224	256	275	324	346	355	323	311	302	312	317	289	289	262	260	232	233	232	212
DESCHUTES R > COLUMBIA R	FROM LITTLE LAVA LAKE TO CRANE PRAIRIE RESERVOIR	80% of Gaged Flow (1989-2018)	78	76	74	72	71	72	74	76	80	80	80	81	83	86	98	99	107	104	94	86	85	82	81	81
		Median of Gaged Flow (1989-2018)	96	90	87	84	83	83	83	89	98	108	108	128	140	154	166	169	167	166	151	141	130	122	112	103
TUMALO CR > DESCHUTES R	FROM SOUTH FK TUMALO CREEK TO THE MOUTH	RUF Median at Mouth	76	75	72	81	68	69	78	92	134	175	183	157	130	97	76	69	67	67	68	69	71	79	72	77
LITTLE DESCHUTES R > DESCHUTES R	FROM CRESCENT CREEK TO THE MOUTH	80% of Median RUF	80	70	80	92	113	156	204	239	288	276	251	164	99	68	46	52	41	62	53	64	53	65	77	62
		Median of RUF	101	88	100	114	141	196	255	299	360	345	314	205	124	85	57	65	52	78	66	80	66	81	96	77
		OWRD-WAA Median	204	204	244	244	236	236	331	331	388	388	311	311	126	126	75	75	92	92	116	116	164	164	196	196
CRESCENT CR > LITTLE DESCHUTES R	FROM CRESCENT LAKE TO THE MOUTH	RUF Median	3	3	3	3	7	8	27	42	71	88	99	66	47	32	26	32	23	29	15	18	3	3	2	3

In addition, Section 9 of the Endangered Species Act (ESA) prohibits 'take' of listed species and Section 10 provides mechanisms for obtaining incidental take permits for three species listed as threatened in the Deschutes Basin: Oregon Spotted Frog (OSF), Middle Columbia River steelhead, and bull trout (U.S. Fish and Wildlife Service 2020). In response to ESA liabilities, eight irrigation districts in the basin (collectively the Deschutes Basin Board of Control, DBBC) and the City of Prineville developed the Deschutes River Basin Habitat Conservation Plan (HCP), which was then approved by the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). The HCP outlines habitat conservation measures that must be implemented, including minimum requirements for ecological flows in certain reaches during certain times of the year (Table 4~~Table 4~~). Conservation measures and minimum ecological flows in the HCP were negotiated between the responsible parties, and do not necessarily reflect actual instream flow needs for OSF. Some of the HCP flow requirements increase over the 30-year implementation timeline. For example, the HCP minimum winter flows (from Sept 16 – March 31) in the Deschutes River below Wickiup Dam are 100 cfs in implementation years 1-7, 300 cfs in years 8-12, and between 400 and 500 cfs in years 13-30 ("Deschutes River Basin Habitat Conservation Plan" 2020). A subsequent Biological Opinion (BiOp) issued by USFWS and NMFS approved the conservation measures and flow objectives outlined by the HCP.

Formatted: Font: (Default) Times New Roman, Highlight

Table 4. Deschutes River Basin Habitat Conservation Plan (HCP) flow objectives.

Reach	Implementation years	Minimum Flow Requirement (cfs)	Time of Year
Deschutes River at Bend	All	250	During storage season only - Nov 1-Mar 31
Deschutes River below Wickiup	Years 1-7	100	Sept 16-March 31
Deschutes River below Wickiup	Years 8-12	300	Sept 16-March 31
Deschutes River below Wickiup	Years 13-30	400-500	Sept 16-March 31
Deschutes River Below Crane Prairie at gage 14054000	All	75	Year-round
Crescent Dam to Little Deschutes confluence with Deschutes River	Years 1-15	10	Year-round, +/- 1 cfs in storage season (Nov 1 - March 31), +/- 5 cfs in irrigation season (Apr 1 - Oct 31)
Crescent Dam to Little Deschutes confluence with Deschutes River	Years 16-20	11	Year-round, +/- 1 cfs in storage season (Nov 1 - March 31), +/- 5 cfs in irrigation season (Apr 1 - Oct 31)
Crescent Dam to Little Deschutes confluence with Deschutes River	Years 21-30	12	Year-round, +/- 1 cfs in storage season (Nov 1 - March 31), +/- 5 cfs in irrigation season (Apr 1 - Oct 31)

The HCP and subsequent Biological Opinion (BiOp) issued by USFWS also describe annual "ramp up" and "ramp down" flow requirements for the Deschutes River below the Wickiup dam, controlled by Wickiup reservoir releases during the transition months between winter and summer (April and September). In the spring, the HCP requires a ramp up from 400 to 600 cfs during the month of April, as informed by OSF monitoring. In the fall, the annual ramp down requires that flows at the Deschutes River at Benham Falls (BENO) gage remain above 1,300 cfs

through September 15. As the draw down continues, flows at BENO are held at 1,200 and 1,100 cfs for 5 days each to allow for frog movement to overwintering areas ("Deschutes River Basin Habitat Conservation Plan" n.d.).

Section 7 of the Wild and Scenic Rivers Act (16 U.S.C. 1278) provides for the protection of the free-flowing, scenic, and natural values of rivers designated as components or potential components of the National Wild and Scenic Rivers System from the effects of construction of any water resources project. In 1994, the US Forest Service developed a comprehensive management plan for the Wild and Scenic Rivers and State Scenic Waterways of the Upper Deschutes River. The management plan guides all development, management, and restoration activities within the river corridor. It also defined Wild and Scenic Rivers flow targets for the Upper Deschutes River below Wickiup (Table 5~~Table 5~~) (Deschutes National Forest, Oregon State Parks, and National Wild and Scenic Rivers Systems 1996). It is important to note that the flows described in the management plan and in Table 5~~Table 5~~ are not requirements, but instead are targets based on the flows needed to maintain the free-flowing, scenic, and natural values of the river. Refer to Section **Error! Reference source not found.**~~2.2.2~~ for more information on Federal Wild and Scenic Rivers and State Scenic Waterways protections.

Formatted: Font: (Default) Times New Roman, Highlight

Formatted: Font: (Default) Times New Roman, Highlight

Table 5. Wild and Scenic Rivers flow targets for the Deschutes River.

	Current Practices	Intermediate Flow Targets*			Long-Term Flow Target*
Minimum	20 cfs	50 cfs	100 cfs for 90% of the time**	200 cfs for 90% of the time**	300 cfs for 90% of the time**
Maximum	No limitation	1650 cfs	1600 cfs	1500 cfs	1400 cfs
Ramping Rate					
Rising Rate	0.5 ft/day***	0.1 ft/4 hr			
Falling Rate	No limitation	0.2 ft/12 hr			

Notes:
*Flow measured at Wickiup gage.
**90% of the time means that on the average 9 out of 10 years the minimum flow would be maintained in the river in winter.
***Existing standards for flow management allow a ramping rate of 1.0 ft/hour. In practice, the watermaster attempts to limit changes to 0.5 ft/day.

While the instream water rights and Wild and Scenic Rivers protections referenced above provide useful information for understanding the flows needed to sustain key ecological functions, they do not represent a full accounting of instream needs or demands for OSF. The US Fish and Wildlife Service (USFWS)'s BiOp for the Deschutes Basin HCP articulated the complex interaction between seasonal flows and OSF habitat, located primarily within floodplain wetlands and oxbows adjacent to the Deschutes River (U.S. Fish and Wildlife Service 2020). The Deschutes River channel has been widened by past, high irrigation season flows. Currently, higher-than-historical flows are needed to reach and support the ecological function of floodplain wetland habitats inhabited by OSF (U.S. Fish and Wildlife Service 2023). Restoration of the stream channel to allow lower flows to inundate these habitats during certain critical times of the year is therefore more important to consider than instream flow objectives alone when the goal is to improve OSF habitat. The relationship between flow and channel restoration on OSF habitat has been a point of emphasis for the DBWC Ecological Needs Technical Committee as it has

worked to characterize all instream water needs in the basin. Given that channel modifications may limit the effectiveness of flow restoration for OSF, further gathering and synthesis of data and identification of data gaps is needed to prioritize areas where restoration efforts are more likely to be effective. The Basin Study points to a study conducted by the River Design Group in 2017 to assess the relationships between flow thresholds and key species habitat. This study will be discussed further in Section 3.5 below.

3.1.4 Future Needs – Groundwater

As stated previously, further work is required to understand the ecological needs for groundwater in the basin.

3.1.5 Meeting existing targets

As part of the Basin Study, the Bureau of Reclamation (Reclamation) conducted an analysis of regulated river flow in the Upper Deschutes Basin using various instream and out-of-stream conditions to understand the magnitude of instream water shortages. This analysis modeled current flow conditions in the basin and compared that to existing ISWRs in specific reaches, including Wickiup outflow (WICO – Certificate #59776 in table) and the Deschutes River below Bend (DEBO) stream gage (protested ISWR – #IS-70695 – for 250 cfs). The analysis did not include State Scenic Waterways flows or other studies of broader instream/ecological flow needs. **The results showed that instream demands (ISWRs) experience median annual shortages of approximately 149 cfs (~108,000 acre-feet), with shortages that may range up to 242 cfs (~175,000 acre-feet) in dry years (Bureau of Reclamation and Oregon Water Resources Department 2019).**

To meet higher flows that could contribute to broader ecological objectives in some reaches (including 600 cfs winter flows from the Upper Deschutes), total median annual shortages for instream needs (including both wet and dry years) are modeled as approximately 276 cfs (~200,000 acre-feet) and could range up to 691 cfs (~500,000 acre-feet) in dry years (Bureau of Reclamation and Oregon Water Resources Department 2019). However, it is important to note that higher flows alone may not be sufficient to meet objectives for aquatic and riparian habitat health, particularly the needs of the OSF. Guidance from the DBWC Ecological Needs Technical Committee suggests prioritizing the integration of both habitat restoration and instream flow restoration efforts. For example, some critical habitats for the OSF are located in a disconnected floodplain, which, under current geomorphological conditions, would only be inundated during high flows. Attempting to inundate those habitats through flow restoration alone would be unrealistic or impossible to achieve. However, restoring the stream channel to reconnect its floodplains would allow those habitats to be inundated by much lower and more realistically achievable flow rates. In this way, habitat restoration is just as important of a strategy as flow restoration for meeting existing ecological targets.

