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CITY OF BEND AMBIENT RIVER WATER QUALITY MONITORING: 2024-2025

Deschutes River and Tumalo Creek

Prepared for
City of Bend
Water Services
21051 NE Talus Pl
Bend, Oregon 97701

CITY OF BEND

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Deschutes River and Tumalo Creek

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Abbreviations and Acronyms

7DADM	seven-day average maximum temperature
AU	assessment unit
AWQMS	Ambient Water Quality Monitoring System
BENO	Benham Falls
BOR	Bureau of Reclamation
City	the City of Bend
°C	degree Celsius
CFS	cubic feet per second
CM	criteria met
COID	Central Oregon Irrigation District
CWA	Clean Water Act
DBBC	Deschutes Basin Board of Control
DBHCP	Deschutes Basin Habitat Conservation Plan
DCMO	Deschutes County MID Canal
DEBO	Deschutes River Below Bend
DL	detection limit
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DR	Deschutes River
EPA	Environmental Protection Agency
ESA	Environmental Science Associates
FY	fiscal year
IR	Integrated Report
ISWMP	Integrated Stormwater Management Plan
mg/L	milligrams per liter
µS/cm	microSiemens per centimeter
mL	milliliters
MOU	memorandum of understanding
MPN	most probable number
MS4	Municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
OAR	Oregon Administrative Rule
ODEQ	Department of Environmental Quality
OSP	Oregon spotted frog
OWRD	Oregon Water Resources Department
UDWC	Upper Deschutes Watershed Council
POR	period of record
PSU	Portland State University
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RM	river mile
TC	Tumalo Creek
TID	Tumalo Irrigation District
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
TUMO	Tumalo Creek below Tumalo Feed Canal
UDWC	Upper Deschutes Watershed Council
UGB	urban growth boundary
USDA	United States Department of Agriculture
SM	Standard Methods

CITY OF BEND AMBIENT RIVER WATER QUALITY MONITORING: 2024-2025

Deschutes River and Tumalo Creek

Introduction

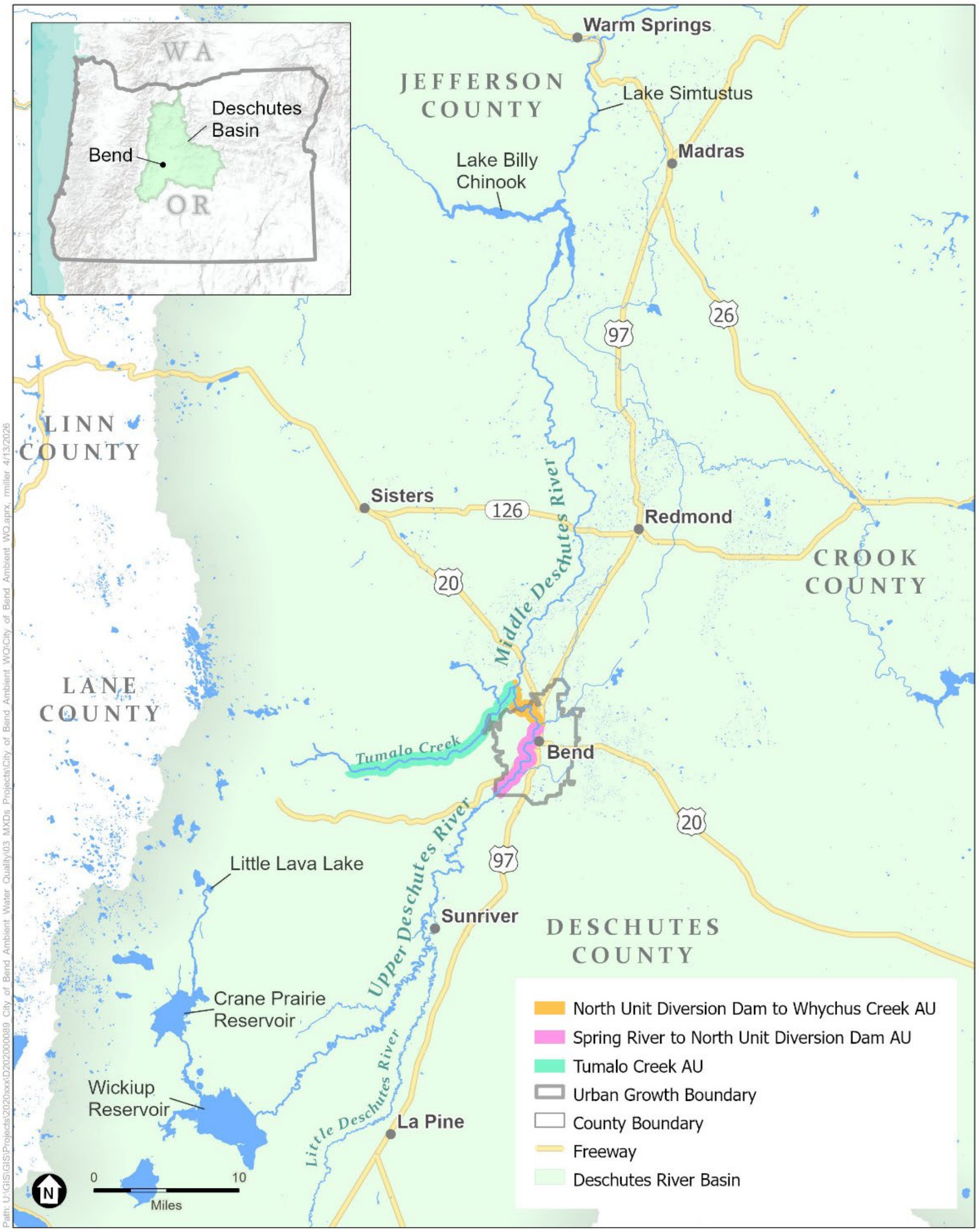
The City of Bend (the City) has been monitoring water quality from Tumalo Creek and the Deschutes River as it enters the City near the southern urban growth boundary (UGB) to where it leaves near the northern UGB. This monitoring has occurred from 2004 through 2025, in accordance with a series of Water Quality Monitoring Plans approved by the City. These data improve understanding of changing conditions over time and data are provided to the Oregon Department of Environmental Quality (ODEQ). This report summarizes water quality data collected from 10 sites along the Deschutes River and six sites along Tumalo Creek to provide a basis for understanding water quality in surface waters within the City, answer water quality questions, and inform ecological processes and protection policies regarding these waterbodies as they flow through the City. The specific objectives of this report that captures the results of the ambient monitoring program activities are to:

- Increase understanding of seasonal and annual variations for conventional water quality parameters in the Deschutes River and Tumalo Creek,
- Satisfy element IX (Monitoring) of the City's *Integrated Stormwater Management Plan* (ISWMP) – a required component under the City's National Pollutant Discharge Elimination System (NPDES) permit number 102901,
- Gather legally defensible data leading to improved understanding and potentially to the listing or de-listing of local waterways under the Federal Clean Water Act Section 303(d) with ODEQ and the United States Environmental Protection Agency (USEPA),
- Gather legally defensible data to aid in establishment of ODEQ's total daily maximum load (TMDL) values for the Deschutes River and Tumalo Creek, and
- Inform staff and local authorities in addressing sediment issues in Mirror Pond on the Deschutes River.

From 2004 to 2009, water quality monitoring was performed under a memorandum of understanding (MOU) between the City and the Upper Deschutes Watershed Council (UDWC) and were summarized in *City of Bend Ambient Water Quality Monitoring: Deschutes River and Tumalo Creek 2005-2008 (Bend Oregon)* (UDWC 2010). In subsequent years, water quality data collected within the Deschutes River through the City of Bend reach and portions of Tumalo Creek were collected by the City and summarized in *City of Bend Ambient River Water Quality Monitoring: Deschutes River 2008-2017* (Environmental Science Associates [ESA] and MaxDepth Aquatics (2019). The main objective was to assess the water quality of the Deschutes River coming into, within, and leaving the City, and to further compare those results to the prior UDWC (2010) report to analyze any changes. The water quality data collected also inform the upper tier of effectiveness evaluation and assist in understanding the health of the river over time. This report builds upon previously reported data with an emphasis on data collected between 2024 and 2025.

Study Area

Central Oregon is located within the counties of Deschutes, Jefferson, and Crook; flanked by the Cascade Mountain Range to the west and the Ochoco Mountains to the east (**Figure 1**). Unlike most communities on the west side of the Cascades, the region is characterized by dry and sunny summers with precipitation largely falling as snow during the winter months. Average annual precipitation for Bend is 11.63 inches (Western Region Climate Center 2024). The City of Bend is in Deschutes County and is the largest city in Central Oregon. The population of Deschutes County was estimated at 213,886 in July 2025, continuing to make it the 7th largest county in the state and the fastest growing at a 7.3% increase between April 2020 and July 2025 (PSU 2025). The population of the City of Bend was estimated at 107,079 in July 2025, or the 5th largest city in the state (PSU 2025), which is slightly less than was projected (109,389) by the City in its Comprehensive Plan (City of Bend 2025). Located along the bank of the Deschutes River, it was originally settled as a logging town but is now considered a gateway community to numerous outdoor activities including skiing, biking, rafting, golf, camping, tubing, and fishing – many of which are enjoyed on the Deschutes River and Tumalo Creek.



SOURCE: ODOT, 2015; BLM, 2015, USGS, 2020; ESRI, 2020 D202401423.01

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Study Area
City of Bend Ambient River Water Quality Monitoring

Figure 1. Study area for the City of Bend Ambient River Water Quality Monitoring

The Deschutes River has its headwaters along the eastern flanks of the Cascade Mountains. Its headwaters are routinely attributed to Little Lava Lake; however, groundwater that flows through porous geologic formations throughout the upper Deschutes Basin are the primary drivers of its upper watershed hydrology (Lite and Gannett 2002).

From Little Lava Lake, the Deschutes River flows into Crane Prairie Reservoir, then Wickiup Reservoir (**Figure 1**). Wickiup Reservoir is a productive system that can support summer algae blooms, as well as elevated primary productivity. These conditions, when combined with dramatic changes in seasonal storage and discharge, can affect and influence downstream water quality conditions (e.g., turbidity, total suspended sediments, temperature, and dissolved oxygen). Below Wickiup, the Little Deschutes River (just south of the community of Sunriver) enters the Deschutes River. Water quality conditions along the Little Deschutes are known to generate exceedances for temperature (year-round) and dissolved oxygen (spawning and year-round) (ODEQ 2022). Near the City's southern UGB, a diversion canal operated by the Central Oregon Irrigation District (COID) is located at river mile (RM) 170.75. Below the COID diversion, within the City, the river flows freely about three miles where it is flanked by the Deschutes River Trail and characterized by a series of waterfalls, riffles, and pools before Colorado Street (**Figure 2**).

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Figure 2. Example of the Deschutes River as it enters the City of Bend

The Colorado Street Dam, once located at RM 167.55, was built in 1915 to serve as a mill pond for lumber mills. In 2014/2015, portions of the dam were removed and extensive improvements were made to allow for instream passage of boaters, and enhancements for fish and wildlife habitat. Downstream, the Pacific Power and Light Hydroelectric Dam forms Mirror Pond, an iconic feature of the City flanked by a number of city parks, private homes, and downtown businesses. Less than a half mile downstream is the Steidl and Tweet Dam operated by Tumalo Irrigation District (TID). Approximately three quarters of a mile downstream is the North Canal Dam, which diverts water for Swalley, North Unit and Central Oregon Irrigation Districts. Beginning in February 2016 and again in August 2017, sections of the Pilot Butte Canal were added to the National Register of Historic Places. Beyond the city limits, Tumalo Creek joins the Deschutes River from the southwest. Further downstream, the Deschutes River is once again impounded by the Pelton Round Butte Hydroelectric Complex, a series of three dams, which in order, create Lake Billy Chinook, Lake Simtustus, and an unnamed reregulation reservoir before continuing to its confluence with the Columbia River.

Tumalo Creek is a tributary to the Deschutes River with the confluence being located approximately 2.5 river miles downstream of the City of Bend’s northern UGB (Figure 1).

Tumalo Creek begins where the Middle Fork Tumalo Creek and North Fork Tumalo Creek meet in the eastern Cascade Range and travels past scenic waterfalls such as Tumalo Falls, which is located about 15 miles west of Bend. Tumalo Falls is a stunning 97-foot waterfall popular with tourists and photographers. From there, Tumalo Creek skirts the westernmost boundary of the City limits as it travels through Shevlin Park (**Figure 3**) on its way to the confluence with the Deschutes River just upstream of Tumalo State Park. The Bridge Creek Fire in 1979 and subsequent salvage logging left three miles of Tumalo Creek without large woody debris for fish habitat and bank stabilization. Between 2003 and 2008, a number of partners, including the Upper Deschutes Watershed Council, the Deschutes National Forest, Oregon Watershed Enhancement Board, National Forest Foundation, City of Bend, the Deschutes River Conservancy, and the Oregon Department of Fish and Wildlife, implemented major restoration efforts to areas most affected by the fire.

Figure 3. Tumalo Creek as it runs through Shevlin Park

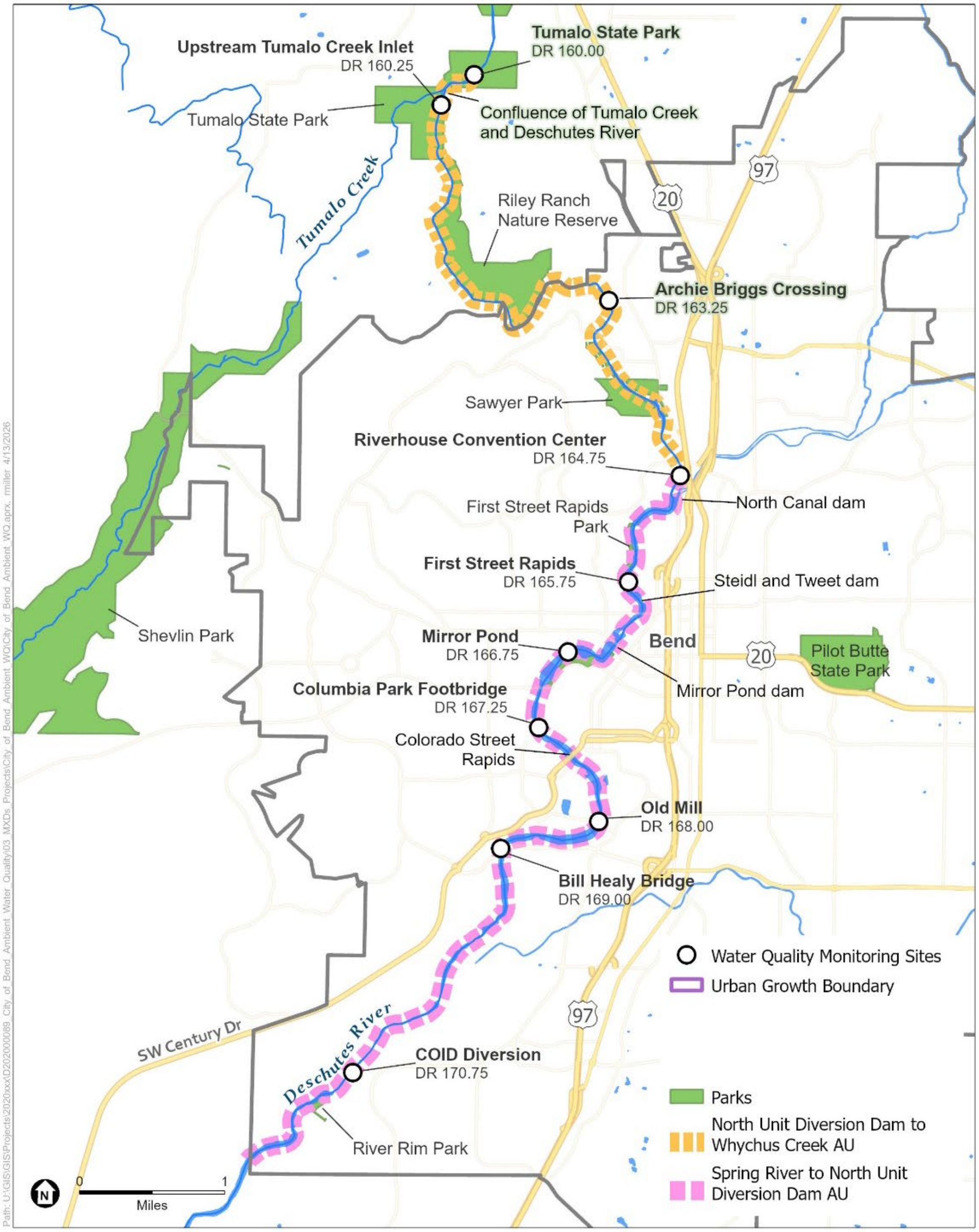
Historically, spring-fed inputs to the Deschutes River resulted in very stable hydrologic regimes on daily, monthly, and even annual timescales (USDA 1996). However, impoundments and diversions along the length of the river have dramatically altered these natural flow regimes. In the Deschutes Basin, water is legally diverted from the river to meet various water rights from March/April to mid-October to provide for mostly agriculture demands in Central Oregon. Due to the topography of the surrounding lands, irrigation districts and related diversion points both above and within Bend, divert a substantial portion of the Deschutes River's streamflow to meet the water rights of the various districts and their patrons. Several of the Districts all have supplemental water rights that allow for seasonal storage in Wickiup, Crane Prairie and Crescent lakes. These combined operations result in low flows in winter months while filling reservoirs, and in summer months, release of the storage rights, create higher than historic flows upstream of Bend. The combined district diversions result in low flows downstream of Bend, most noticeably below the North Canal Dam. These large discharge swings and reductions in streamflow have contributed to degradation in streambank and fish habitat, fish passage and water quality. Within the Middle Deschutes River (between the City of Bend and Lake Billy Chinook), modern day flows are significantly lower during the summer irrigation season though recent strides have been made by numerous stakeholders in the Deschutes Basin to increase instream flow and decrease overall fluctuations. Significant drivers of flow improvements are related to the relicensing of the Pelton project, which reintroduced listed steelhead in 2007, and led to the start of the Habitat Conservation Plan (HCP). Steelhead were included as an experimental population which delayed the need for an incidental take permit. In August 2017, while the HCP study was already underway, the U.S. Fish and Wildlife Service listed the Oregon spotted frog (OSP) (*Rana pretiosa*) as threatened, and that species was added to the HCP planning.

The Deschutes Basin HCP (DBHCP) was finalized and approved by the U.S. Fish and Wildlife Service December 31, 2020. The HCP is a large-scale planning effort intended to help the City of Prineville and the eight irrigation district members of the Deschutes Basin Board of Control (DBBC) meet their current and future water needs while enhancing fish and wildlife habitat (USFWS 2020). Conservation measures in the DBHCP are intended to minimize and mitigate impacts caused by the "take" of covered listed species (OSP, bull trout, spring Chinook salmon, sockeye salmon and steelhead) that may result from the storage, release, diversion and return of irrigation water by the member irrigation districts and the City of Prineville. Under the HCP, minimum fall/winter flows in the Deschutes River below Wickiup Dam would be increased incrementally to 400 cubic feet per second (cfs) within the next 30 years. Up until the storage season of 2015/2016, winter releases in the river downstream from Wickiup Reservoir were as low as 20 cubic-feet-per-second (cfs) (Stout 2025).

Methods

Since 2008, the City has monitored a number of sites along the Deschutes River and Tumalo Creek both within and outside the city limits and sites have shifted somewhat over time. **Figure 4, Figure 5, and Table 1** illustrate and describe the monitoring locations that occurred in 2024 and 2025 in the Deschutes River (DR) and Tumalo Creek (TC). The monitoring sites are grouped by Assessment Unit (AU) per the ODEQ

2022 Integrated Report (see Regulatory Framework section below). Monitoring parameters included: (1) grab samples for laboratory analysis of total coliform, *E. coli*, chloride, fluoride, sulfate, orthophosphate, total phosphate, nitrate, nitrite, and total suspended solids from all sites (2) continuous (e.g., 15-minute interval) temperature monitoring using temperature-specific loggers at all but one site, and (3) continuous (e.g., 15-minute interval) monitoring with a multi-parameter sonde for temperature, dissolved oxygen (DO), specific conductance, and pH at four Deschutes River sites. ODEQ has an established Ambient Water Quality Monitoring System (AWQMS) sample site co-located with DR 166.75 (Mirror Pond). When possible, City staff monitor this site at the same time as ODEQ. Specific information on analytical methods is provided in **Table 2**.



SOURCE: ODOT, 2015; BLM, 2015, USGS, 2020; ESRI, 2020

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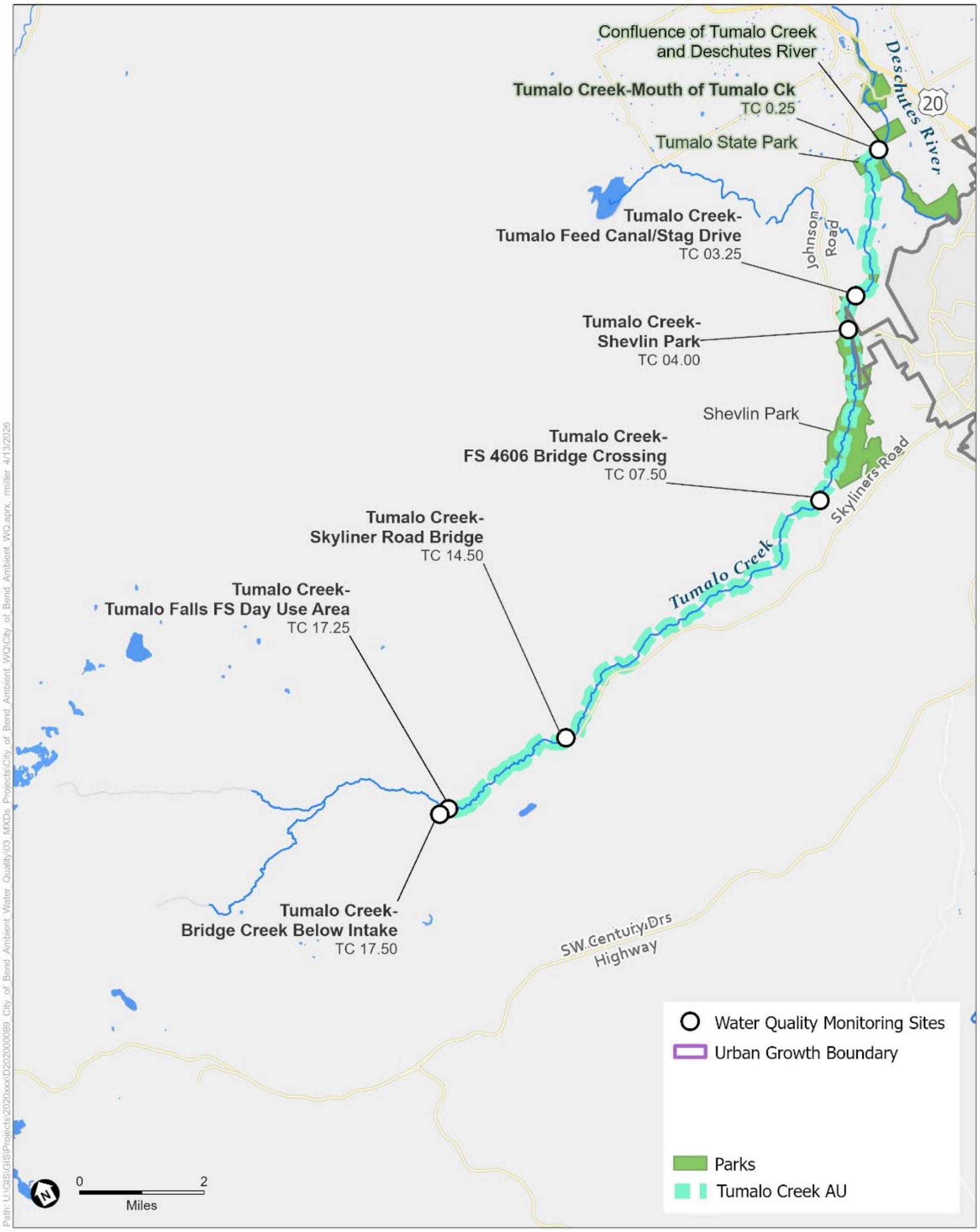
Water Quality Monitoring Sites
City of Bend Ambient River Water Quality Monitoring

Figure 4. Water quality monitoring sample sites, parks, and assessment units along the Deschutes River



SOURCE: ODOT, 2015; BLM, 2015, USGS, 2020; ESRI, 2020 D202401423.01

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Water Quality Monitoring Sites
City of Bend Ambient River Water Quality Monitoring

Figure 5. Water quality monitoring sample sites, parks, and assessment unit on Tumalo Creek

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TABLE 1. ASSESSMENT UNITS, SAMPLE SITES, AND LOCATIONS

Assessment Unit	Site No.	Site Name	Site Description	Latitude	Longitude
Tumalo Creek	TC 0.25	TC Mouth	Tumalo Creek at Mouth	44.115950	-121.339290
	TC 3.25	TC Canal	Tumalo Creek at Tumalo Feed Canal/Stag Drive	44.040564	-121.330014
	TC 4.00	TC Shevlin Park	Tumalo Creek at Shevlin Park	44.082873	-121.376368
	TC 7.50	TC FS Bridge	Tumalo Creek at FS 4606 Bridge Crossing	44.051480	-121.411349
	TC 14.50	TC Skyliner Br.	Tumalo Creek at Skyliner Road Bridge	44.032310	-121.520430
	TC 17.25	TC Falls	Tumalo Creek at Tumalo Falls FS Day Use Area	44.031218	-121.564654
North Unit Diversion Dam to Whychus Creek	DR 160.00	DR State Park	Deschutes River at Tumalo State Park	44.117746	-121.334802
	DR 160.25	DR above TC	Deschutes River Upstream Tumalo Creek Inlet [1]	44.114726	-121.339286
	DR 163.25	DR Archie Briggs	Deschutes River at Archie Briggs Crossing	44.095352	-121.315838
	DR 164.75	DR Riverhouse	Deschutes River at Riverhouse Convention Center	44.077958	-121.305693
Spring River to North Unit Diversion Dam	DR 165.75	DR First St. Rapids	Deschutes River at First Street Rapids	44.067314	-121.313013
	DR 166.75	DR Mirror Pond	Deschutes River at Mirror Pond[2]	44.060242	-121.320994
	DR 167.25	DR Columbia Park	Deschutes River at Columbia Park Footbridge	44.05269	-121.324939
	DR 168.00	DR Old Mill	Deschutes River at Old Mill	44.043359	-121.316476
	DR 169.00	DR Bill Healy Br.	Deschutes River at Bill Healy Bridge	44.040564	-121.330014
	DR 170.75	DR COID Diversion	Deschutes River above COID Diversion[3]	44.01808	-121.350176