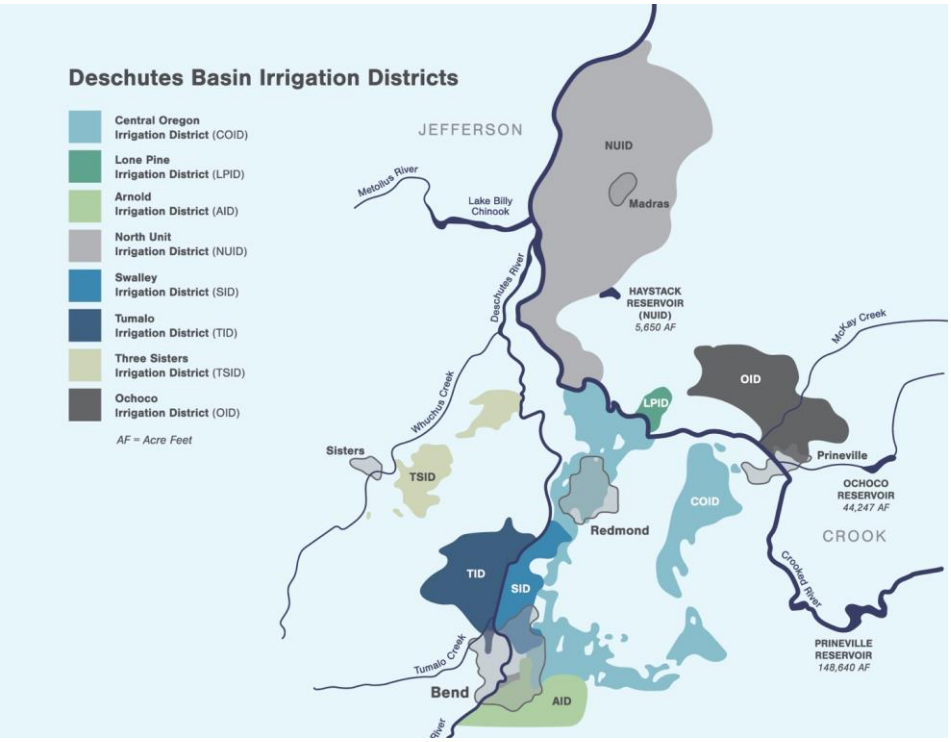
3.2 Agricultural uses

More than 100 years ago, Federal and state policies encouraged the settlement of Central Oregon's high desert by facilitating access to land and irrigation water. This water has made possible the diverse agricultural sector that has helped shape the region. Today, there are eight major irrigation districts (collectively referred to as the Deschutes Basin Board of Control or DBBC), which use water from the Upper Deschutes Basin (defined by the Basin Study as

including the Crooked River and Whychus Creek) to provide their patrons with irrigation supply. Six of these districts are located within the DBWC Phase I planning area – the two excluded from this Plan are Three Sisters Irrigation District and Ochoco Irrigation District. Figure 3~~Figure 3~~ shows a map of the service areas of each irrigation district in the Upper Deschutes Basin.

Formatted: Font: (Default) Times New Roman, Highlight

Figure 3. Map of the irrigation districts serving the Upper Deschutes Basin (source: COID).



There are six irrigation districts which store and divert water from the Upper Deschutes River: Arnold, Central Oregon (COID), Lone Pine, North Unit (NUID), Tumalo, and Swalley. Water for irrigation is stored upstream in reservoirs (Wickiup, Crane Prairie, Crescent, and others) during the winter season, released during the summer irrigation season (April 1 to October 31), and delivered through the Deschutes River and a system of conveyance infrastructure (main canals and laterals) to supply irrigation water to district patrons. Information about the number of acres and patrons served by each district, the priority and duty of their surface water diversion rights, and average diversions and delivery rates are summarized in Table 6~~Table 6~~. COID is the largest district by number of patrons served and by quantity of water diverted. Swalley ID has the most senior water right and NUID has the most junior right in the basin. Despite being the district with the most junior water right and being located furthest downstream (north), NUID serves the

Formatted: Font: (Default) Times New Roman, Highlight

greatest number of acres of some of the most productive agricultural land in the basin. See Section 2.1.7 for more information on each district's water supplies and conveyance systems.

Table 6. Summary of irrigation district water rights and deliveries information, compiled from district historical diversion records, System Improvement Plans (SIPs) and On-Farm Studies.

Irrigation District	Acres	Patrons	Surface Water Right(s)		Avg. Annual Diversion, 2006-14 (AF/year)	Transmission Loss (Duffy Decree, %)	On-Farm Efficiency (%)
			Priority Date(s)	Certificated Duty (after losses, AF/acre)			
Swalley	4,333	668	9/1/1899	5.46	25,900	43%	51%
Tumalo	7,417	667	8/5/1900; 8/5/1905; 10/29/1913	5.35	37,300	46%	60%
Lone Pine	2,369	19	10/31/1900	4.20	12,096	35%	89%
Arnold	4,384	663	2/1/1905	5.40	30,200	65%	52%
Central Oregon	42,666	Over 4,000	10/31/1900 - 12/2/1907	5.45	295,200	45%	43%
North Unit	58,887	961	2/28/1913 - 9/18/1968	5.25	116,109*	21%**	86%

*North Unit annual diversion from 2006-2016 District diversion records
**North Unit transmission loss not certificated in water right diversion amount, calculated from seepage loss assessment

3.2.1 Existing Demands – Surface Water

A Reclamation study described the baseline annual diversion request of each of these irrigation districts to use as a measure of annual agricultural water demand for hydrologic modeling (Bureau of Reclamation 2018a). Table 7~~Table 7~~ lists the baseline annual diversion request for the six irrigation districts which divert from the Upper Deschutes River and fall within the DBWC Phase I planning area.

Commented [AE2]: Keep discussion of baseline annual diversion request or replace with new methodology discussed in Section 3.2.5?

Formatted: Font: (Default) Times New Roman, Highlight

Table 7. Summary of baseline annual diversion requests for the six major irrigation districts in the Upper Deschutes Basin.

Entity	Stream	Baseline Annual Diversion Request (AF)
Arnold Irrigation District (AID)	Deschutes River	32,800
Central Oregon Irrigation District (COID)	Deschutes River	301,400
Lone Pine Irrigation District (LPID)	Deschutes River	12,200
North Unit Irrigation District (NUID)	Deschutes River	182,000
Swalley Irrigation District (SID)	Deschutes River	26,200
Tumalo Irrigation District (TID)	Deschutes River, Tumalo Creek, Crescent Lake	50,000
	Total:	**604,600**

In total, the analysis found that the average annual surface water diversion for all irrigation districts (including TSID and OID) total approximately 720,000 AF. **When including all eight irrigation districts, modeled irrigation district shortages total approximately 30,000 AF in average or wet years and approximately 160,000 AF in dry years.** This includes TSID and OID, but it does not include other irrigation diversions on the Crooked, whose diversions were

not gaged (Sussman and McMurtrey 2017). TSID and OID are the two irrigation districts that fall outside the DBWC Phase I planning area. The average annual surface water diversion for the six irrigation districts within the Phase I planning area (those listed in Table 7~~Table 7~~) is about 605,000 AF. Shortages within these six irrigation districts were not calculated by the Basin Study.

Formatted: Font: (Default) Times New Roman, Highlight

3.2.2 Existing Demands – Groundwater

Irrigation water used by the districts comes from surface water diversions in the Upper Deschutes Basin. Some demand for agricultural groundwater exists for irrigators outside of the districts. An analysis of water rights completed for the Basin Study found that there were 31,591 acres for a combined maximum authorized rate of about 185 cfs of groundwater rights for irrigation (Sussman and McMurtrey 2017). This analysis was conducted for the broader geographic extent of the Basin Study, including the Crooked River below Bowman Dam and Whychus Creek below the TSID diversion, which are not part of the Upper Deschutes Basin Phase I Planning Area.

3.2.3 Future Needs – Surface Water

Irrigation water demands are likely not going to increase in the future and may be more likely to decrease from what they currently are. However, meeting existing irrigation demands for junior water rights holders will require efficiency improvements in senior districts. In order to meet its patrons' irrigation water needs NUID must enter into agreements with the other districts, particularly COID, so that they can divert their water out of priority. These agreements are often tied to OSF flow needs and commitments under the HCP and Inter-District Agreement, driven by the ESA. In recent years, the irrigation districts have been working on projects to modernize the efficiency of their irrigation infrastructure, and as a result, reduce their demand for water and leave more available for junior irrigators and instream flow. For example, the AID Infrastructure Modernization Project, which submitted its final Watershed Plan/Environmental Assessment in August 2022, plans to pipe 11.9 miles of its canals, upgrade 88 turnouts, and install monitoring technology in two locations. These actions would save an estimated 11,083 AF from seepage loss during the irrigation season, pass up to 10,862 AF of water to NUID, release and protect up to 10,446 AF for instream uses below Wickiup Reservoir during the non-irrigation season, improve supply reliability for its patrons, and reduce operations and maintenance costs (Farmers Conservation Alliance 2022). These efforts are detailed in Chapter 4 of the Plan.

3.2.4 Future Needs – Groundwater

While water for agricultural uses will continue to be sourced mostly from surface water diversions, future demand may increase for supplemental groundwater. Projected short-term future demand for groundwater mitigation was estimated as part of the Basin Study. The 20-year projected mitigation demand for irrigation use from 2016-2035 was 1,134 mitigation credits (which equals 1,134 AF of instream flow) (Sussman, McMurtrey, and Grigsby 2017). This was determined by calculating the amount of groundwater applications submitted for irrigation use for the years 2005 to 2014, dividing that by 10 years to get an annual demand, and multiplying that by 20 years to get the short-term projected demand for 2016-2035. In addition, with drought conditions persisting in the Deschutes Basin, there may be more emergency drought permits for groundwater issued. Under OAR 690-019-0040, emergency drought permits allow the use of water to replace water that is not available under an existing right due to drought. In each of the

past two years there were emergency permits issued for over 1,000 acres of supplemental irrigation water supply (from OWRD WRIS search).

3.2.5 Updated Methodology for Determining Agricultural Needs

Per discussion with DBWC Planning Team members, the agricultural water needs calculation should consider other factors than just water rights and historical diversions. These factors include crop water demands (Cuenca), reductions in transmission losses from canal piping projects, changes in crop mixes grown under future climate conditions, water marketing, and the urbanization of previously agricultural acreage. This section will provide information on these factors and will update estimates of future agricultural water demand.

Overall, agricultural water demands in the Deschutes Basin are expected to be lower in the future as a result of conservation opportunities. To understand the total potential water supply that could become available if conservation actions are implemented, this analysis calculated the difference between historical diversion amounts (using 2006-2014 data as a representative period before piping projects were completed) and various water conservation scenarios. Conservation activities and potential water savings are broken out into two categories: existing or planned piping of district-owned canals and laterals, and any potential future conservation activities which would reduce on-farm duty, including additional district canal and lateral piping projects which have not yet been planned, as well as efficiency improvements to private lateral conveyance and on-farm application. Water planned to be made available from existing/planned district piping projects to contribute to instream flow and junior district supply reliability totals about 82,000 AF of water. Note that any reductions in agricultural water demand due to conservation would not result in the reduction or forfeiture of the districts' certificated water rights.