TABLE 2. CONTINUOUS AND GRAB SAMPLE PARAMETERS AND METHODS

Parameters	Analysis Technique/Equipment[a]
Grab Sample Monitoring (Quarterly)	
Ammonia (mg/L)	SM 4500 - NH3-N
Coliform, Total (MPN/100 ml)	SM 9223 B
Coliform, E. coli (MPN/100 ml)	SM 9223 B
Chloride (Cl) (mg/L)	SM 4110 B
Dissolved Oxygen (mg/L)	Multiparameter sonde (YSI Pro DSS)
Fluoride (F) (mg/L)	SM 4110 B
Orthophosphate (PO4) (mg/L)	SM 4110 B 0
Nitrate (NO3) (mg/L)	SM 4110 B
Nitrite (NO2) (mg/L)	SM 4110 B
pH	Multiparameter sonde (YSI Pro DSS)
Phosphate, Total (PO4) (mg/L)	SM 4500-PE
Specific Conductance (µS/cm)	Multiparameter sonde (YSI Pro DSS)
Sulfate (SO4) (mg/L)	SM 4110 B
Temperature (°C)	Multiparameter sonde (YSI Pro DSS)
Total Suspended Solids (TSS) (mg/L)	SM 2540D
Turbidity (FNU)	Field probe HACH 2100P
Synoptic and Continuous Monitoring	
Temperature (°C)	Multiparameter sonde (YSI EX02) Continuous data logger (LI-COR HOBO)
Dissolved Oxygen (mg/L)	Multiparameter sonde (YSI EX02)
Specific Conductance (µS/cm)	Multiparameter sonde (YSI EX02)
pH	Multiparameter sonde (YSI EX02)

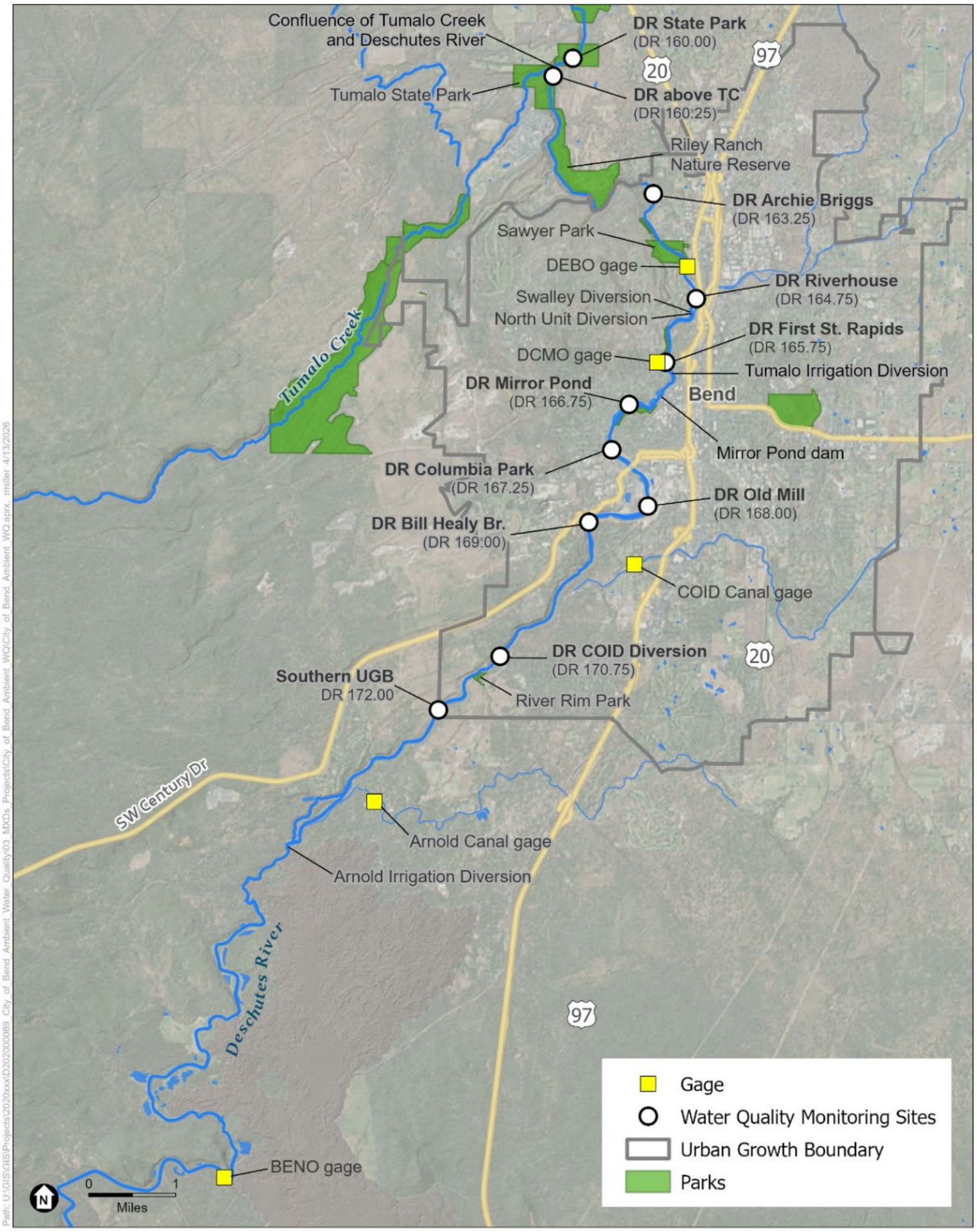
NOTES:

[a] Equipment listed are current and do not reflect improvements made over time.

Daily mean water flow data from 2024 to 2025 for the Deschutes River, Tumalo Creek, and applicable irrigation canals were taken from Bureau of Reclamation (BOR) and Oregon Water Resources Department (OWRD 2025) gaging stations.

Figure 6 illustrates the location of gages in relation to monitoring sites and other landmarks along the Deschutes River. **Figure 7** illustrates the location of gages in relation to monitoring sites and other landmarks along Tumalo Creek. **Figure 8** illustrates the river reaches between gaging stations. The Benham Falls (BENO) gage is located upstream of the COID and Arnold Irrigation District diversions. Information from this gage, combined with the Arnold diversion at Lava Falls, provides an estimate of flow at the upstream UGB and is used to describe flow rates at the Southern UGB site[1] to the COID Diversion site (DR 170.75). Flows from the COID diversion were further subtracted to provide estimated rates for sites from the DR Bill Healy Br. site (DR 169.00) to the DR Mirror Pond site (DR 166.75). Flows from the Deschutes County Mid Canal (DCMO) gage were further subtracted to provide estimated rates for the DR First St. Rapids site (DR 165.75). The Deschutes River Below Bend (DEBO) gage is downstream of the major diversions within the city. The DEBO gage was used to estimate flows below the North Unit and Swalley Irrigation District diversions but prior to the confluence with Tumalo Creek. This stretch encompasses the DR Riverhouse site (DR 164.75) to the DR above Tumalo Creek site (DR 160.25). Lastly, flows from the Tumalo Creek below Tumalo Feed Canal (TUMO) gage was added to the DEBO gage to estimate flows at the DR State Park site (DR 160.00). Tumalo Creek flows for the TC Shevlin Park site (TC 4.00) were taken from the OWRD gage located at Skyliners Road (downstream of TC Skyliner Br. site, TC 14.50). A second Tumalo Creek gage located downstream of TC Shevlin Park site and the Tumalo Feed Canal represents conditions at the mouth of Tumalo Creek (TC Mouth site, TC 0.25). The dataset for this gage, however, was more limited compared to the gage at Skyliners Road. It should be noted that the flow rates are based solely on previously described gage information and do not account for gains and losses from groundwater recharge, canal leakage, or evaporation as detailed in Gannett et al. (2017).

[1] Monitoring at the Southern UGB site (DR 172.00) was moved farther downstream in 2015 to the COID Diversion site (DR 170.75).



SOURCE: ODOT, 2015; BLM, 2015, USGS, 2020; ESRI, 2020

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River Streamflow Gauge Stations
City of Bend Ambient River Water Quality Monitoring

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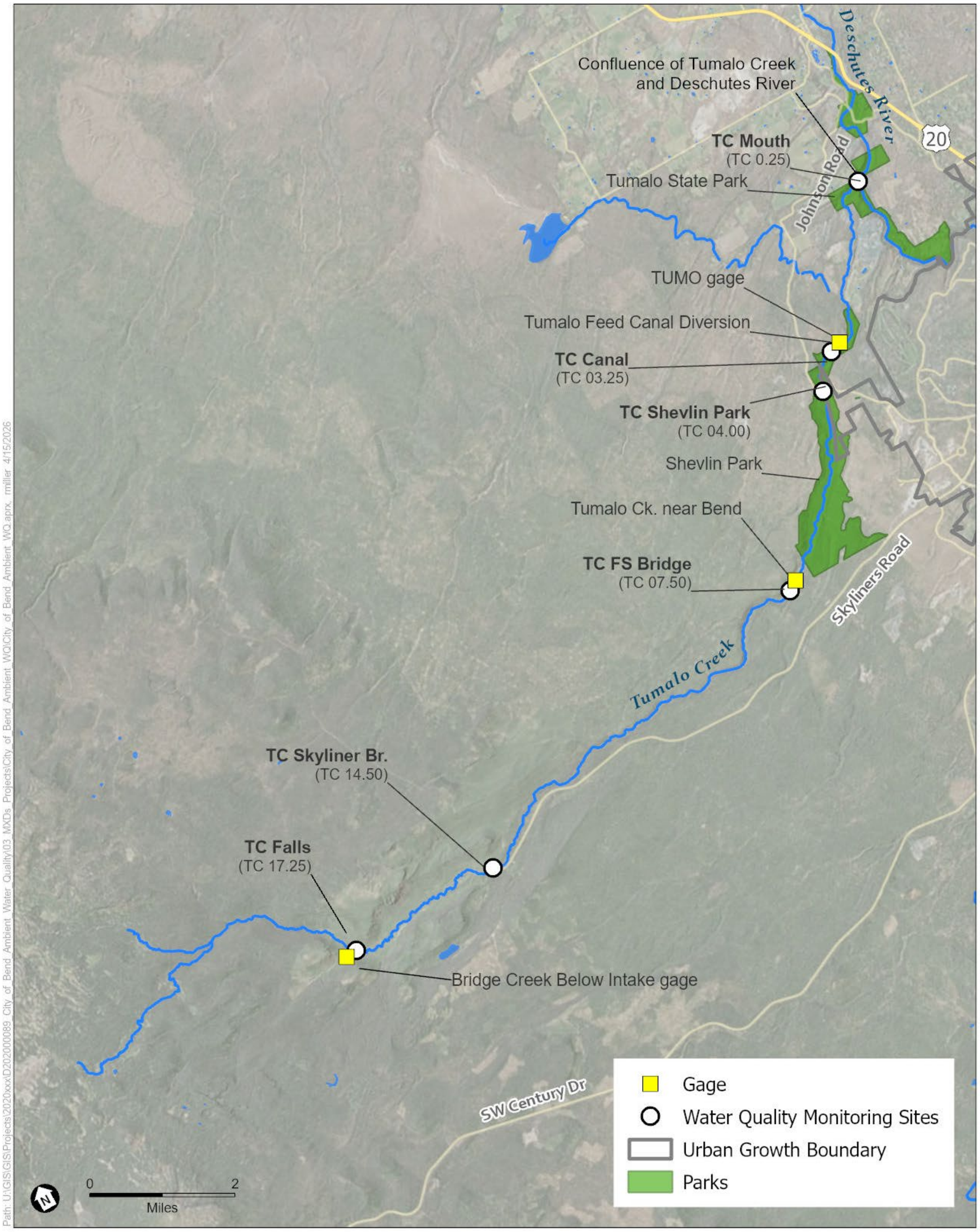
Figure 2. Location of river flow gages in relation to sample sites along the Deschutes River (see text for full gage names)



SOURCE: ODOT, 2015; BLM, 2015, USGS, 2020; ESRI, 2020

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River Streamflow Gauge Stations
City of Bend Ambient River Water Quality Monitoring

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Figure 7. Location of river flow gages in relation to sample sites along Tumalo Creek (see text for full gage names)

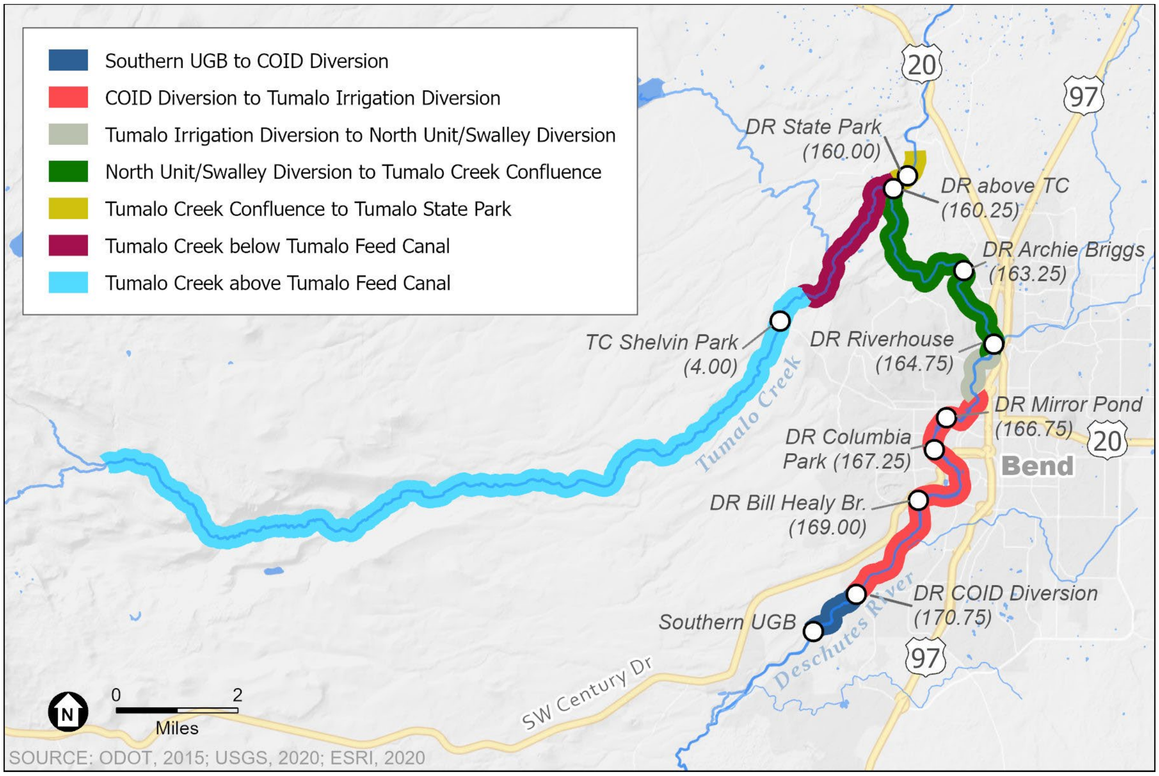

Figure 8. Location of river reaches between gaging stations and water quality monitoring sites.

As previously mentioned, reservoir storage and irrigation canal diversions substantially alter Deschutes River streamflow through the City of Bend resulting in lower winter flows, higher summer irrigation period flows and lower flows downstream of diversions. The “ramp up” process for irrigation releases is set by the OWRD and begins in April of each year with complete releases not reached until mid-May. The annual “ramp down” process is more abrupt beginning on or near October 15. The greatest withdrawal from the Deschutes River is via the North Unit and Swalley Irrigation Districts diversion.

Figure 9 illustrates the summer and winter flows in different reaches though the City of Bend in relation to water quality monitoring sites. Average flows during the 2024-2025 summer period decreased from 1420 cfs at the urban growth boundary to 161 cfs above the confluence with Tumalo Creek.

A similar pattern was present during the winter, but average flows were lower at the urban growth boundary (639 cfs) than during the summer with less loss due to withdrawals resulting in 409 cfs above the confluence with Tumalo Creek. The DBHCP winter minimum flow threshold of 300 cfs, which will be enforced at the end of 2028 (USFWS 2020), was exceeded downstream of the North Unit/Swalley Diversion during 2024 and 2025.

The DBHCP summer maximum flow target of no more than 10 days per year with 1,400 cfs was exceeded during 91 days in 2024 and 112 days in 2025 upstream of the Central Oregon Canal Diversion. No exceedances occurred below the Bend Feed Canal Diversion.

Seasonal changes in flow rates in Tumalo Creek are less dramatic than in the Deschutes River (**Figure 10**). Discharge in the lower reach of Tumalo Creek is greatly reduced by irrigation withdrawal though the Tumalo Feed Canal.

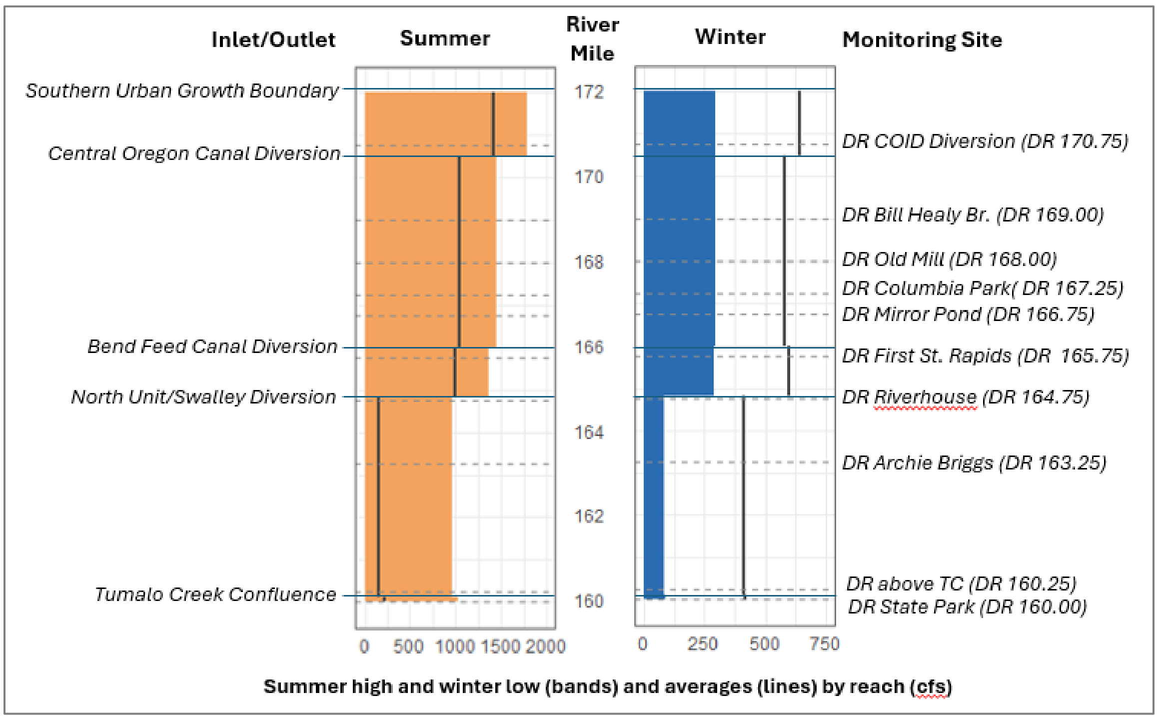

Figure 9. Average, minimum, and maximum summer and winter flow (cubic feet per second, cfs) in Deschutes River reaches from the southern urban growth boundary to below the confluence of Tumalo Creek. Dashed horizontal lines are locations of monitoring sites, solid horizontal lines are inlets/outlets - City of Bend from 2024 to 2025

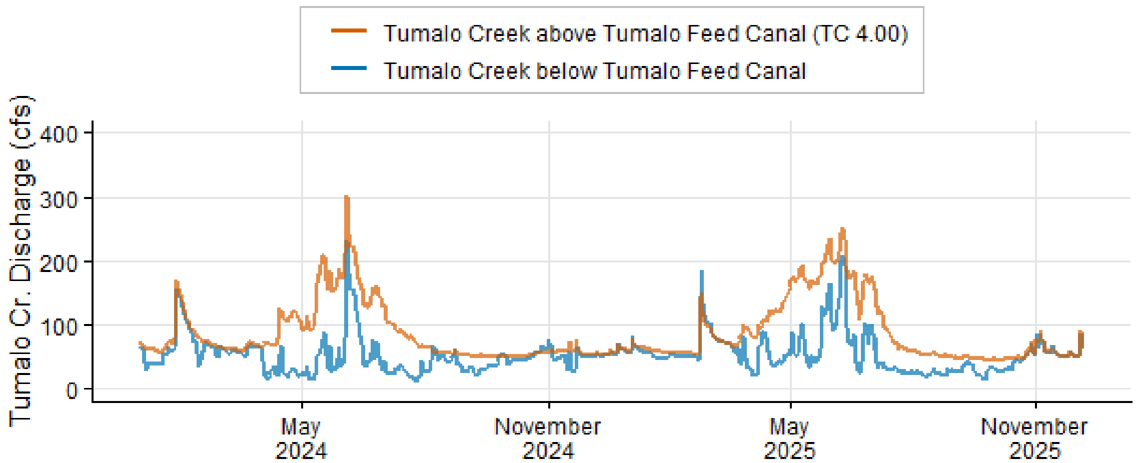

Figure 10. Mean daily discharge in Tumalo Creek above and below the Tumalo Feed Canal – City of Bend from 2024 to 2025

Quality Assurance/Quality Control

Data for this effort were collected by City staff following a *City of Bend Water Quality Monitoring Plan* (Monitoring Plan) (**Appendix A**). Continuous measurements, synoptic measurements, and grab samples were collected (Table 2). Continuous data were collected using calibrated multi-parameter data sondes and temperature-specific loggers. The accuracy of continuous sonde measurements was assessed through comparison with a separate calibrated sonde during quarterly field visits.

Measurements were graded according to criteria in the ODEQ (2013) *Data Validation Criteria for Water Quality Parameters Measured in the Field*, which is included in the Monitoring Plan. With the exception of six pH sampling events at the Mirror Pond (DR 166.75) site and one dissolved oxygen event at the COID Diversion (DR 170.75), all of which qualified as Grade B, every other measurement met Grade A data quality.

- Grade A is data of known quality which meets QC limits established in the approved QAPP.
- Grade B data is of known but lesser quality; the data does not meet established QC but is within marginal acceptance criteria.

Only data that passed the QA/QC process outlined in the Monitoring Plan are included in this report.

Continuous data underwent additional review beyond DEQ grading to identify issues not captured during standard validation. Data failing these checks were flagged as suspect and removed from analysis. Screening included evaluation of:

- The accuracy of deployment and retrieval dates and times.
- Periods with known equipment malfunctions or field disturbances (e.g., debris, burial, sediment load, or sensor fouling) were removed.
- During certain low-flow conditions, river stage dropped sufficiently to expose sondes or loggers. Instruments continued logging during exposure, producing unrealistic values.
- Air-exposure events were identified by abrupt temperature changes (typically within 15–30 minutes) or readings inconsistent with expected diel patterns.
- Parameter-specific anomalies with unrealistically high or low outliers, large discrepancies between measurements at different sites, or instrument drift over the course of deployment. These data were identified by creating and inspecting plots using R software.

Regulatory Framework

The Federal Clean Water Act (CWA) requires Oregon to report on the quality of its surface waters every two years. Oregon surface waters are assessed to determine if they contain pollutants at levels that exceed protective water quality standards. The result of these analyses and conclusions is called the “Integrated Report” because it combines the requirements of Clean Water Act section 305(b) to develop a status report and the section 303(d) requirement to develop a list of impaired waters.

The Integrated Report assigns a Category to all assessed waterbody segments. ODEQ uses data to evaluate the most common beneficial uses, such as aquatic life, drinking water or recreation. If waterbodies exceed protective water quality standards, they are placed on the 303(d) list of impaired waters. Placing a waterbody on the 303(d) list initiates the prioritization and development of a Total Maximum Daily Load (TMDL). The 303(d) list portion of the Integrated Report is submitted to the U.S. EPA for final approval.

ODEQ submitted the complete 2012 Integrated Report to EPA in 2014. That portion of the Deschutes River between RM 116 to 222.2 (which includes that portion in the City of Bend) was placed on the 303(d) list of impaired waters for DO. Specifically, the January 1 – May 15 criteria for resident trout spawning where DO should not be less than 11.0 mg/L or 95% of saturation. Between RM 168.2 and 189.4, the Deschutes River was listed for Chlorophyll *a* due to exceedances above 0.0015 mg/L during the summer months. Lastly, RM 126.4 to 162.6 was listed for pH exceedances (below 6.5/above 8.5) during all seasons.

The 2022 Integrated Report (IR) introduced the use of Assessment Units (AUs) to group stretches of river miles where impaired listings are identified. Three AUs apply to the study area: Spring River to North Unit Diversion Dam (DR 170.75 to 165.75), North Unit Diversion Dam to Whychus Creek (DR 164.75 to 160.00), and Tumalo Creek (**Figure 11**). The 2022 IR was approved by EPA September 1, 2022. **Figure 11** and **Table 3** summarize the applicable 303(d) listed impaired AUs in the study area. Notable changes on the Deschutes River between the 2018/2020 and 2022 IRs include listing pH for the Spring River to North Unit Diversion Dam AU and delisting pH for the North Unit Diversion Dam to Whychus Creek AU. ODEQ released the draft 2024 IR on Surface Water Quality and 303(d) List of Impaired Waters April 2024 and accepted comments through July 1, 2024. ODEQ released a Draft 2024 IR Supplemental using previously unsubmitted data from the U.S. Geological Survey. The supplemental data do not include the Deschutes River or Tumalo Creek. Listings in this report are based on the final 2022 IR; however, there are no proposed listings or delistings on the Deschutes River or Tumalo Creek within the study area. According to ODEQ, waterbodies are delisted for a variety of reasons, including:

1. current data indicate that water quality standards are attained, and the waterbody is no longer impaired,
2. there is an error in the original Category 5 determination,
3. water quality standards, such as through updated science or improved measuring processes, have changed or no longer apply to a waterbody,
4. the expression of water quality standard pollutant has changed (e.g., now being measured as the dissolved fraction, when previously had been measured as the total amount of the pollutant),
5. a TMDL or other pollution control plan is in place, or
6. the impairment is caused by pollution rather than a known pollutant (i.e., flow or habitat modification) (ODEQ 2022).