To determine the savings which could be achieved from future potential conservation activities (not including the planned/existing piping projects), crop consumptive water use numbers were used as a scientific basis for the amount of water that a crop actually needs. These numbers, in turn, are a starting point to define agricultural demands in the Upper Deschutes. In 1992, Richard Cuenca calculated crop water use and irrigation requirements for crops grown in various regions throughout Oregon, including in the Deschutes Basin (Cuenca et al. 1992). Cuenca crop coefficient tables were applied to the mix of crops grown in each of the six irrigation districts which use water from the Upper Deschutes Basin to calculate total crop water demand in AF/acre for each district (Table 8~~Table 8~~).

Table 8. Irrigation district crop water use requirement estimates.

District	Crop Water Requirement (Cuenca, AF/acre)***	Potential Current Crop Water Requirement (Cuenca + 30%, AF/acre)
Arnold	2.25	2.93
COID	2.36	3.07
Lone Pine	2.13	2.77
NUID	2.03	2.64
Swalley	2.33	3.03
Tumalo	2.31	3.00

Commented [AE3]: Should this be its own section or could it replace the info in the "Future Needs - Surface Water" section (3.2.3)?

Commented [AE4]: Best place to put this?

Formatted: Font: (Default) Times New Roman, Font color: Text 1, Ligatures: None

It is understood that Cuenca crop consumptive water use numbers are outdated, and underestimate current crop needs due to changes in the crops grown in the basin and increases in evapotranspiration rates due to a warming climate. As such, OWRD is in the process of revising crop consumptive water use estimates using an alternative methodology (i.e., satellite imagery). As a proxy for these anticipated revised estimates, this analysis included a set of numbers with a buffer of 30% above the original Cuenca numbers. Understanding that uncertainty exists around future climate conditions and crop mixes, the analysis laid out a range of scenarios with additional buffers to the crop consumptive water needs (3 AF/acre, 3.5 AF/acre, and 4 AF/acre). For these reasons, a range of potential on-farm conservation savings was estimated, ranging from 69,000 AF to 182,000 AF of savings potential. The lower end of the range assumes conveyance and application can be reduced to an on-farm volume of 4 AF/acre and the higher end of the range assumes on-farm volume can be reduced further to 3 AF/acre, which corresponds closely to the 30% above Cuenca crop consumptive demands.

Adding in the savings from existing and planned district piping projects, a total of between 151,000 AF and 264,000 AF could be potentially available from agricultural conservation activities. Demand could be further reduced through the implementation of voluntary market-based transactions.

3.3 Municipal

The Basin Study included evaluations to better understand the current water use and future water needs of municipal and quasi-municipal water suppliers in the basin. Municipal water suppliers primarily include cities and water districts. Quasi-municipal water suppliers are entities other than a public corporation or a Federally recognized Indian tribe that supply water for uses usual and ordinary to municipal water use. This section does not include analysis of future destination resorts in the study area, though they may potentially be a major user of groundwater and groundwater mitigation credits in the future.

The estimated population of the Upper Deschutes Basin is approximately 170,000 people. According to the OWRD well log database, there are 24,930 exempt wells within the Upper Deschutes Groundwater Study Area (data received from OWRD, 2023). The remainder obtain water from a water supplier. Water suppliers includes municipal water suppliers, quasi-municipal water suppliers that supply water within urban areas under franchise agreements, homeowners' associations, and water systems serving transient populations, such as destination resorts or campgrounds. The major municipal and quasi-municipal water suppliers in the Upper Deschutes Basin planning area are:

Commented [AE5]: Confirm

Municipal:

- City of Bend
- City of Redmond
- City of La Pine

Quasi-Municipal:

- Avion Water Company
- Roats Water System, Inc.
- Agate Water Company
- Cline Butte Water Utility
- Sun River Water, LLC

Water suppliers have implemented successful water conservation and efficiency programs in compliance with the Oregon Water Resource Department's requirements for Water Management and Conservation Plans (WMCPs). Municipal WMCPs require water suppliers to provide information about water production (use of water from the source), water sales, water loss, water conservation and efficiency programs, and projected future water supply needs. OWRD requires water suppliers to implement five specific water conservation measures:

- Complete annual water audits (comparison of water production to water sales to estimate water losses). If the annual water audit indicates that Water Losses exceed 10 percent, the water supplier must provide an analysis identifying potential factors responsible for the loss and selected actions for remedy.
- Fully meter all water service connections
- Develop a program to regularly test and maintain water meters consistent with manufacturer recommendations.
- Implement a water rate structure that is based, in part, on the quantity of water metered at each service connection.
- A public education program commensurate to the size of municipal water supplier to encourage efficient indoor and outdoor water use.

As a result of conditions related to municipal water rights, most municipalities are also required to implement, where feasible, the following measures to ensure efficient use of water and waste prevention.

- Provide technical and financial assistance programs commensurate to the size of the Municipal Water Supplier to encourage implementation of conservation measures.
- Providing financial assistance for retrofitting or replacement of existing inefficient water using fixtures, including distribution of residential conservation kits and rebates for customer investments in water conservation.
- Water reuse, recycling, and non-potable water use opportunities.
- Other conservation measures identified by the water supplier that would improve water use efficiency.

A few examples of water conservation programs among major municipal water suppliers are described below.

City of Bend

In recent years, the City of Bend has:

- Expanded its public education campaign to include television, radio, and billboard ads and increase awareness of new conservation measures like water efficient fixture rebates.
- Expanded customer assistance efforts, include automated leak notifications, free sprinkler inspections.
- Expanded its rebate program to include indoor and outdoor devices for residential customers.
- Increased enforcement on water code to work with customers to address issues of water waste and improve compliance with irrigation violations.
- Worked to develop new codes and standards for private development landscaping and irrigation.

- Developed memorandums of understanding with large water use customers (e.g., parks, schools, and city streets) to collaborate toward code compliance at all sites and reduce water use through water efficient landscaping.

Identifying specific causes for observed reductions in water demands is difficult. Due to what is likely an interrelated combination of drought awareness, densification, conservation messaging, and the availability of water conservation tools for water users, Bend has seen significant reductions in per-capita water demands, with the water service population growing faster than annual water demands. Table 9~~Table 9~~ shows the City's water use from 2014 through 2023.

Formatted: Font: (Default) Times New Roman, Font color: Text 1, Ligatures: None

Table 9. City of Bend annual municipal water demands and change over time, 2014-2023 (analysis by Owen McMurtrey).

City of Bend			
Year	Total Annual Demand (MG)	Estimated Water Service Population	Gallons Per Capita Per Day (GPCD)
2014	4,461	59,744	204.6
2015	4,746	60,673	214.3
2016	4,727	62,091	208.6
2017	4,746	64,905	200.3
2018	4,793	67,187	195.4
2019	4,370	68,379	175.1
2020	4,854	69,126	192.4
2021	4,780	76,500	171.2
2022	4,518	78,786	157.1
2023	4,587	79,686	157.7
Annualized Growth Rate (%)	**0.31%**	**3.20%**	**-2.89%**

City of Redmond

In addition to indoor water efficiency programs and outreach, Redmond has developed conservation programs targeting outdoor water use. These efforts include:

- Making AquaHawk online customer engagement software available to all customers. This product allows customers to monitor water use, set water use threshold alerts, and receive leak alerts, while informing customers about water use patterns.
- Creating an irrigation system rebate program for weather-based irrigation controllers, soil moisture sensors, and rotating sprinkler nozzles.
- Updating development codes to guide water-wise plantings, irrigation, and reduce turf area in private developments.
- Conversion of City-owned green spaces from turf to desert landscaping, where appropriate.

Similar to Bend, Redmond has seen reductions in per-capita water demands that are likely attributable to a number of interrelated factors, including the City's water conservation programs. Redmond's total demands have generally exceeded previous projections due to faster than

anticipated population growth. Table 10~~Table 10~~ shows Redmond's total annual demand, estimated water service population, and per capita water demand.

Formatted: Font: (Default) Times New Roman, Font color: Text 1, Ligatures: None

Table 10. City of Redmond annual municipal water demands and change over time, 2014-2023 (analysis by Owen McMurtrey).

City of Redmond			
Year	Total Annual Demand (MG)	Estimated Water Service Population	Gallons Per Capita Per Day (GPCD)
2014	2,094	26,770	214
2015	2,130	27,050	216
2016	2,144	27,595	213
2017	2,094	28,265	203
2018	2,359	29,190	221
2019	2,176	30,600	195
2020	2,449	32,215	208
2021	2,542	36,200	192
2022	2,444	37,211	180
2023	2,439	38,208	175
Annualized Growth Rate (%)	1.70%	5.08%	-2.90%

City of Prineville

Commented [AE6]: Prineville and Sisters are outside planning area (based on watershed boundaries), but their groundwater use might be useful info as it pertains to the regional aquifer.

Question - should these be included or not?

Prineville's water conservation efforts have focused primarily on reducing water loss. In 2008, Prineville's calculated non-revenue water, including water loss and unmetered customer connections, was 171 MG, representing 28 percent of the City's 618 MG of total water produced. The primary cause of water loss was aging water distribution infrastructure. Prineville experienced rapid growth during World War II when steel was required to support war efforts. Consequently, a significant portion of the City's water distribution lines were made from wood pieced together and bound with steel wire. The City has replaced an average of approximately 3,000 linear feet of pipe per year over the past 15 years. By 2015, water loss had been reduced to approximately 5 percent. The City has continued to replace aging pipes to maintain low rates of water loss.

Prineville has also invested in the development of Aquifer Storage and Recovery (ASR). Water is collected during periods of cooler temperatures, higher streamflow, and lower demands. The stored water can later be recovered and used during periods of hotter temperatures and higher water demands—typically during the summer months—thereby easing peak demand stress on native water sources and reducing the need to build expensive water infrastructure (e.g. above-ground storage, etc.)

In addition to these large-scale efforts, Prineville also supports the following customer-facing water conservation efforts:

- Providing free water-saving resources for water customers, including leak detection tables, lawn water gauges, faucet aerators, and showerheads.
- Conducting water conservation outreach, with a focus on reducing summer water use.

- Rebates for weather-based irrigation controllers, rotating sprinkler nozzles, and soil moisture sensors.

As shown in Table 11~~Table 11~~, Prineville's total water demands have not increased significantly compared to its 2008 demand of 618 MG, mainly due to reductions in water loss, even as the population has increased significantly during that time. Per-capita water demand has declined less than those of other Central Oregon cities but was at a lower starting point to begin with.