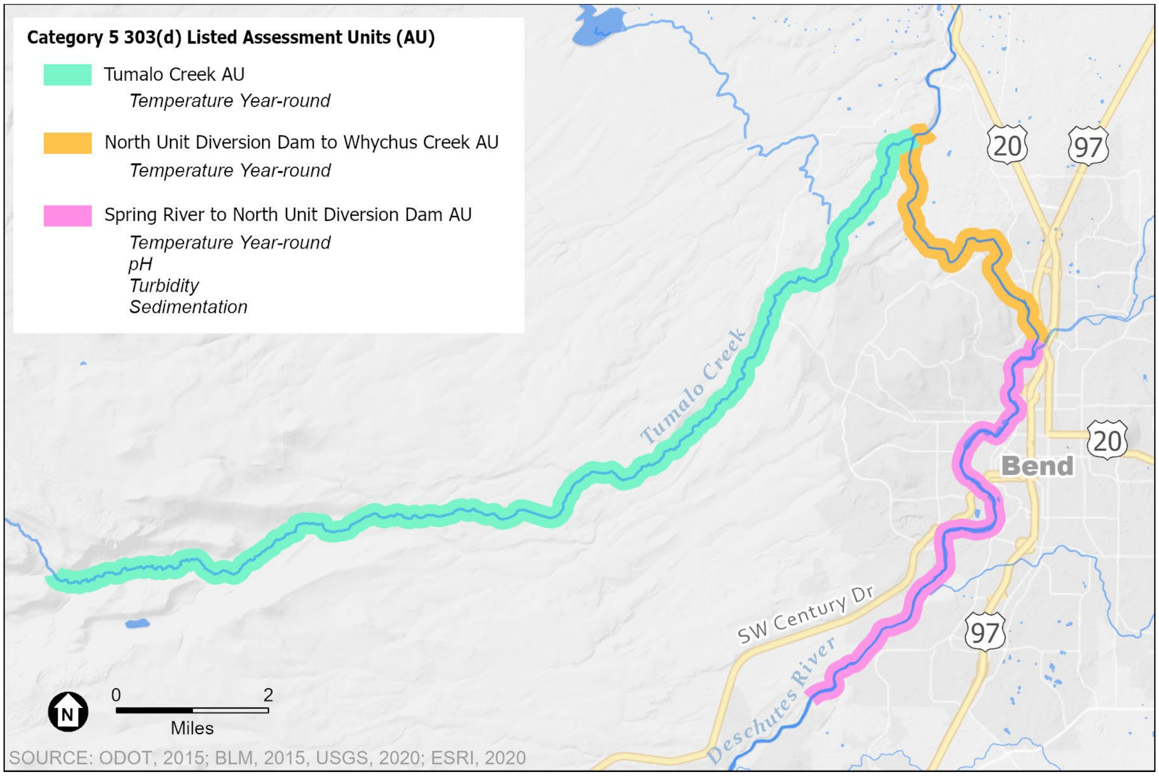

Figure 11. ODEQ 2022 Category 5 303(d) Listed Assessment Units (AU) for the Tumalo Creek Watershed AU, North Unit Diversion Dam to Whychus Creek AU, and the Spring River to North Unit Diversion Dam AU

TABLE 3. APPLICABLE CATEGORY 5 303(D) LISTED ASSESSMENT UNITS WITHIN THE STUDY AREA

Parameter	Season	Criteria	Spring River to North Unit Diversion Dam (DR 170.75 to 165.75)	North Unit Diversion Dam to Whychus Creek (DR 164.75 to 160.00)	Lower Tumalo Creek (TC 00.25 to TC 07.50)	Upper Tumalo Creek (TC 14.50 to TC 17.25)
Flow Modification			303(d)	303(d)	303(d)	NA
Habitat Modification			303(d)	NA	NA	NA
Sedimentation	Undefined	Note 1	303(d)	NA	NA	NA
Temperature	Year Round (non-spawning)	< 18°C; 7DADM Note 2, Note 3	303(d)	303(d)	303(d)	303(d)
Turbidity	Spring/ Summer	10% NTU increase Note 4	303(d)	NA	NA	NA
pH	Year Round	6.5-8.5	303(d)	CM	CM	IN

CM = Criteria Met; 303(d) = AU is listed on the 2022 DEQ Integrated Report - State Final as being Category 5 303(d) listed - Impaired a TMDL is needed, IN = Insufficient data for assessment, NA =not assessed.

NOTES:

1. The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed. Data to support evaluation of this standard was not directly evaluated under this study.
2. "Seven-Day Average Daily Maximum Temperature (7DADM)" means a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis (OAR 340-041-0002(56)).
3. The Upper Tumalo Creek AU Year-Round criterion is 12°C.
4. Turbidity should not increase by more than 10% during the early spring when irrigation water is released, according to the state standard. Historically, turbidity increased substantially when irrigation water is released in the spring.

The ambient water quality data collected by the City of Bend is provided to ODEQ when requests for data are made by the agency every two years. The City is not required to collect stormwater monitoring data for the NPDES municipal separate storm sewer system (MS4) Phase II permit; however, per the permit, any data that is collected is submitted to ODEQ. ODEQ last issued a call for data between March 25, 2025 through May 7, 2025. City staff compiled and submitted data to ODEQ and will be used for the 2026 Integrated Report. The next call for data is expected in 2027.

Results

The City has analyzed ambient river water conditions since 2004 when grab sampling began. Over time, the program has added analytical parameters, shifted sites, and improved in situ measurement approaches and laboratory practices. Table 4 summarizes the types of monitoring that occurred (e.g., grab sampling, continuous temperature, continuous sonde) at each site and when. The sections below summarize results of water samples collected between 2024 and 2025.

TABLE 4. ASSESSMENT UNITS, SAMPLE SITES, LOCATIONS, AND MONITORING ACTIVITY PERIODS

Assessment Unit	Site No.	Site Name	Grab samples		Continuous Temperature		Continuous Sonde	
			2024	2025	2024	2025	2024	2025
Tumalo Creek	TC 0.25	TC Mouth	✓	✓	1/29 - 12/31	3/4 - 9/27	-	-
	TC 3.25	TC Canal	✓	✓	2/4 - 12/31	2/5 -08/15	-	-
	TC 4.00	TC Shevlin Park	✓	✓	-	-	-	-
	TC 7.50	TC FS Bridge	✓	✓	-	-	-	-
	TC 14.50	TC Skyliner Br.	✓	✓	-	3/4 - 10/16	-	
	TC 17.25	TC Falls	✓	✓	2/22 - 5/31	6/2 - 11/10	-	-
North Unit Diversion Dam to Whychus Creek	DR 160.00	DR State Park	✓	✓	1/1 - 7/22	4/1 - 10/1	5/29 - 7/22	Lost sonde
	DR 160.25	DR above TC	✓	✓	4/25 - 12/31	1/1 - 06/9	-	-
	DR 163.25	DR Archie Briggs	✓	✓	1/1 - 12/31	1/1 - 10/15	1/10 - 12/31	1/1 - 10/15
	DR 164.75	DR Riverhouse	✓	✓	-	2/25 - 10/21	-	-
Spring River to North Unit Diversion Dam	DR 165.75	DR First St. Rapids	✓	✓	-	2/24 - 10/21	-	-
	DR 166.75	DR Mirror Pond	✓	✓	-	2/24 - 10/16	1/15 - 12/31	1/1 - 10/16
	DR 167.25	DR Columbia Park	✓	✓	-	-	-	-
	DR 168.00	DR Old Mill	✓	✓	4/24 - 12/31	1/1 - 08/20	-	
	DR 169.00	DR Bill Healy Br.	✓	✓	1/1 - 05/8	2/2 - 12/30	-	-
	DR 170.75	DR COID Diversion	✓	✓	1/10 - 12/21	3/6 - 10/8	1/10 - 12/21	3/6 - 10/15

First presented are results of parameters included in the EPA approved 2022 Integrated Report, followed by parameters no longer on the 303(d) list, nutrients, and other parameters. Applicable numeric criteria are included on figures for temperature, pH, and dissolved oxygen.

Temperature

Temperature is a critical determinant of most biological and physiochemical processes in water, for example, chemical equilibria, water density, photosynthesis, and respiration (Wetzel 2001). By extension, water temperature determines the preferred habitat and life history of aquatic species. Excessive water temperature causes fish stress and increases vulnerability to parasites and reduced dissolved oxygen (Raleigh et al. 1984, Dorson and Touchy 1981). In Oregon, specific temperature standards have been established for waterbodies, including the Deschutes River within the City. The applicable standard within the Deschutes River reaches examined here is a year-round seven-day average of the daily maximum water temperature below 18°C for the protection of salmon and bull trout rearing and migration. Seven-day average daily maximum temperature (7DADM) is a metric used to characterize sustained high-temperature conditions in rivers and streams. It is calculated by determining the daily maximum water temperature for each day and then computing a seven-day moving average of those daily maxima. By smoothing short-term, single-day spikes while emphasizing multi-day exposure, 7DADM captures biologically relevant thermal stress that aquatic organisms experience during prolonged warm periods. This metric is used in Oregon because it aligns with physiological thresholds for cold-water species, including reduced growth, impaired migration, and increased mortality associated with sustained elevated temperatures.

The same criterion applies to Tumalo Creek from the TC Mouth monitoring site (TC 0.25) upstream to the TC Bridge site (TC 7.00). Further upstream, a 12°C criterion to protect bull trout spawning and juvenile rearing applies to the TC Skyliner Bridge (TC 14.50) and TC Falls (TC 17.25) sites.

Presented are results from continuous temperature monitoring in 2024 and 2025 from the Deschutes River and Tumalo Creek using temperature-specific loggers (**Table 1**). When data from temperature specific loggers were unavailable at a site due to logger malfunction or deployment problems, data gaps were filled with multiparameter sonde temperature data when available. The continuous temperature loggers and multiparameter sondes were set to a 15-minute interval. Temperature data are presented as the 7DADM and plotted by monitoring site and grouped by AU[2].

Seasonally, water temperatures at the Deschutes River sites ranged from near freezing in winter months to just above 20°C in the summer (mid-July) (**Figure 12**). Temperatures

[2] Seven-Day Average Maximum Temperature" means a calculation of the average of the daily maximum temperatures from seven consecutive days made on a rolling basis. (OAR 340-041-0002)

generally increased moving downstream in the Spring River to North Unit Diversion Dam and the North Unit Diversion Dam to Whychus Creek reaches. In Tumalo Creek, maximum water temperature was measured during the summer months and generally increased from upstream (TC Falls, TC 17.25) to downstream (TC Mouth, TC 0.25) though some data are missing from the evaluation (**Figure 13**).

In 2024, the warmest maximum 7DADM was 21.0°C, recorded on July 11 at the DR above TC site (DR 160.25) (**Table 5**). In 2025, the warmest maximum 7DADM was 20.1°C, also recorded on July 11, but at DR Archie Briggs site (DR 163.25). Water temperature data for at the DR above TC site were not available during peak summer during 2025. The coolest maximum 7DADM in 2025 of 18.2°C occurred at the upstream-most site at the DR COID Diversion site (DR 170.75). During 2024, however, the coolest maximum 7DADM of 19.0°C occurred at the DR Old Mill site (DR 168.00).

Taken together, water temperatures at all Deschutes River sites during 2024 and 2025 exceeded the ODEQ criteria for year-round (non-spawning) 7DADM temperature of 18°C for substantial periods each summer (**Figure 14**). This includes the DR COID Diversion (DR 170.75) site, which is located upstream of other irrigation diversions and urban impacts within the UGB. The duration of exceedance was generally greater at downstream sites during both years (**Figure 14**), however, the presence of data gaps at some of the sites complicates comparisons. Of the sites with near complete temperature records, the most exceedance days during 2024 (69 days) occurred at DR Archie Briggs (DR 163.25) and the fewest days (34) occurred at the DR COID Diversion site (DR 170.75). During 2025 the most exceedance days also occurred at the DR Archie Briggs site (71 days). The fewest exceedance days during 2025 (32 days) were at the DR Mirror Pond (DR 166.75) and DR Bill Healy Br. (DR 169.00) sites. Valid temperature data were not collected for large portions of the summer at the uppermost site (DR COID Diversion) so exceedance days could not be summarized. During 2024 exceedances started June 6 at the DR Archie Briggs (DR 163.25) and DR above TC (DR 160.25) sites, and one month later on July 5 at the DR COID Diversion site (DR 170.75). The latest exceedances (August 19) were recorded at the DR Archie Briggs (DR 163.25) and DR above TC (DR 160.25) sites. The earliest end to the 2024 exceedance period was August 7 at the DR Bill Healy Br. (DR 169.00) site.

During 2025, the earliest exceedance period started on June 6 at the DR Riverhouse (DR 164.75) site and the latest start July 9 at was one month later at the DR Mirror Pond (DR 166.75) and DR Bill Healy Br. (DR 169.00) sites. The latest exceedance (August 25) was recorded at the DR Riverhouse (DR 164.75) site. The earliest end to the 2025 exceedance period was August 19 at the DR Mirror Pond (DR 169.00) site.

Temperature data from 2024 to 2025 are comparable to those presented in previous summaries of ambient river conditions in the Deschutes River and are consistent with the 2022 IR 303(d) listings.

Temperatures measurements in both the Upper and Lower Tumalo Creek AUs during 2024 and 2025 are consistent with the 2022 IR 303(d) listings based on measurements at one site within each AU. In the Lower Tumalo Creek AU there were 19 days of exceedances of the 18°C criterion at the TC Mouth site (TC 0.25) between July 6 and August 4, 2024, and 6 days between July 16 and August 14, 2025. (**Figure 14**). There were no 7DADM criterion exceedances at the TC Tumalo Canal site (TC 3.25) during 2024 or 2025. The warmest temperatures at the TC Mouth site were 19.2°C and 18.8°C on June 21, 2024, and August 12, 2025, respectively. The warmest temperatures at TC Tumalo Canal (TC 3.25) were 17.2°C and 16.2°C on August 3, 2024, and July 16, 2025, respectively

In the Upper Tumalo Creek AU there were 50 days of exceedances of the 12°C Bull Trout Spawning and Rearing criteria at TC Skyliner Bridge (TC 14.5) between July 8 and September 3, 2025. There were no exceedances at the other Upper Tumalo AU site (TC Tumalo Falls, TC 17.25) during 2025. No measurements were collected from either site during 2024. Warmest temperatures during 2025 were 13.9°C at TC 14.5 on July 16 and 12.1°C at TC 17.25 on July 14.