Formatted: Font: (Default) Times New Roman, Font color: Text 1, Ligatures: None

Table 11. City of Prineville annual municipal demands and change over time, 2014-2023 (analysis by Owen McMurtrey).

City of Prineville			
Year	Total Annual Demand (MG)	Estimated Water Service Population	Gallons Per Capita Per Day (GPCD)
2014	537	9,385	156.8
2015	534	9,462	154.5
2016	575	9,645	163.3
2017	610	9,880	169.2
2018	644	10,010	176.3
2019	583	10,220	156.2
2020	665	10,355	176.0
2021	637	11,042	158.1
2022	671	11,513	159.7
2023	640	11,598	151.1
Annualized Growth Rate (%)	**1.94%**	**2.35%**	**-0.42%**

City of Sisters

Sisters has recently accelerated key elements of its water conservation program:

- Retrofitting park, street, and school irrigation to include increased xeriscaping, limit turf, and use subsurface drip irrigation where possible.
- Replacing water customer meters with new Automated Metering Infrastructure (AMI) meters to improve accuracy of water audits and provide additional information about customer water use.
- Expanding public outreach campaign to provide additional information about water conservation and drought.
- Updating water rates to incentivize conservation with escalating rates for using increased volumes of water.

Similar to other cities in the Upper Deschutes basin, per capita water use has been reduced significantly in recent years. Sisters has experienced the second fastest rate of growth among cities in the Deschutes Basin over the past decade (La Pine has grown at a rate of 7 percent). Sisters also faces a unique challenge in the form of a high transient population (e.g., visitors for the events, users of short-term rentals). This can skew the true water service population, as the summer population, when demands are high, might exceed the typical year-round service population. The impact of conservation messaging or water rate increases may also be more limited among those visiting the City on a temporary basis. Nevertheless, as shown in Table

Formatted: Font: (Default) Times New Roman

12~~Table 12~~, Sisters' per capita demands have decreased at a similar rate to other cities over the past decade.

Table 12. City of Sisters annual municipal demands and change over time, 2014-2023 (analysis by Owen McMurtrey).

City of Sisters			
Year	Total Annual Demand (MG)	Estimated Water Service Population	Gallons Per Capita Per Day (GPCD)
2014	243	2,190	304
2015	260	2,280	313
2016	281	2,390	323
2017	294	2,540	317
2018	332	2,725	334
2019	281	2,985	258
2020	327	3,220	278
2021	371	3,286	310
2022	304	3,578	233
2023	336	3,823	241
Annualized Growth Rate (%)	**1.94%**	**6.19%**	**-2.59%**

3.3.1 Existing Demands – Surface Water

The City of Bend utilizes a dual source system of surface and groundwater for its drinking water supply. The City holds municipal water rights for surface water diversions from the federally protected Bend Municipal Watershed, which consists of Bridge Creek and Prowell Springs in the Middle Fork Tumalo Creek watershed. This watershed is fed by spring water, which reliably discharges out of the Cascade Mountains. The combined flows of natural springs (the Prowell Springs Diversion) and Bridge Creek in the Bend Municipal Watershed are diverted approximately 11.5 miles west of the City limits at the Heidi Lansdowne Intake Facility located on Bridge Creek near the confluence with Tumalo Creek. A 1926 agreement between the U. S. Forest Service (USFS) and the City created the Bend Municipal Watershed (BMW), and subsequent USFS plans recognize and designate municipal use as the highest and best use of the watershed. The BMW lies within the Deschutes National Forest, which is managed by the USFS. The City's diversion at the intake is limited to 18.2 cubic feet per second by municipal code and by the terms of the City's Special Use Permit authorizing operation of the surface water system on USFS lands. In addition, Deschutes Valley Water District holds surface water rights for artesian wells. There is also demand for surface water in the Middle Deschutes associated with Deschutes Basin Groundwater Mitigation Program requirements for mitigation credits on which the cities rely for groundwater development.

While most of the City's surface water demand is for municipal use, the City also serves irrigation and fire hydrant uses. In 2019, about 10 percent of all meters were commercial or irrigation-only and only 0.6 percent of all meters were hydrant meters (City of Bend 2021). The City's irrigation-only account category includes meters providing water for seasonal outdoor irrigation only to locations such as parks and school fields as well as irrigated landscapes owned by the City and larger home owners' associations. Hydrant meters measure and charge for water

use for temporary uses, including construction and dust abatement. A single hydrant meter box can be used at multiple job sites for different purposes over a season (City of Bend 2021).

3.3.2 Existing Demands – Groundwater

The Basin Study included evaluations to better understand the current water use and future needs of municipal and quasi-municipal water suppliers in the basin. With the exception of the surface water rights described in Section 3.3.1, the municipal and quasi-municipal water providers utilize only groundwater supply. The City of Bend appropriates groundwater from the Deschutes Regional Aquifer using 20 active wells and associated water rights (City of Bend 2021). The City relies on groundwater during the peak demand season, and during interruptions to the City's surface water supply due to turbidity events, lightning strikes, and planned and unplanned maintenance. Current annual diversions for municipal and quasi-municipal purposes are derived primarily from OWRD groundwater use reports and total approximately 32,000 acre-feet per year (Sussman and McMurtrey 2017; McMurtrey, personal communication, 2023).

Commented [MEL*W7]: I believe Joe Kemper is working on an update number here. Please update with 2023 numbers.

3.3.3 Future Needs – Surface Water

In the 1990's, a groundwater study completed by the U.S. Geological Survey, in cooperation with OWRD and other Deschutes Basin partners, found that there is a one-to-one hydraulic connection between groundwater and surface water within the Deschutes Groundwater Study Area (DGWSA). As a result of this connection, additional groundwater uses within the DGWSA impact established instream flows and other existing surface water rights. The Deschutes Groundwater Mitigation Program was developed to provide for new groundwater uses while maintaining scenic waterway and instream water right flows in the Deschutes Basin (OAR 690-505-0500). Under OWRD's Deschutes Basin Groundwater Mitigation Rules (Mitigation Rules), new groundwater permits require mitigation. Mitigation is generally created by transferring existing surface water rights instream, thus demand for mitigation credits is a demand for surface water. The continued ability to transfer existing surface water rights instream to create mitigation is therefore necessary for water suppliers' ability to obtain access to new groundwater supplies. Even if water suppliers are unable to obtain new groundwater permits through the mitigation program, there are currently insufficient mitigation credits available for water suppliers to pump the full amount of water authorized under their existing permits.

To assess future municipal and quasi-municipal water needs, the Basin Study evaluated the amount of mitigation credits the water providers would require under the Mitigation Rules to allow their future uses of groundwater within the study area (Sussman, McMurtrey, and Grigsby 2017). **The evaluation concluded that meeting projected 50-year demands for cities and private water suppliers will require approximately 16,000 AF of water dedicated instream for permanent mitigation.**

Commented [KP8]: Can you send this out to the planning team so they can review along side this section when commenting? Thx!

Commented [AE9R8]: This was a memo completed as part of the Basin Study. Task 6 memo - https://www.deschutesriver.org/Mitigation_Demand_Draft%20Final.pdf

Future demand for mitigation credits was evaluated in terms of short-term (20-year) and long-term (50-year) projected demand for, and supply of, permanent mitigation credits (Sussman, McMurtrey, and Grigsby 2017). Projection of the short-term demand considered the following: existing permits that require mitigation but for which mitigation has not yet been provided; mitigation projected to be required for permits issued during the next 20 years; and mitigation requirements currently met with temporary credits, with the assumption that permanent credits would replace temporary credits (each permanent mitigation credit equates to 1 acre-foot of

water legally protected instream). The long-term demand for mitigation credits was estimated based on the mitigation projected to be required for permits issued from 2036 through 2065. The long-term demand evaluation considered the need for new mitigation credits associated with growth within the urban growth boundaries of Bend, Sisters, and La Pine (Redmond has sufficient mitigation credits to meet its own long-term demands) (Sussman, McMurtrey, and Grigsby 2017). Note that the resulting projections include Prineville and Sisters, both of which are outside of this planning area.

For all projected groundwater demands in the next 50 years (not just municipal and quasi-municipal), it is anticipated that approximately 21,000 AF of permanent mitigation will be required to meet projected groundwater demands (Sussman, McMurtrey, and Grigsby 2017). The projected supply of mitigation credits was also evaluated using data from OWRD regarding the number of existing credits not assigned to permits and pending instream water rights transfers that are expected to generate credits. The evaluation found a projected supply of about 551 permanent mitigation credits, significantly far below the projected demands for such credits in the basin.

Both the short-term and long-term mitigation credit demand projections for municipal and quasi-municipal water suppliers are influenced by water suppliers' demands. Demands are influenced by population growth, water user profiles, climatic conditions, and water conservation efforts. Water suppliers are constantly thinking about long-term water supply needs and strategies to help meet those needs, including water conservation. The successful implementation of water conservation programs that reduce water demands would decrease the projected need for mitigation credits over both the short-term and long-term.

Additionally, the projected need for mitigation credits over the short term assumed that municipal and quasi-municipal water suppliers would need to obtain credits in accordance with the schedules outlined in incremental mitigation plans. Municipal and quasi-municipal water suppliers serving areas within urban growth boundaries need to plan for water supplies over long time horizons. Given the scarcity of mitigation credits and the long timelines required to negotiate and complete credit purchases, water suppliers seek to obtain mitigation credits years in advance of actually requiring their use. The existence of a mechanism like a water bank that enabled water suppliers to reliably obtain mitigation credits on an as-needed basis would not affect the number of mitigation credits water suppliers need to meet water demands but would delay the need to acquire those mitigation credits.

The long-term mitigation credit demand projections evaluated two water demand scenarios for the Bend, Sisters, and La Pine UGBs, one with demands of 200 gallons per capita per day (gpcd) and one with 300 gpcd. It is important to note that in this context, per-capita water demands are calculated by dividing the water suppliers' total annual water demand and dividing it by the total service population. Commercial, manufacturing, and water use for transient service populations (e.g., short-term rentals) are included in the total water demand. Per-capita demands are therefore effective for measuring changes in a single community's water use over time, or for comparing communities with similar water use profiles, but may be misleading when used to compare water use in dissimilar communities.

As shown above, since the mitigation demands were estimated, water suppliers have seen significantly reduced water demands. Recent models of water conservation potential completed by the City of Bend indicated the potential for a further 8 to 12 percent reduction in per-capita demand with implementation of new and expanded water conservation measures. A similar analysis by Redmond indicated the potential for a 17 percent reduction in water demand. Basin-wide per capita water demands of approximately 140 gallons per day for all water suppliers, including small water districts and other water suppliers not discussed in detail in section 3.1, would represent a reduction of 30 to 50 percent compared to the long-term demand scenarios evaluated as part of the basin study, Additional description of the specific conservation programs and strategies that could be implemented to achieve further reductions in water use are described in greater detail in Chapter 4.

Further analysis of the impact of water conservation measures on mitigation credit needs over the next 20 and 50 years can be completed as part of the water bank effort.

Commented [OM10]: Would need to do more complex analysis to provide this.

3.3.4 Future Needs – Groundwater

Municipal and quasi-municipal water demands are expected to increase given forecasted future population growth in the Upper Deschutes Basin. As part of the City of Bend's Water Management and Conservation Plan (WMCP), projections of future water demand were forecasted through 2050. Future water demands for 2030 and 2040 were developed using City planning data for existing and future housing units, customer demand information, and water production data. The City projected demands for 2041 and 2050 by extending the average annual growth rate from 2030 through 2040 (City of Bend 2021). Projected average day demand and maximum day demand are expected to increase steadily and nearly double from 2018 to 2050 (Figure 4~~Figure 4~~).

Formatted: Font: (Default) Times New Roman

Figure 4. Projected Average Day, Max. Day, and Peak-Hour Demand and associated AAGRs, 2018 through 2050 (City of Bend 2021).

Year	ADD (cfs)	ADD AAGR	MDD (cfs)	MDD AAGR	Maximum Operational Demand (cfs)
2018	20.3	N/A	43.5	N/A	50.8
2030	27.5	2.55%	58.8	2.52%	68.8
2040	32.6	1.70%	69.9	1.74%	81.8
2041	33.2	1.70%	71.2	1.74%	83.3
2050	38.7	1.70%	83.2	1.74%	97.4

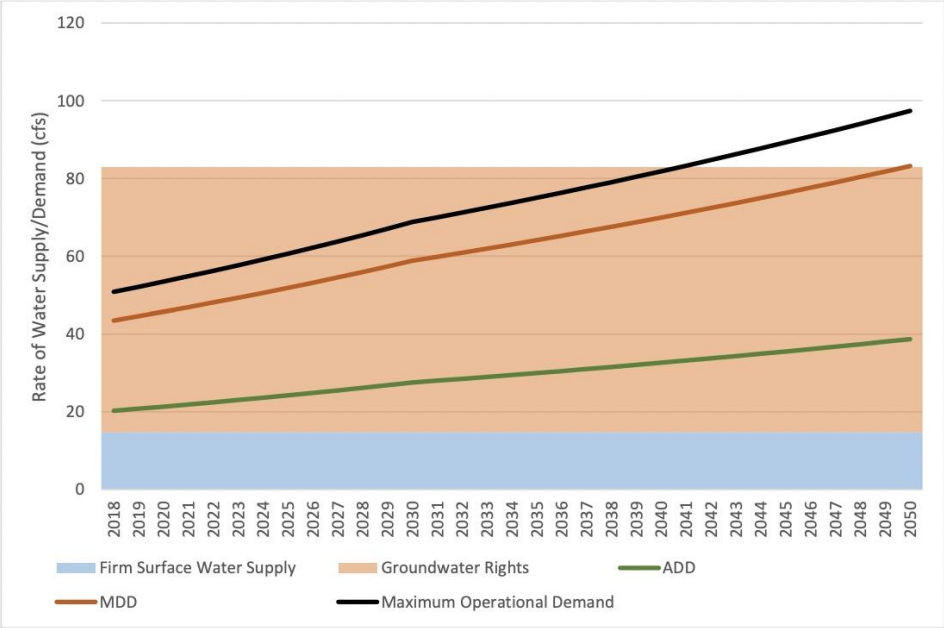
Notes
ADD = average day demand
AAGR = average annual growth rate
cfs = cubic feet per second
MDD = maximum day demand

Extending the projection through 2050, shows that the City of Bend's maximum operational demand (97.4 cfs) is projected to exceed the City's reliable supply by 14.5 cfs (Figure 5~~Figure 5~~) (City of Bend 2021). Therefore, the City will likely need to apply for a new groundwater right

Formatted: Font: (Default) Times New Roman

within the next 10 years to ensure adequate time to obtain a new permit, obtain required mitigation credits, and develop the infrastructure needed to apply the water to beneficial use.

Figure 5. Projected Average Day, Maximum Day, and Maximum Operational Demand and Reliable Water Supply (City of Bend 2021).



3.4 Other Existing/Potential Sector Needs

While the three legs of the stool are the three most significant water users in the Upper Deschutes Basin, there are other, smaller uses which are important to characterize as well. These include rural domestic water use from permit-exempt groundwater wells and recreation/tourism.

3.4.1 Domestic uses (including exempt wells)

In Oregon, certain groundwater uses are exempt from the requirement of obtaining a water right before withdrawing water from a well (ORS 537.545). Exempt uses include up to 15,000 gallons per day (gpd) for domestic purposes, up to 5,000 gpd for industrial or commercial uses, and up to one-half acre of lawn or noncommercial garden watering, or stock watering (Oregon Water Resources Department, n.d.). Domestic water uses in the Upper Deschutes Basin come from rural domestic water users who receive their water from exempt use groundwater wells rather than public or private water suppliers. According to its well log database, OWRD estimates about 24,390 exempt wells exist in the basin, with a total estimated annual consumptive use of 5,036 AF (about 6 cfs). For the annual consumptive use calculation, completed as part of the Basin Study, it was assumed that all of the wells were used for exempt domestic use (300 gpd) and

commercial use (100 gpd), and that 20% of the wells were used for irrigation of one half-acre (Sussman, McMurtrey, and Grigsby 2017).

3.4.2 Recreation/Tourism

The waterways of the Upper Deschutes Basin are often used for recreation – an important aspect of the tourism industry that brings many visitors to the basin. Protection for recreational uses of water comes primarily from Federal Wild and Scenic Rivers and State Scenic Waterways designations. Section 7 of the Federal Wild and Scenic Rivers Act sets instream flow recommendations for listed reaches (see Table 5~~Table 5~~) and prohibits federal assistance or licensing for water development projects or any activities that will negatively affect the unique characteristics of a listed reach. There are eight federally listed Wild and Scenic River reaches in the Deschutes Basin. In 1987, the State of Oregon passed legislation designating most of the Upper Deschutes River as a State Scenic Waterway. A comprehensive management plan was developed by the US Forest Service and Oregon State Parks to guide development, management, and restoration of the designated river corridors in order to protect and enhance the "Outstandingly Remarkable Values" of the Upper Deschutes River (Deschutes National Forest, Oregon State Parks, and National Wild and Scenic Rivers Systems 1996). These flows are discussed in more detail in Section 3.1.1.

Formatted: Font: (Default) Times New Roman, Highlight

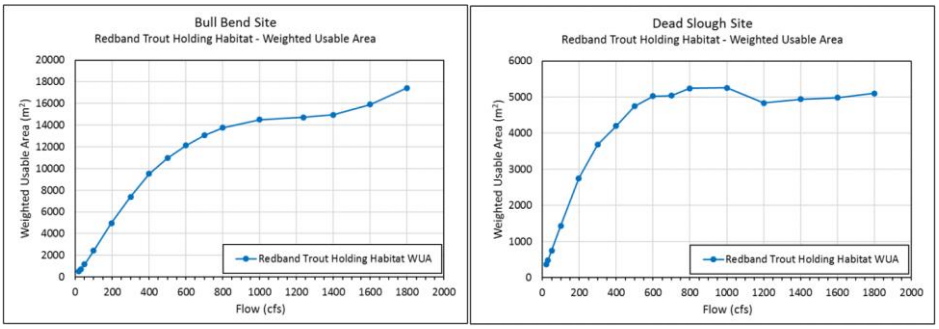
3.5 Flow/Habitat Needs

The water management goal for environmental water needs, as defined by the Basin Study Working Group (BSWG), referenced the importance of both increasing streamflow and improving water quality for the benefit of fish and wildlife in the Upper Deschutes Basin. To help refine desired outcomes for ecological benefits, the Basin Study included assessments of relationships between flows and habitat for the Upper Deschutes River for key species (River Design Group 2017) and relationships between flows, air temperature, and stream temperature for the Middle Deschutes River, Whychus Creek, and Tumalo Creek (Upper Deschutes Watershed Council 2016).

An instream flow study was conducted as part of the Basin Study for two sites on the Upper Deschutes River below Wickiup Reservoir (i.e., Dead Slough and Bull Bend) to evaluate the relationship between streamflow and instream/riparian wetland habitats for both redband trout and OSF. The study considered weighted usable area (WUA) as a metric to evaluate the surface area having specific habitat suitability characteristics at various flow rates; WUA is a habitat suitability index that allows comparisons of localized habitat conditions in response to changes in river flows. For redband trout, WUA curves developed for adult holding habitat at the Dead Slough and Bull Bend sites indicate that increases in streamflow up to 700 cfs are associated with significant increase in usable habitat. For flows above 700 cfs, the WUA curve for Bull Bend is much flatter, while the WUA curve for Dead Slough declines, indicating minimal change in holding habitat with changing streamflow in this range (Figure 6~~Figure 6~~) (River Design Group 2017).

Formatted: Font: (Default) Times New Roman

Figure 6. WUA curves for redband trout holding habitat (River Design Group, 2017).



In addition to suitable water depth and velocity, the highest holding habitat values for redband trout require riparian vegetation, stream wood, or undercut banks. The Basin Study assessment looked at adult holding habitat for redband trout; similar, prior instream flow studies that helped inform ODFW recommendations relevant to instream water right applications to address different trout species and habitat needs.

For the OSF, habitat suitability is influenced by many factors other than just streamflow and can be more variable, especially for breeding habitat. Overwintering habitat is sensitive to substrate type, water depth, and water velocity; desirable breeding habitat is driven by water depth, water velocity, substrate composition, and proximity to vegetation. Under existing channel and wetland conditions, the total WUA for overwintering varies between sites, but in general increases with increasing water depth. As winter flows increase, more high-quality overwintering habitat is created along the margins of the river and in adjacent wetlands, while larger patches of low-quality habitat within the river channel become unsuitable. For breeding habitat, WUA values remain relatively low with moderate increases up to flows of 800 cfs when water enters the sedge vegetation for the studied locations. At this point, the rate of increasing suitable habitat for breeding is more variable, with changes in water depth and vegetation transitions driven by local topography. The riparian vegetation component of the study found that high summer streamflows were the limiting factor in the distribution of vegetation (specifically sedges) along channel margins and in wetlands at the two study locations. With decreasing summer streamflow, sedge vegetation could expand into the river margins and wetlands (River Design Group 2017).