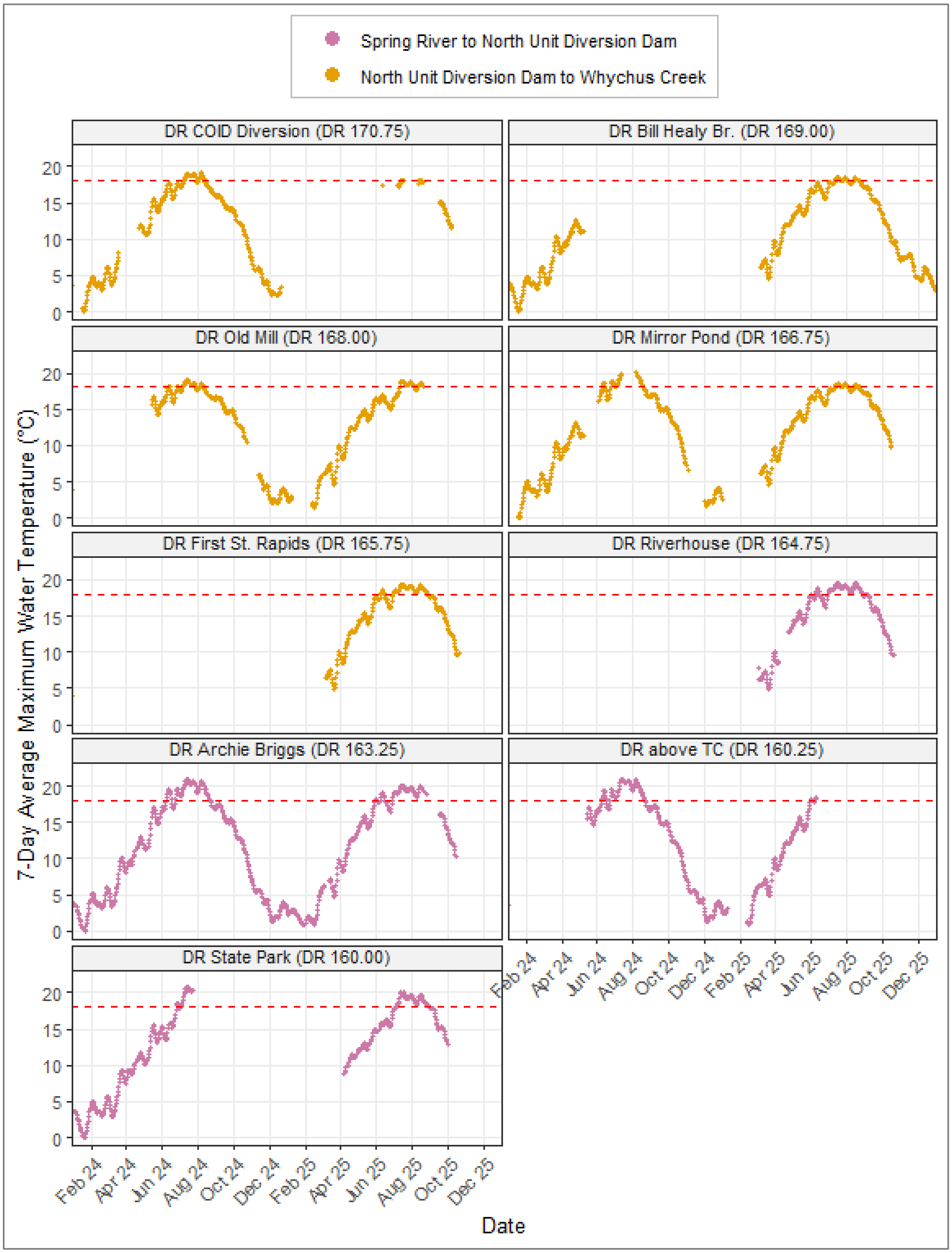

Figure 12. The 7DADM water temperature for the monitoring stations in the Deschutes River Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75), and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00). - City of Bend 2024 and 2025. The dashed red line indicates the 18°C temperature criteria

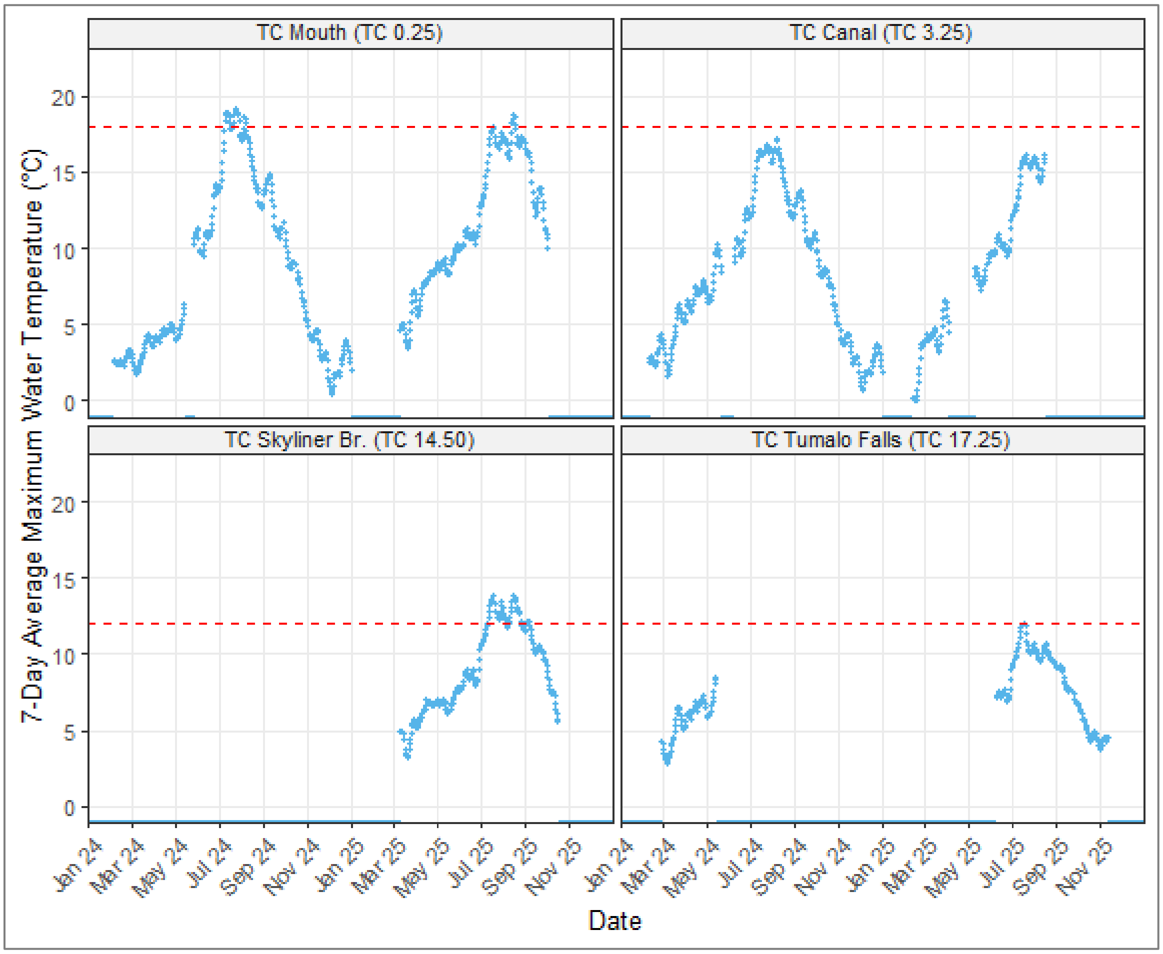

Figure 13. The 7DADM water temperature for the monitoring stations in the Upper and Lower Tumalo Creek AUs - City of Bend 2024 and 2025. The dashed red lines indicate the 18°C and 12°C temperature criteria

TABLE 5. MAXIMUM ANNUAL SEVEN-DAY AVERAGE DAILY MAXIMUM TEMPERATURES (7DADM) AND COUNT OF DAYS EACH YEAR EXCEEDING TEMPERATURE CRITERIA IN THE DESCHUTES RIVER AND TUMALO CREEK.

Site	7DADM Temperature Criterion	Maximum Annual 7DADM Temp. (°C) and Date of Maximum	
		2024	2025
DR State Park (DR 160.00)	18°C	20.8°C - Jul 10	20.0°C - Jul 15
DR above TC (DR 160.25)	18°C	21.0°C - Jul 11	*
DR Archie Briggs (DR 163.25)	18°C	20.9°C – Jul 10	20.1°C – Jul 11
DR Riverhouse (DR 164.75)	18°C	-	19.5°C - Jul 14
DR First St. Rapids (DR 165.75)	18°C	-	19.4°C - Jul 15
DR Mirror Pond (DR 166.75)	18°C	20.1°C - Aug 3	18.5°C - Jul 16
DR Old Mill (DR 168.00)	18°C	19.0°C - Jul 10	18.8°C - Jul 15
DR Bill Healy Br. (DR 169.00)	18°C	*	18.5°C - Jul 16
DR COID Diversion (DR 170.75)	18°C	19.1°C - Aug 3	18.2°C - Aug 13
TC Mouth (TC 0.25)	18°C	19.2°C - Jun 21	18.8°C - Aug 12
TC Canal (TC 3.25)	18°C	17.2°C - Aug 3	16.2°C - Jul 16
TC Skyliner Br. (TC 14.5)	12°C	-	13.9°C - Jul 16
TC Falls (TC 17.25)	12°C	-	12.1°C - Jul 14

* No valid temperature data available during the warmest periods.

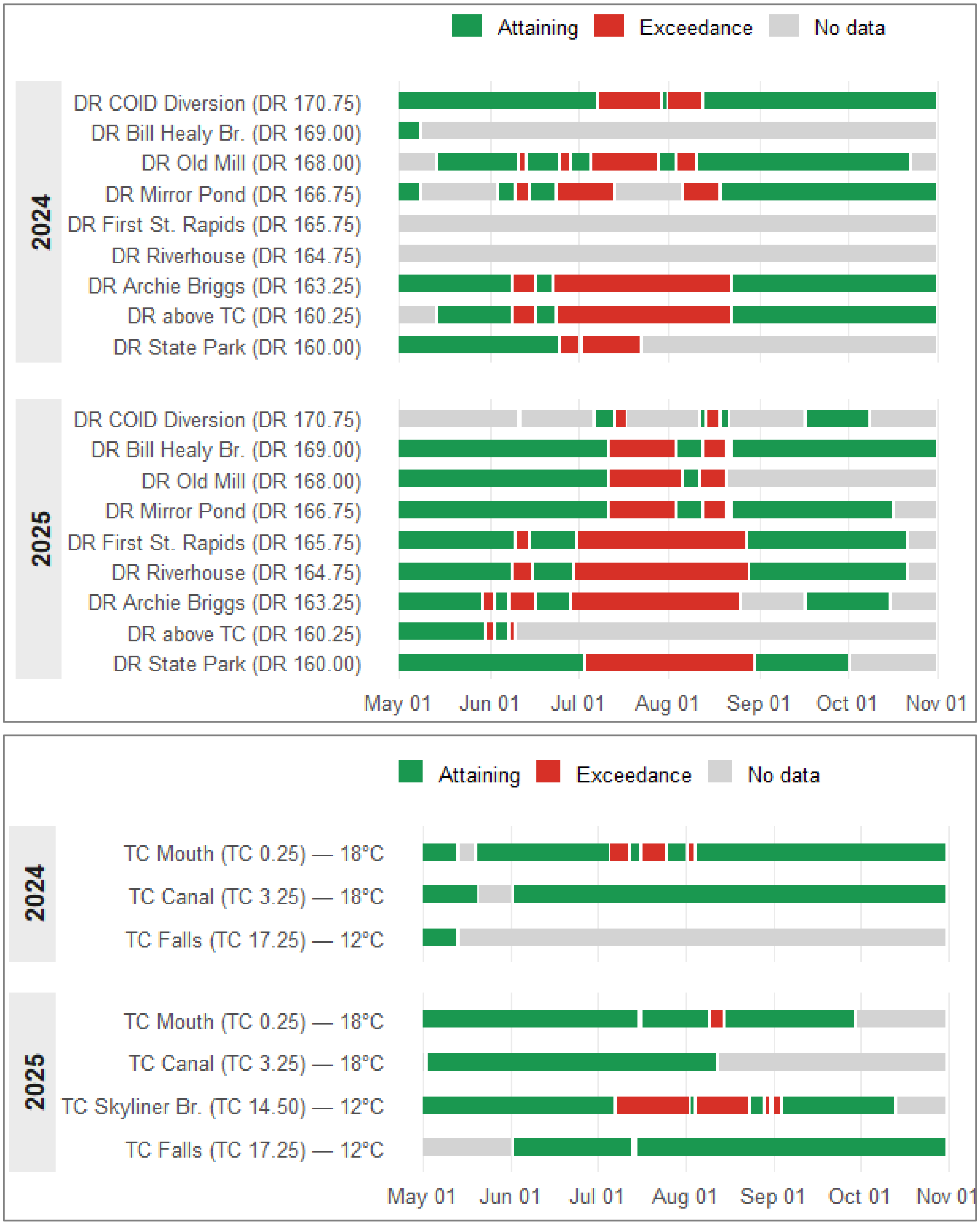

Figure 14. 7DADM 18°C water temperature criterion exceedance and attainment periods for May through October of 2024 and 2025 for Deschutes River sites (top) and Tumalo Creek sites (bottom) – City of Bend 2024 and 2025

pH

pH describes the measurement of how acidic or basic a substance is, with values below 7.0 being acidic and above being basic. The pH of water determines the solubility and bioavailability of chemical constituents. For example, pH drives the availability and form of nutrients such as phosphorus and nitrogen, but also the solubility and toxicity of heavy metals such as lead and copper. Diel (daily) and seasonal pH fluctuations commonly occur in waters where phytoplankton and aquatic plants are actively growing. During periods of photosynthesis, these organisms remove carbon dioxide from the water and cause pH to rise. When photosynthesis slows, while respiration continues, carbon dioxide accumulates, leading to a decrease in pH. In slow moving water with high photosynthetic activity, a daily pattern can be quite evident from early morning (lowest pH) to late afternoon (peak pH). Values in pH can also be influenced by snow melt, rain, groundwater and inputs from tributaries. Most of the Deschutes River within the study area are included on the ODEQ 303(d) for pH. Specifically, for pH values below 6.5 or above 8.5 (OAR 340-041-0135).

Presented are pH results from continuously logging multi-parameter data sondes in 2024 and 2025 from four sites in the Deschutes River set at 15-minute intervals (**Table 4**). Specific start and end times varied by site and between years. Measurements of pH are presented as the raw data by site and year with the ODEQ 6.5 minimum and 8.5 maximum pH criteria indicated (**Figure 15**).

Seasonally, pH values were highest in late June and July during 2024 and 2025, due primarily to increased photosynthetic activity (**Figure 15**). Across sites, pH values were highest during the mid summer at the DR Mirror Pond site (DR 166.75), ranging up to approximately 9.0 during 2024.The lowest values were observed at the DR COID Diversion site (DR 170.75), as low as 8.3 during 2025. Daily fluctuations in pH were more dramatic in areas of slower moving water (**Figure 16**). For example, diel variation in pH ranged up to 1.5 pH units at the DR Mirror Pond site (DR 166.75) during the summer and was routinely greater than 1 pH unit at the DR Archie Briggs site (DR 163.25) during 2024. Variation at the DR COID Diversion site (DR 170.75) remained lower than 1.0 pH units throughout the summer of 2024. Diel variation at the DR Mirror Pond site (DR 166.75) during July-September of 2025 was suspiciously lower than at DR Archie Briggs (DR 163.25) or at the DR Mirror Pond site during previous years; however, the data passed quality assurance checks and was not removed from analysis. Limited valid pH data is available at DR Archie Briggs (DR163.25) during 2025 and at DR State Park (DR 160.00) sites either year.