Overall, while the results of the flow/habitat studies provide context for projecting potential ecological benefits associated with various water management options, there are some limitations in using the River Design Group (2017) study to describe the needs of the basin. The study only looked at two small study areas and a limited number of species and lifestage needs. In addition, the utilization of an instream flow assessment methodology for OSF presents some challenges since the model is uses physical attributes (i.e., water depth, water velocity, substrate composition) to describe the quality of the habitat as per the suitability indexes. Yet, there are other habitat features that characterize the quality and suitability of habitat for OSF such as the availability of year-round water within slough wetlands, presence of micro-habitat features created by muskrats and beavers (e.g., lodges, channels, dens), shelter from predators, and close proximity between breeding and overwintering habitats. These temporal, spatial, and biological

elements of habitat are not assessed within the model developed for the River Design Group (2017) study. A much more comprehensive instream flow modeling effort, in terms of both geographic extent and habitat suitability characteristics, would be required to determine streamflow needs and predicted species- and lifestage-specific habitat availability.

Reservoir operations in the Upper Deschutes Basin are managed in part based on conservation measures agreed upon for the benefit of OSF habitat needs. Generally, the operation is intended to minimize elevation fluctuations in Crane Prairie Reservoir and outflow fluctuations from Wickiup Reservoir. In addition, outflows from Crane Prairie, Wickiup, and Crescent were all increased to enhance habitat conditions in the downgradient stream network. The operations described in Table 13~~Table 13~~ are from the conservation measures agreed upon as part of the Deschutes Basin Habitat Conservation Plan ("Deschutes River Basin Habitat Conservation Plan" 2020). Additionally, 37,870 AF of Crane Prairie storage water is dedicated to flow releases for OSF habitat. The account is kept full unless there is not enough inflow or other stored water to maintain a minimum 30 cfs outflow from the reservoir.

Formatted: Font: (Default) Times New Roman, Highlight

Table 13. Summary of reservoir outflow operations under HCP agreements

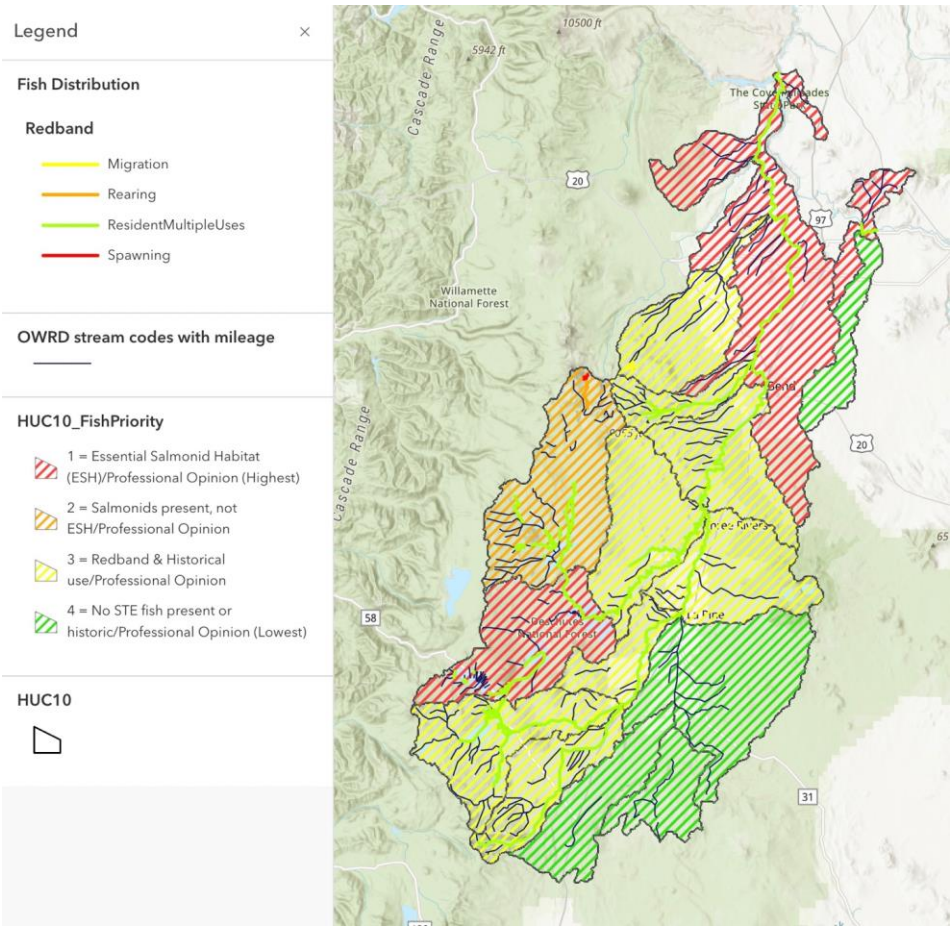
Reservoir	Maximum Flow of Operation	Minimum Flow(s) of Operation	Additional Operational Notes
Crane Prairie	400 cfs year-round	100 cfs from Dec 1-Aug 30; 75 cfs for rest of year	COID may choose to release up to 5,000 AF of additional stored water from Crane Prairie for OSF flow needs downstream of Wickiup. This option may be exercised up to two times in Years 1-7 of HCP implementation, and once every 5 years after that.
Wickiup	800 cfs from April 1 - April 30 unless USFWS has verified that OSF eggs at Dead Slough in La Pine State Park have hatched or are situated in a portion of the slough that will not be harmed by the increase in flow	Years 1-7: 100 cfs from Sept 16-March 30; Years 8-12: 300 cfs from Sept 16-March 30; Years 13-30: 400-500 cfs from Sept 16-March 30; 600 cfs from March 30-Sept 15 (in all years)	For all years, the volume of water equivalent to the amount scheduled for winter releases in excess of 100 cfs may be stored in Wickiup Reservoir for release later in the same water year. These releases would be designed to provide the maximum conservation benefit to the covered species, based on the current condition of the covered lands.
Crescent	None	Years 1-15: 10 cfs from Oct 1-June 30; Years 16-20: 11 cfs from Oct 1-June 30; Years 21-30: 12 cfs from Oct 1-June 30; 50 cfs in irrigation season (July 1-Sept 30) (in all years)	Volumes of storage in Crescent Lake Resrvoir are made available for OSF conservation under DBHCP. Volumes vary by storage volume on July 1st and increase over the implementation timeline of the HCP. View the full table of OSF volume amounts in Table 6 of Section 2.1.8.

As part of its work for the Ecological Needs Technical Committee, ODFW has developed a spatial tool which provides as a visualization of available data on instream water demands and ecological priorities for the Upper Deschutes Basin. The spatial tool includes various data layers which provide information on streamflows, instream water rights, existing HCP targets, critical habitats, fish and OSF distributions, water quality parameters, ecological priorities and data availability by HUC10 subwatershed, locations of fish passage barriers and seeps/springs, and more. Streamflow data include both current instantaneous flow rates from OWRD gages as well as modeled unregulated flows from Riverware. Instream water rights are displayed by stream reach and provide links to view a specific certificate on the OWRD Water Rights Information System (WRIS) database. Fish species distribution layers visualize which stream reaches currently provide habitat for rearing, spawning, and migration of spring chinook, summer

steelhead, redband trout, bull trout, and pacific lamprey. At the HUC10 subwatershed level, the spatial tool summarizes ODFW fish habitat priorities, data availability, and existing HCP targets.

Figure 7~~Figure 7~~ through Figure 9~~Figure 9~~ show examples of how the spatial tool may be used to visualize the various demands and priorities for the instream/ecological leg of the stool. Figure 7~~Figure 7~~ shows priority HUC10 subwatersheds for salmonid habitat compared to redband trout distribution to visualize potential restoration priorities. Figure 8~~Figure 8~~ shows the spatial distribution of OSF and the HUC10 subwatersheds for flow targets were agreed upon in the HCP. Figure 9~~Figure 9~~ shows the reaches and HUC10 subwatersheds where stream gage and Riverware data are available to identify where data gaps exist.

Figure 7. Distribution of redband trout and priority HUC10 subwatersheds for salmonid habitat in the Upper Deschutes Basin (from ODFW spatial tool).



Commented [AE11]: What other examples could potentially be useful/interesting to display here - instead of or in addition to these three?

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Formatted: Font: Times New Roman

Figure 8. Spatial distribution of OSF and HUC10 subwatersheds with existing HCP targets (from ODFW spatial tool).