The total number of days where pH exceeded the criteria could not be counted for all sites because of missing data, however, there were no days at DR COID Diversion (DR 170.75) during 2024, and few valid measurements during 2025. Despite the large gap of valid data at DR Mirror Pond (DR 166.75) during the summer of 2024, there were still 89 days with exceedances ranging from May 1 to October 24 (**Figure 17**). Exceedances of pH above 8.5 occurred at DR Archie Briggs (DR 163.25) for 50 days during 2024, and 23 days during 2025 and 72 days during 2021. Exceedances were not recorded at DR State Park site (DR 160.00), however, this was due to lack of valid data. Low pH exceedances (less than 6.5) were not measured at any site during the 2024 through 2025 period.

Observations of elevated continuously monitored pH compared to the maximum criteria of 8.5 are consistent with the 2022 IR 303(d) listing for the Spring River to North Unit Diversion Dam AU. However, the removal of the North Unit Diversion Dam to Whychus Creek AU from the 2022 303(d) list was not supported due to continuously monitored pH exceedances at the DR Archie Briggs (DR 163.25) site during 2024 and 2025. Continuous monitoring of pH was not performed in Tumalo Creek; however, it should be noted that no pH exceedances were measured during grab sample measurements.

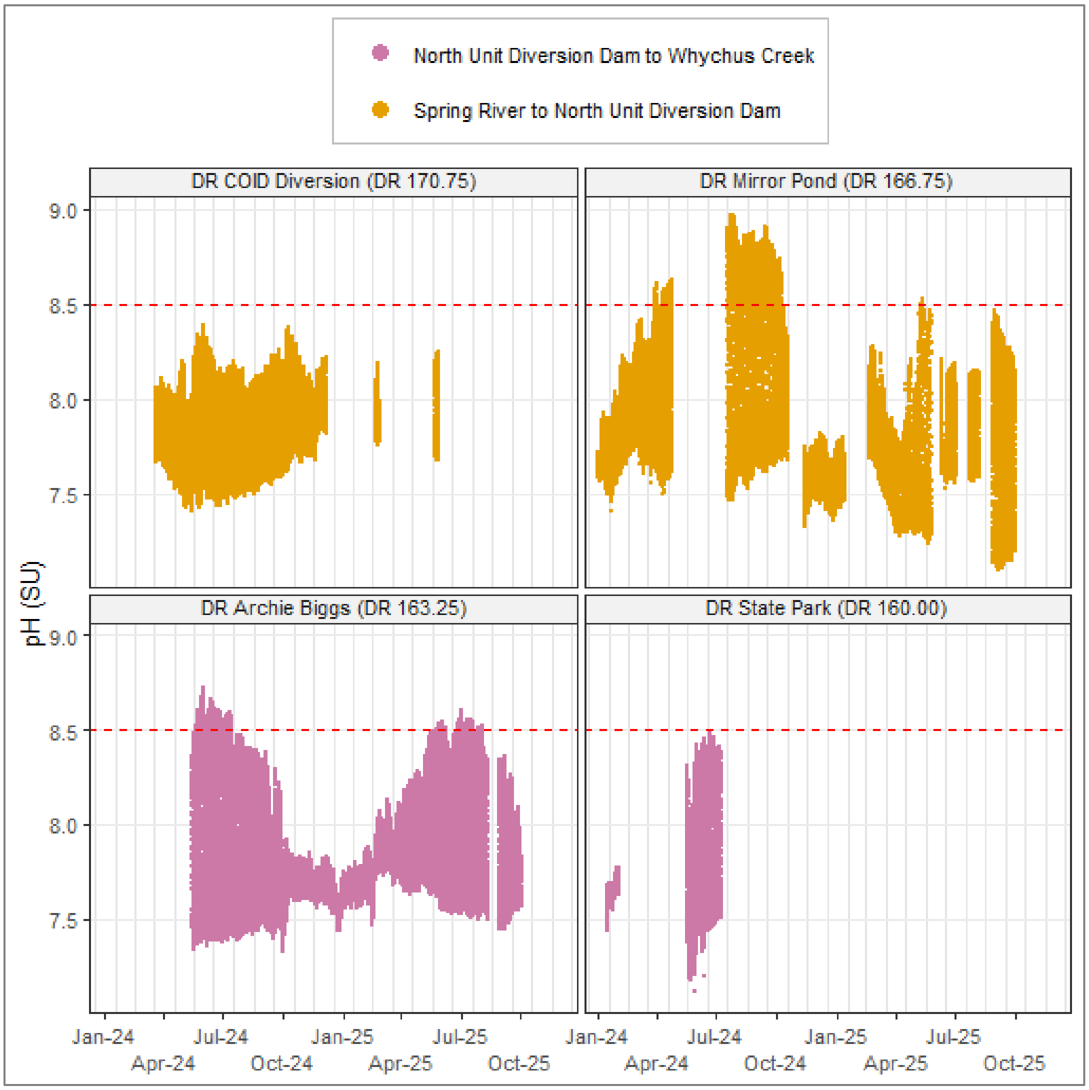

Figure 35. Continuous pH measurements for the monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75) (orange dots) and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00) (pink dots) Dashed red lines indicate the maximum 8.5 pH criteria - City of Bend 2024 and 2025.

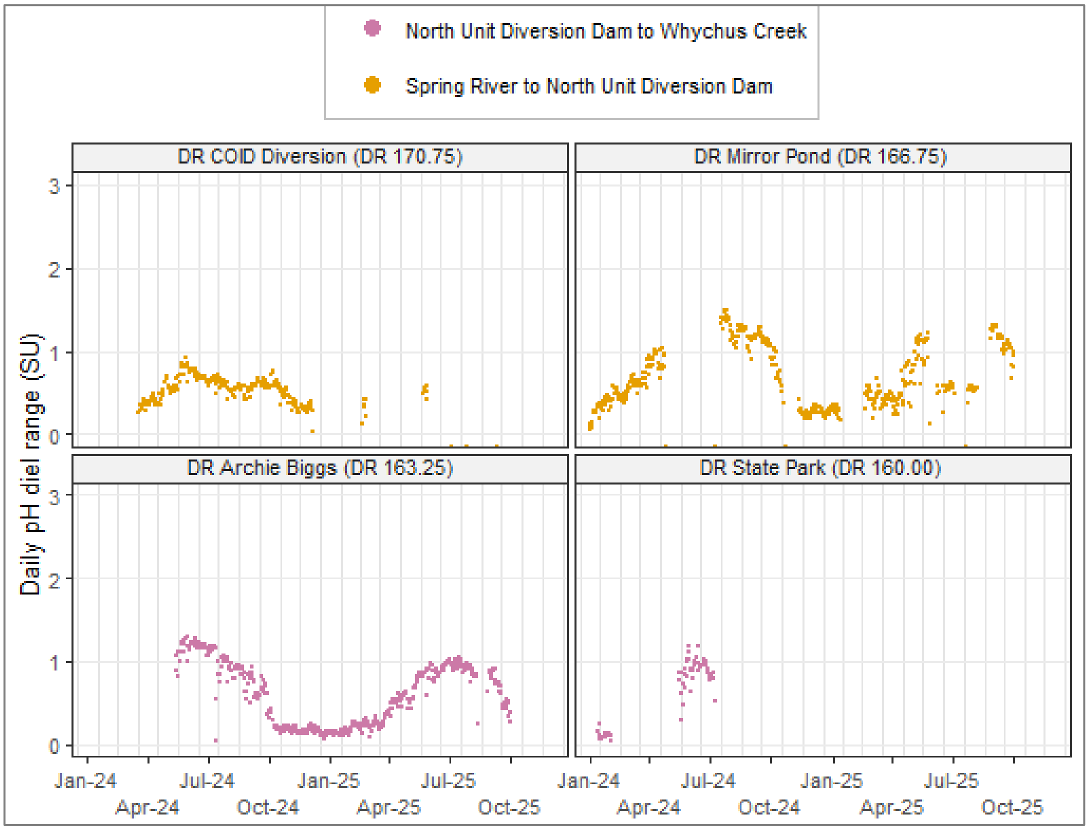

Figure 46. Diel pH variation at the four sonde monitoring sites during 2024 and 2025 - City of Bend 2024 and 2025 - City of Bend 2024 and 2025

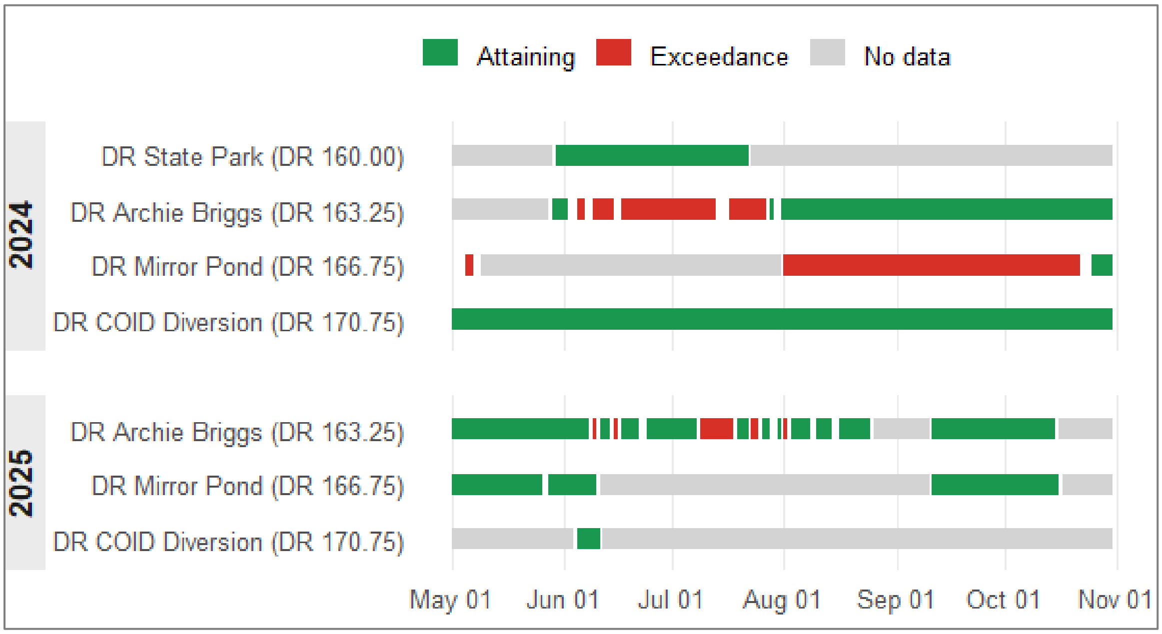

Figure 57. pH status in comparison with the pH 8.5 criterion showing periods attaining the criteria, exceeding the criteria, and periods with no data - City of Bend 2024 and 2025

Turbidity

Turbidity is an optical property of water resulting from the suspension of particles in the water column. Turbidity sources include erosion from the watershed or river sediments. Land disturbance and high flow often increase turbidity while dams can decrease turbidity via sedimentation in relatively still water. The particles that cause turbidity scatter, reflect, and refract (change direction) light penetration in the water. High levels of particulates block light available for photosynthetic algae and macrophytes, can be harmful to aquatic organisms, and can attach and carry harmful pollutants. High turbidity levels are considered harmful to beneficial uses, including resident fish, other aquatic life, and water supply.

There is no specific numeric criterion for high turbidity in Oregon. Oregon Administrative Rule 340-041-0036, however, states that “no more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity.” Since turbidity measurement relative to an upstream control was not conducted, the ten percent cumulative increase in turbidity criteria is not applicable. Comparisons against undisturbed watersheds is informative, however. During the wet season, median turbidity in most undisturbed watersheds in Oregon is below 5 NTU (ODEQ 2014).

Discrete turbidity measurements were collected using a field turbidity meter at ten Deschutes River sites and six Tumalo Creek sites in 2024 and 2025 (**Figure 18**).

Continuous turbidity was measured at 15- minute intervals at a subset of four Deschutes River sites using data sondes (**Figure 19**).

Average turbidity measured with the field turbidity meter over the three-year period in the Spring River to North Unit Diversion Dam Assessment Unit AU was 2.3 NTU with a maximum of 4.3 NTU. The North Unit Diversion Dam to Whychus Creek AU averaged 1.8 NTU with a maximum of 3.8 NTU Turbidity at the Tumalo Creek AU sites averaged 1.4 NTU with a maximum of 4.8 NTU.

The observed decrease in turbidity from upstream to downstream in the Deschutes River agrees with reporting since 2010 by UDWC (2010). It is presumed that the dam at Mirror Pond traps sediment that would otherwise contribute to downstream turbidity. Mirror Pond has not been dredged since 1984 and is the subject of discussion for future dredging efforts.