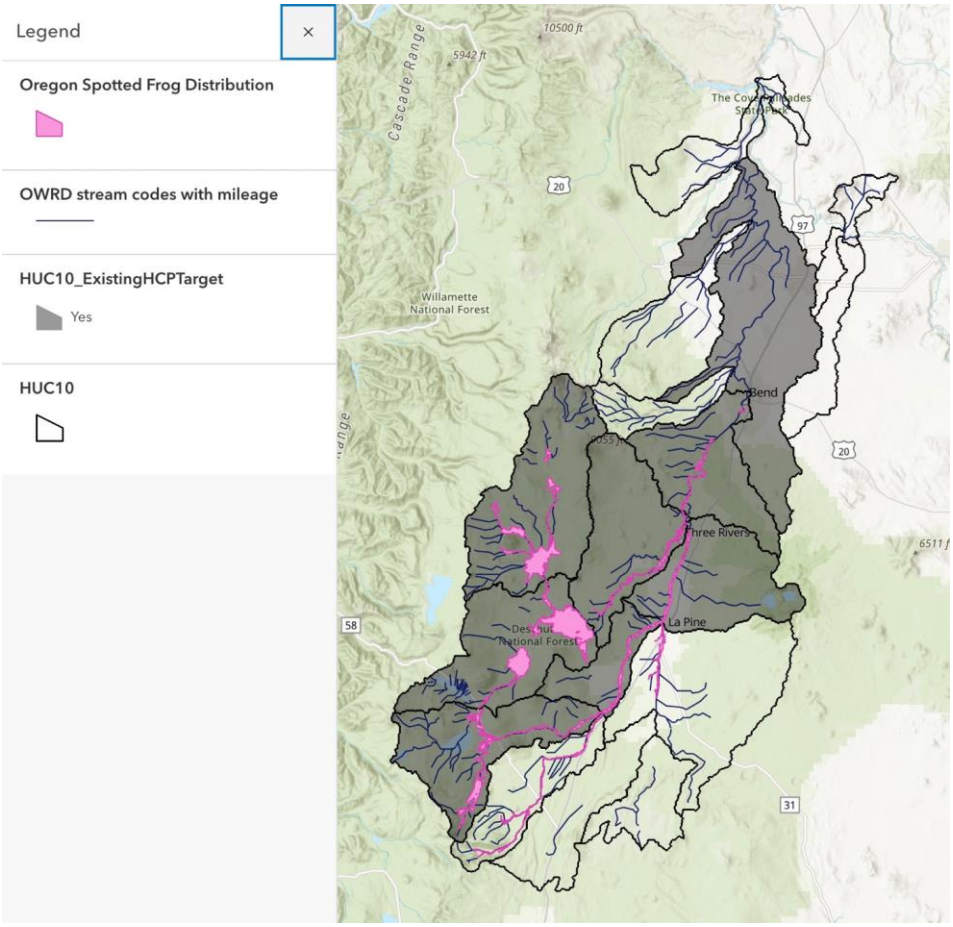
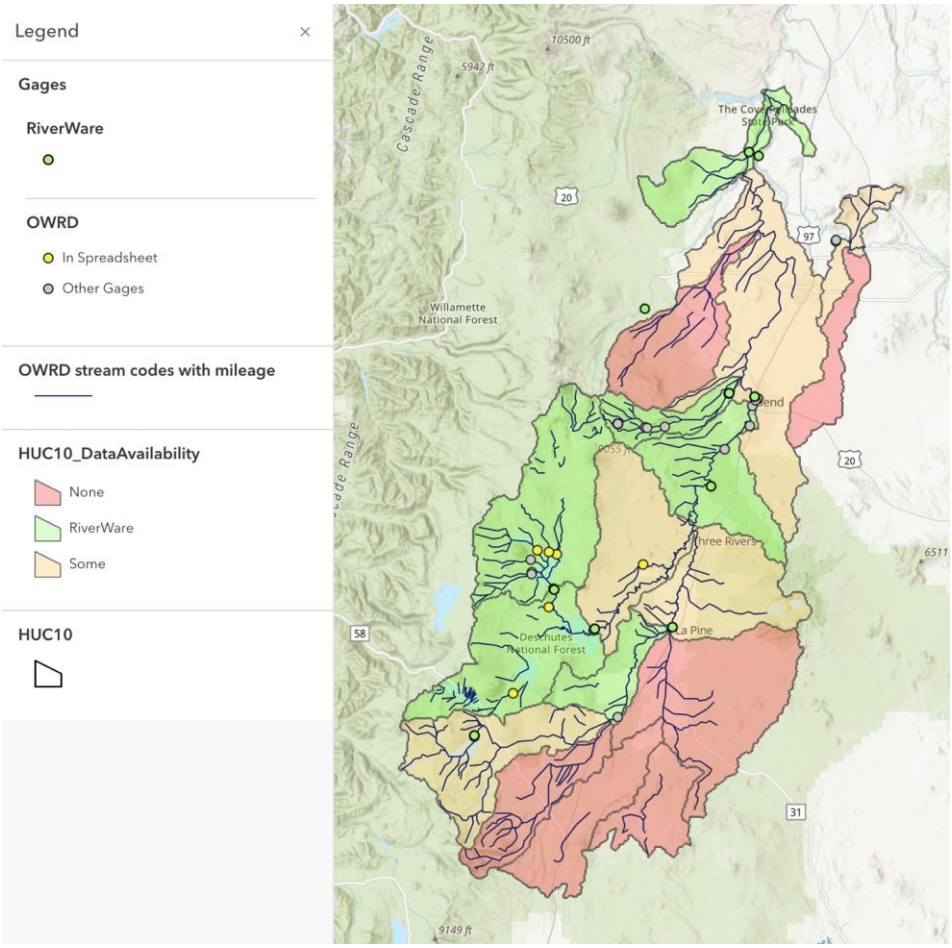


Figure 9. Spatial distribution of flow gages and data availability by HUC10 subwatershed in the Upper Deschutes Basin (from ODFW spatial tool).



3.6 Water Quality Considerations

The language of the Basin Study's broad objectives for meeting the needs of the three legs of the stool highlights the importance of water management solutions addressing both water quantity and quality for out-of-stream uses and for instream ecological needs. The BSWG endorsed the concept that all three of the broad goals for addressing the three legs of the stool should be valued and pursued in parallel.

The 2022 DEQ Integrated Report was approved by the U.S. Environmental Protection Agency in September of 2022. The report is a combination of the Clean Water Act 305(b) which requires

the development of the report and section 303(d) which requires the development of a list of impaired waterbodies. The Integrated Report describes the status of water quality in Oregon, specifically when a waterbody is impaired its pollutant levels have exceeded the protective water quality standards.

Category 5 listings indicate that a designated use or water quality standard is not attainted and a TMDL is needed. Category 4C impairments are caused by pollution, not a pollutant. Parameters in Category 4 indicate that a TMDL is not needed to address the pollutant. The Upper Deschutes and Little Deschutes Subbasins are on DEQ's high and medium priorities for development. These subbasins sit in more of the medium priority range with an estimated submission in April of 2030 (Mitchie and Liverman 2022).

The Upper Deschutes River is Category 5 listed for temperature, dissolved oxygen, pH, sedimentation, and turbidity and Category 4C for flow and habitat modification. The Little Deschutes River is listed as Category 5 for temperature and dissolved oxygen and Category 4C for flow modification. Crescent Creek is also listed as Category 5 for year-round temperature (Oregon Department of Environmental Quality 2022).

Water quality in the Upper Deschutes Basin planning area is measured by the Oregon Water Quality Index (WQI), which is a statistical tool developed by DEQ to prescribe a water quality score to a water body based on the analysis of a defined set of water quality variables. DEQ monitors 163 ambient water quality sites in Oregon six times a year (Brown 2016). Five of these sites are located within the Phase I planning area – four on the mainstem Deschutes River and one on the Little Deschutes River. All five of these sites show good to excellent overall WQI scores. The one site with a 'good' rating – the Deschutes River at Lower Bridge – is the only waterway with 'range' as the predominant land use, while the rest are in forest or mixed land use areas and show 'excellent' ratings (Table 14~~Table 14~~). Despite receiving a 'good' rating, the Deschutes River at Lower Bridge site shows improvement in water quality trends for biochemical oxygen demand (B) and phosphorus (P). At all other sites, there is at least one improving trend in the sub-index status and trend section (Table 14~~Table 14~~) (Brown 2023). The sub-index status and trend section of Table 14~~Table 14~~ shows that some of the water quality variables in certain reaches received lower scores than their overall average WQI score would suggest. For example, the biochemical oxygen demand (B) and phosphorus (P) variables received either 'poor' (orange) or 'fair' (yellow) scores in all reaches of the Deschutes River. The Deschutes River at Lower Bridge site also received 'poor' sub-index scores for temperature and pH. WQI scores cannot be compared to the Integrated Report list of impaired waterbodies – these are different measures of assessing water quality (ODEQ, personal communication, 2023).

Formatted: Font: (Default) Times New Roman, Highlight

Formatted: Font: (Default) Times New Roman, Highlight

Formatted: Font: (Default) Times New Roman, Highlight

Table 14. WQI results for Upper Deschutes water quality monitoring sites, with key (Hendrickson, 2023).

Station	Location Description	Land Use	Water Year Range	OWQI Score	OWQI Status	OWQI Trend and Magnitude		OWQI Trend for Past 10 Reporting Years	Sub-Index Status and Trend							
									T	pH	D	B	TS	N	P	E
DESCHUTES BASIN																
10686	Deschutes R at Harper Bridge (Sunriver)	Forest	2013-22	91	Excellent	NT				↑	↑	↑		↑	↑	
10508	Deschutes R at Lower Bridge	Range	2013-22	87	Good	↑	2.0					↑			↑	
10511	Deschutes R at Mirror Pond (Bend)	Mixed	2013-22	92	Excellent	NT						↑		↑		
10688	Deschutes R at Pringle Falls	Forest	2013-22	90	Excellent	NT				↑		↑		↑	↑	
10696	Little Deschutes R at HWY 42	Forest	2013-22	92	Excellent	NT					↑		↑	↑		

Studies have also been conducted towards the goal of improving water quality for the benefit of fish and wildlife in the Upper Deschutes. The 2011 DEQ water quality assessment concluded that the most important and widespread water quality concern for fish and wildlife habitat in the basin is increased stream temperature, particularly in summer and early fall months (Department of Environmental Quality 2011). Increased stream temperature is caused in part due to water supply shortages in streams and rivers during the irrigation season. For the Basin Study, stream temperature analyses were completed by selecting one site each from Whychus Creek, the Middle Deschutes River, and Tumalo Creek to develop relationships among stream temperature, stream flow, and air temperature during the irrigation season (Upper Deschutes Watershed Council 2016). Regression analyses indicated that flow rates and air temperatures correlated with stream temperature, with better correlations seen for the months from April through July. Analyses of data for each location generated relationships indicating how flow increases correlated with decreases in stream temperature, and how different changes in air temperature correlate with changes in stream temperature (Upper Deschutes Watershed Council 2016). The outcomes were used in the Basin Study to help inform assessments of water management strategies, which could improve streamflow to reduce temperature and benefit fish and wildlife habitat.

3.7 Climate Change, Future Variation, Resilience and Risk Considerations

A key element of the Basin Study was to understand future conditions that may impact water supply shortages to meet instream and out-of-stream demands. These include population growth and resulting land use changes, as well as projected pressures from climate change. The population of the Deschutes Basin has steadily increased over the past few decades and is expected to continue to increase. A larger population generally comes with greater pressure on out-of-stream water demands and associated land use changes and development could potentially threaten or impact aquatic and riparian habitat in the basin. However, much of the aquatic and riparian habitat in the Upper Deschutes Basin is protected from development by the Wild and Scenic Rivers Act and State Scenic Waterways Act. Section 7 of the Federal Wild and Scenic Rivers Act helps to protect against any water development or activities that could negatively affect the unique characteristics of a listed reach (Deschutes National Forest, Oregon State Parks, and National Wild and Scenic Rivers Systems 1996). In addition, the State Scenic Waterways Act prohibits new activities in a listed area if those activities would impair flow and if that impaired flow would harm the unique qualities of the waterway (ORS 736-040-0030). However,

these protections only apply to eight reaches federally listed as Wild and Scenic and six reaches listed as State Scenic Waterways.

Climatic changes are underway across Oregon and are likely to increase in the coming decades. These changes are likely to include more intense storms and floods, altered river hydrograph patterns, extended drought, increased wildfire, and more heat waves. These will affect native species, agriculture, forestry, and human health. Communities will need to plan for such changes to prevent potentially catastrophic consequences and/or declines in their quality of life (Barr, Journet, and Leonard 2011).

A study conducted by Bureau of Reclamation in 2015 assessed how climate change will impact the hydrology and water resources of the Columbia River Basin as part of their West-Wide Climate Risk Assessment. The study found climate change could result in possible 21st century impacts on fish and wildlife habitat, ESA-listed species flood risk, water quality, hydropower generation, reservoir conditions and water delivery, ecological resilience, and recreation (Table 15~~Table 15~~).

Formatted: Font: (Default) Times New Roman, Highlight

Table 15. Potential climate change impacts on various water resources categories in the Columbia River Basin.

Water Resource Category	Overall 21st Century Possible Impacts
Fish and Wildlife Habitat	Possible decreased summer flow
ESA Listed Species	Potential negative impacts on adult salmonid migration in summer months
	Potential negative impacts on Incubating eggs and juvenile Coho, chum, Chinook, and steelhead survival in winter months
Water Quality	Possible increased water temperature
	Possible increased total dissolved gas (TDG)
Flood Control Operations	Possible increased reservoir discharges during the late winter/spring to follow flood control rule curves
	Possible increase in downtream flood risk
Reservoir Conditions and Water Delivery	Potential to increase fill of reservoirs during spring runoff
	Higher reliance on stored water than natural flow
Hydropower Generation	Possible increased power generation in late winter and spring
	Possible decreased generation in summer
Flow and Water Dependent Ecological Resilience	Non-adaptable species may possibly by negatively impacted
Recreation	Possible decrease in reservoir recreation season
	Possible decrease in stream recreation season

Given the potential impact of climate change, one of the goals of the Basin Study as defined by the Plan of Study was to develop relevant and detailed climate change projections that will help stakeholders further refine water supply projections (Deschutes Basin Board of Control and Bureau of Reclamation 2015). To accompany the Basin Study, a range of available climate change models were used to evaluate climate conditions approximately 10 to 50 years in the future. Those models indicate that future annual precipitation in the basin is projected to increase by approximately 5 percent for median projections, with a potential range from a 3 percent decrease to an 11 percent increase. Future average temperatures may increase by 2.8° C (4.9° F) based on climate change models for median projections. Climate models also indicate that the

timing patterns for precipitation may change in the future. The changes in timing of precipitation may result in increased precipitation in the winter, and, coupled with higher temperatures, could shift runoff to earlier in the year on average (Bureau of Reclamation 2018b). The potential impacts on temperature, precipitation, and runoff timing can be used to qualitatively describe the following potential impacts on the current system:

- Increased winter and spring runoff volumes could increase the possibility of higher peak flows.
- Increased winter and spring runoff volumes could increase the likelihood that reservoirs would fill in the spring; however, demands on stored water could increase as noted below.
- Lower natural flows in the summer could increase reliance on stored water for those irrigation districts that use stored water.
- Exacerbated water quality impacts, particularly on stream temperature, emphasizing the need for migratory fish to be able to access cold, groundwater-influenced stream reaches.

3.8 Conclusion

Water supply shortages found in the Basin Study varied with location, time of year, and modeled conditions. Current conditions modeling for the Upper Deschutes Basin overall resulted in the following conclusions (Bureau of Reclamation and Oregon Water Resources Department 2019):

- Total annual inflows to the basin (the Upper Deschutes drainage including the Tumalo, Whychus, and Crooked systems) vary from 860,000 acre-feet to 2.3 million acre-feet, depending on how much precipitation falls in a given year or sequence of years (estimates based on calculated unregulated flows in each sub-basin).

- Relative to an objective of meeting existing instream water rights established to support ecological objectives (including 600 cfs winter flows for the Upper Deschutes), instream demands experience median annual shortages of approximately 108,000 acre-feet. Those shortages may range up to 175,000 acre-feet in dry years. Note that these shortages were calculated in the Basin Study and do not include State Scenic Waterways flows, ODFW presumptive flows, and flows needed for OSF.

- The average annual surface water diversion for eight irrigation districts totals (including two that are outside the Planning Area) approximately 720,000 acre-feet. Modeled irrigation district shortages total approximately 30,000 acre-feet in average or wet years and approximately 160,000 acre-feet in dry years. With the implementation of conservation projects in the future, it is possible that the six districts in the Upper Deschutes Basin could reduce total annual agricultural water demand up to 151,000 to 264,000 AF, potentially making that water available for instream flow and/or junior district supply.

- The current annual water use for municipal and quasi-municipal purposes are derived primarily from groundwater and total approximately 40,000 acre-feet. It is anticipated that meeting all projected groundwater demands for cities and private water suppliers will require approximately 16,000 acre-feet of permanent mitigation (water dedicated

Commented [AE12]: We don't have one grouped number to report for instream shortages - there isn't one number that fully represents all of the instream/ecological needs. I have added a statement here that the shortages listed come from the Basin Study and add a statement about what it doesn't include - is there a better way to report this result?

instream). In order to meet all projected groundwater demands in the next 50 years will require approximately 21,000 acre-feet of permanent mitigation (water dedicated instream). Because water for mitigation is dedicated instream, meeting projected groundwater demands also contributes to addressing instream flow needs.

- To meet higher flows that could contribute to broader ecological objectives in some reaches (including 600 cfs winter flows for the Upper Deschutes), total median shortages for instream are modeled as approximately 200,000 acre-feet and could range up to 500,000 acre-feet in dry years.

In addition, shortages could become more pronounced depending on how potential climate change conditions impact future supplies and demand. The Basin Study evaluated shortages for instream and out-of-stream uses and then used large-scale climate change models to help frame how future hydrology might affect water supply shortages. The Basin Study used climate change models to evaluate climate conditions in the future (i.e., approximately 10 to 50 years out) and assess the potential impact on water resources (Bureau of Reclamation 2018b). Climate projections for both drier and wetter trends suggest potential future annual average temperature increases ranging from 2.5 to 6.1° F. Though there is wide variation in modeled future changes in precipitation, there is general agreement that winter precipitation may increase while summer precipitation may decrease. The potential impacts on temperature, precipitation, and runoff timing can be used to qualitatively describe potential impacts on the current system:

- Increased winter and spring precipitation and an increase in relative amount of precipitation falling as rain could alter the timing and increase the magnitude of peak flows.
- Increased winter and spring precipitation and an increase in relative amount of precipitation falling as rain could increase the likelihood that reservoirs would fill in the spring; however, demands on stored water could increase as noted below.
- Lower natural flows in the summer could increase reliance on stored water for those irrigation districts that rely on stored water.

3.9 References

Barr, Brian R, Alan R P Journet, and Jessica L Leonard. 2011. “Projected Future Conditions and Sector Background Information for the Deschutes River Basin of Central Oregon.” Geos Institute.

Brown, D. 2016. “Oregon Water Quality Index: Background, Analysis, and Usage.” Oregon Department of Environmental Quality.

———. 2023. “Oregon Water Quality Index Data Summary.” Oregon Department of Environmental Quality.

Bureau of Reclamation. 2018a. “Technical Memorandum: Analysis of Regulated River Flow in the Upper Deschutes Basin Using Varying In-Stream and Out-of-Stream Conditions.” Boise, Idaho: US Department of the Interior, Bureau of Reclamation.

———. 2018b. “Technical Memorandum: Compilation and Analysis of Climate Change Information in the Deschutes Basin.” US Department of the Interior, Bureau of Reclamation.

Bureau of Reclamation and Oregon Water Resources Department. 2019. “Upper Deschutes River Basin Study.”

City of Bend. 2021. “Water Management and Conservation Plan.” Bend, OR: GSI Water Solutions, Inc.

Cuenca, Richard H, Jeffery L Nuss, Antonio Martinez-Cob, and Gabriel G. Katul. 1992. “Oregon Crop Water Use and Irrigation Requirements.” Oregon State University Extension Service: Oregon State University.

Department of Environmental Quality. 2011. “Deschutes Basin Water Quality Status and Action Plan - Summary 2011.” Bend, OR: State of Oregon Department of Environmental Quality - Water Quality: Eastern Region, Bend Office.

Deschutes Basin Board of Control and Bureau of Reclamation. 2015. “Upper Deschutes River Basin Study Memorandum of Agreement.” Boise, Idaho: US Department of the Interior, Bureau of Reclamation.

Deschutes National Forest, Oregon State Parks, and National Wild and Scenic Rivers Systems. 1996. “Upper Deschutes Wild and Scenic River and State Scenic Waterway Comprehensive Management Plan.” USDA Forest Service Pacific Northwest Region.

“Deschutes River Basin Habitat Conservation Plan.” 2020. FWS.Gov. 2020. https://www.fws.gov/project/deschutes-river-basin-habitat-conservation-plan.

Farmers Conservation Alliance. 2022. “Arnold Irrigation District Infrastructure Modernization Project: Final Watershed Plan-Environmental Assessment.” Deschutes County, OR: USDA NRCS, DBBC, Arnold ID.

Mitchie, R, and A Liverman. 2022. “TMDL Priorities and Schedule.” ODEQ. https://www.oregon.gov/deq/wq/Documents/IR2022-TMDLPriorities.pdf.

Oregon Department of Environmental Quality. 2022. “2022 Integrated Report Database.” https://rstudioconnect.deq.state.or.us/2022_IR_Database/.

Oregon Department of Fish and Wildlife. 2023. “ODFW Guidance for Determining Instream Flow Needs.”

Oregon Water Resources Department. n.d. “Exempt Use Wells.”

Richter, Brian D, Colin Apse, Christopher P Konrad, and M.M. Davis. 2011. “A Presumptive Standard for Environmental Flow Protection.” The Nature Conservancy.

River Design Group. 2017. “Oregon Spotted Frog and Deschutes Redband Trout Habitat Modeling and Riparian Analysis at Two Sites on the Upper Deschutes River.” Prepared

for Deschutes Basin Board of Control on Behalf of the Basin Study Work Group. Corvallis, OR.
Sussman, Adam, and Owen McMurtrey. 2017. “Technical Memorandum Task 1A - Water Right Assessment: Historical Diversions and Instream Water Rights in the Deschutes Basin.” Technical Memorandum. GSI Water Solutions, Inc. https://www.deschutesriver.org/Water%20Use%20Memo__Draft%20Final.pdf.
Sussman, Adam, Owen McMurtrey, and Kim Grigsby. 2017. “Technical Memorandum: Task 6 - Groundwater Mitigation under the Deschutes Basin Groundwater Mitigation Program; A Summary of Projected Supply and Demand.”
Upper Deschutes Watershed Council. 2016. “Whychus Creek and Middle Deschutes River Temperature Assessments.” Prepared for Basin Study Work Group.
U.S. Fish and Wildlife Service. 2020. “Final Environmental Impact Statement for the Deschutes Basin Habitat Conservation Plan - Volume 1: Chapters 1-7.” U.S. Fish and Wildlife Service Columbia-Pacific Northwest Interior Region 9.
———. 2023. “Draft Recovery Implementation Strategy for Oregon Spotted Frog (Rana Pretiosa).” Portland, OR: USFWS.