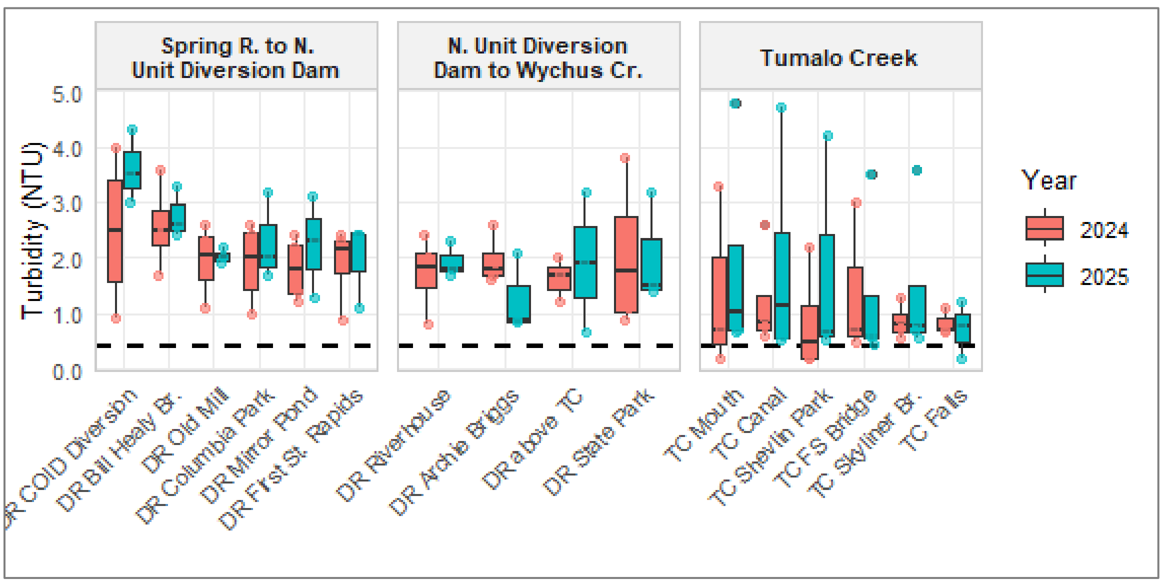

Figure 18. Boxplots of turbidity collected in 2024 and 2025 for samples collected at monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75), the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00), and the Tumalo Creek AU

A relatively complete, valid continuous turbidity monitoring dataset is available from DR Mirror Pond (DR 166.75) and DR Archie Briggs (DR 163.25) sites during 2024 and 2025, and the DR COID Diversion (DR 170.75) site during 2024 (**Figure 19**). No valid data is available from DR State Park (DR 160.00) site during either year. In general, turbidity at the most upstream site (DR COID Diversion) was lower and less variable than at the sites downstream. Most values at the DR COID Diversion site were below 5 NTU with occasional spikes above 5 NTU. Turbidity values at the other sites were higher and more variable. Seasonally, higher turbidity values were observed during several periods at all sites with data: April to May 2024, November 2024, and April 2025. These periods correspond to higher flows in the spring and fall. Some of the short-term variability that was observed may be due to temporary fouling as particles settle and are washed off sensors.

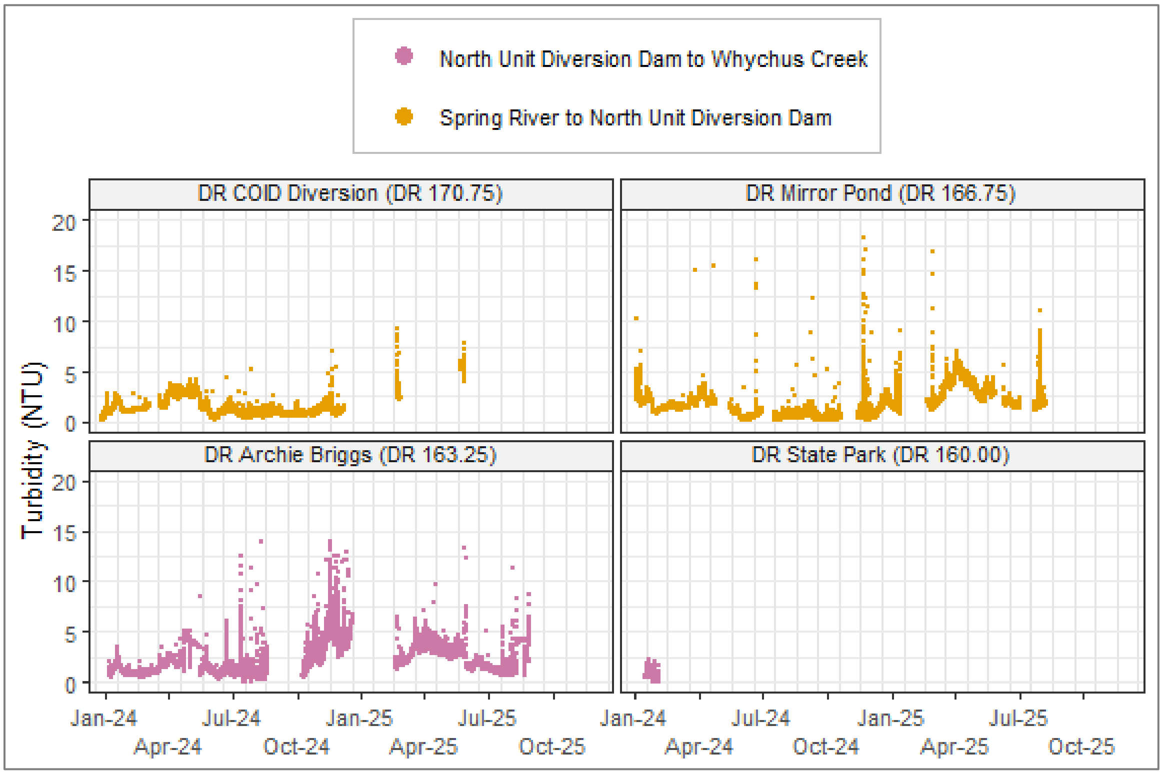

Figure 19. Results of *in situ* turbidity measured at 15-minute intervals at monitoring stations in the Spring River to North Unit Diversion Dam AU (DR 170.75 and DR 166.75) (orange points) and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 and 160.00) (pink points) - City of Bend 2024 and 2025

Total Suspended Solids

Like turbidity, total suspended solids (TSS) are derived from similar sources, but TSS measurements include particles (including phytoplankton) greater than 0.45 microns. Therefore, generally the smaller particles that do not settle out by gravity and instead remain suspended in the water column are not incorporated in TSS and are considered total dissolved solids (TDS) (not considered here). High levels of TSS reduces light availability and photosynthesis, can increase water temperature, reduce the ability of fish to see, clog fish gills, and harm egg and larval development.

Presented are results from samples analyzed for TSS from monthly to quarterly grab samples in 2024 and 2025 from the Deschutes River (**Figure 20**). Overall, TSS ranged from 2.58 mg/L to a high of 12.1 mg/L with values being generally lower in 2024 across both AUs. Values were not only higher in 2025 but there was greater variation over the year in the Spring River AU compared to the North Unit Diversion AU.

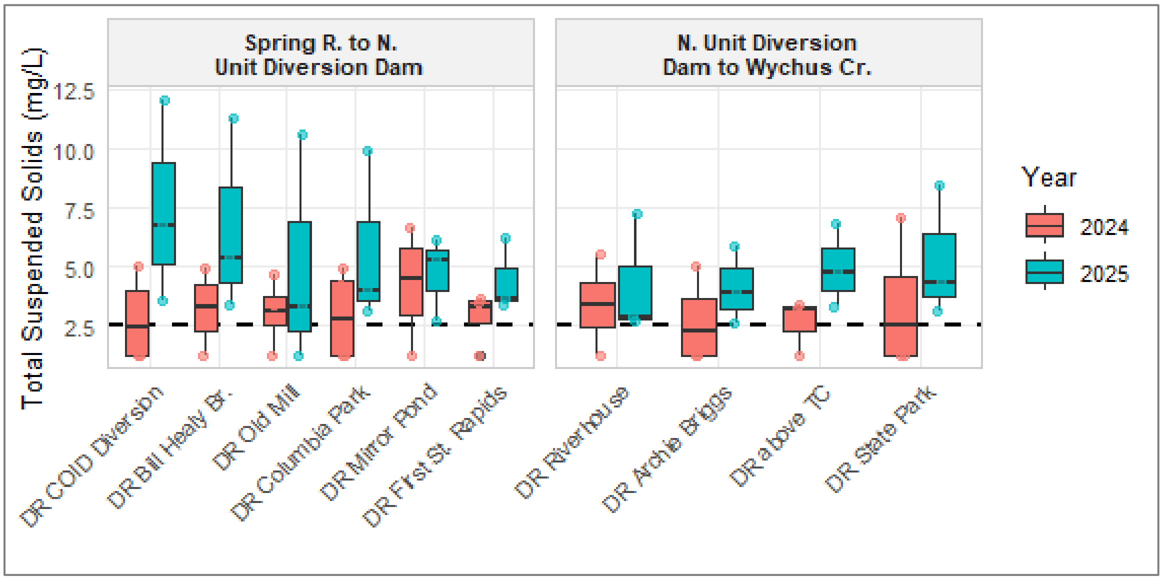

Figure 20. Box and whisker plots of the annual total suspended solids concentrations of samples collected at monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 165.75) and the North Unit Diversion Dam to Whychus Creek AU (DR 164.75 to 160.00) in 2024 and 2025

Dissolved Oxygen

Dissolved oxygen (DO) is fundamental to the metabolism of aerobic organisms, including fish, invertebrates, bacteria, and plants growing in aquatic environments. DO concentration when at saturation with the atmosphere is influenced by external factors such as water temperature, salinity and atmospheric pressure. Water with higher temperature, higher salinity, and lower pressure contains less DO when at equilibrium with the atmosphere. As such, seasonal and regional variations are observed in the DO capacity of an aquatic system. Hydrologic influences such as atmospheric inputs through wind mixing, aeration from waterfalls and rapids, groundwater discharge, dam releases, and pumps also influence DO concentrations. More importantly, the balance between the biological factors of primary productivity, respiration, and decomposition impact deviations from atmospheric saturated DO concentrations within an aquatic environment. When the DO saturation is near 100% air saturation, it is said to be in equilibrium. DO concentration below saturation levels are often attributed to the dominance of respiration and decomposition over primary productivity. Low DO concentrations can be lethal to sessile aquatic organisms that depend on DO. Conversely excessive DO concentrations can lead to supersaturation which has long been known to be detrimental to fish health (Weitkamp and Katz 1980). Similar to pH, fluctuations in DO commonly occur throughout the day as photosynthesis increases to an afternoon peak and decreases into the evening and night. The 2022 IR provides separate DO criteria for the stream AUs for each of the Deschutes River AUs and the Tumalo Creeks AUs included in the study (**Table 6**).

TABLE 6. DISSOLVED OXYGEN CRITERIA BY ASSESSMENT UNIT

Season[1]	Spring River to North Unit Diversion Dam[1] (DR170.75 to DR165.75) and Lower Tumalo Creek (TC00.25 to TC07.25)	North Unit Diversion Dam to Whychus Creek[1] (DR164.75 to DR160.00)	Upper Tumalo (TC14.50 and TC17.25)
Year Round (Non-spawning)	"Cold water" Not less than 8.0 mg/L as an absolute minimum	"Cool water" Not less than 6.5 mg/L as an absolute minimum	"Cold water" Not less than 8.0 mg/L as an absolute minimum
Year Round (Non-spawning)	8.0 mg/L as a 30-day mean minimum	Minimum 6.5 mg/L of the 30 consecutive-day floating averages of the calculated daily mean dissolved oxygen concentration (OAR 340-041-0002)	8.0 mg/L as a 30-day mean minimum
Year Round (Non-spawning)	6.5 mg/L as a 7-day mean minimum	Minimum 5.0 mg/L of the seven consecutive-day floating average of the calculated daily mean dissolved oxygen concentration (OAR 340-041-0002)	6.5 mg/L as a 7-day mean minimum
Year Round (Non-spawning)	6.0 mg/L absolute minimum	Absolute minimum 4.0 mg/L for surface samples when applying the averaging period, spatial median of IGDO2 (OAR 340-041-0016)	6.0 mg/L absolute minimum
(Spawning)	Not less than 11.0 mg/L 7-day mean minimum (January 1 – May 15)		Not less than 11.0 mg/L 7-day mean minimum (August 15 – June 15)

1 Dissolved oxygen criteria for resident trout spawning is applied differently between Assessment Units (AU).

2 "Spatial Median" means the value that falls in the middle of a data set of multiple intergravel dissolved oxygen (IGDO) measurements taken within a spawning area. Half the samples should be greater than and half the samples should be less than the spatial median. (OAR 340-041-0002).

Presented are DO concentrations from continuously logging multi-parameter sondes in 2024 and 2025 from four Deschutes River sites set at 15-minute intervals (**Table 4**). Specific start and end times varied by site and between years. Measurements of DO are presented as the 30-day mean minimum (**Figure 21**) and seven-day mean minimum (**Figure 22**) by AU. Although continuous monitoring data is not available from the Tumalo Creek AUs, the lowest synoptic grab sample measurement was 9.9 mg/L, considerably higher than the absolute minimum criterion of 8.0 mg/L.

There were no instances of dissolved oxygen falling below the 30-day mean minimum 8.0 mg/L criteria at any of the four sites during either year. The lowest 30-day mean minimum value observed was 7.7 mg/L at the DR Mirror Pond (DR166.75) site on August 11, 2024. There were no instances of dissolved oxygen falling below the 30-day mean minimum of 6.5 mg/L criteria for the North Unit Diversion Dam to Whychus Creek AU. That is, monitoring data from the Deschutes River since 2016 meet the ODEQ criteria for year-round (non-spawning) 30-day mean minimum DO criteria the vast majority of the time with the exception of the DR Mirror Pond (DR166.75) site during June-July 2021, and July-August 2022.

In addition to the year-round non-spawning DO criteria, each assessment unit has a seven-day mean minimum spawning criteria of 11.0 mg/L for specific designated spawning periods. For the Deschutes River and Lower Tumalo Creek AUs, the spawning period extends from January 1 to May 15. The spawning period for the Upper Tumalo Creek AU, designated for Bull Trout spawning, extends from August 15 to June 15. For all sample sites in both Deschutes River AUs, the seven-day mean minimum of 11.0 mg/L was exceeded starting in March during 2024 and 2025 (**Figure 22**). Exceedances at the DR State Park (DR 160.00) site in 2025 could not be evaluated due to gaps in valid data.

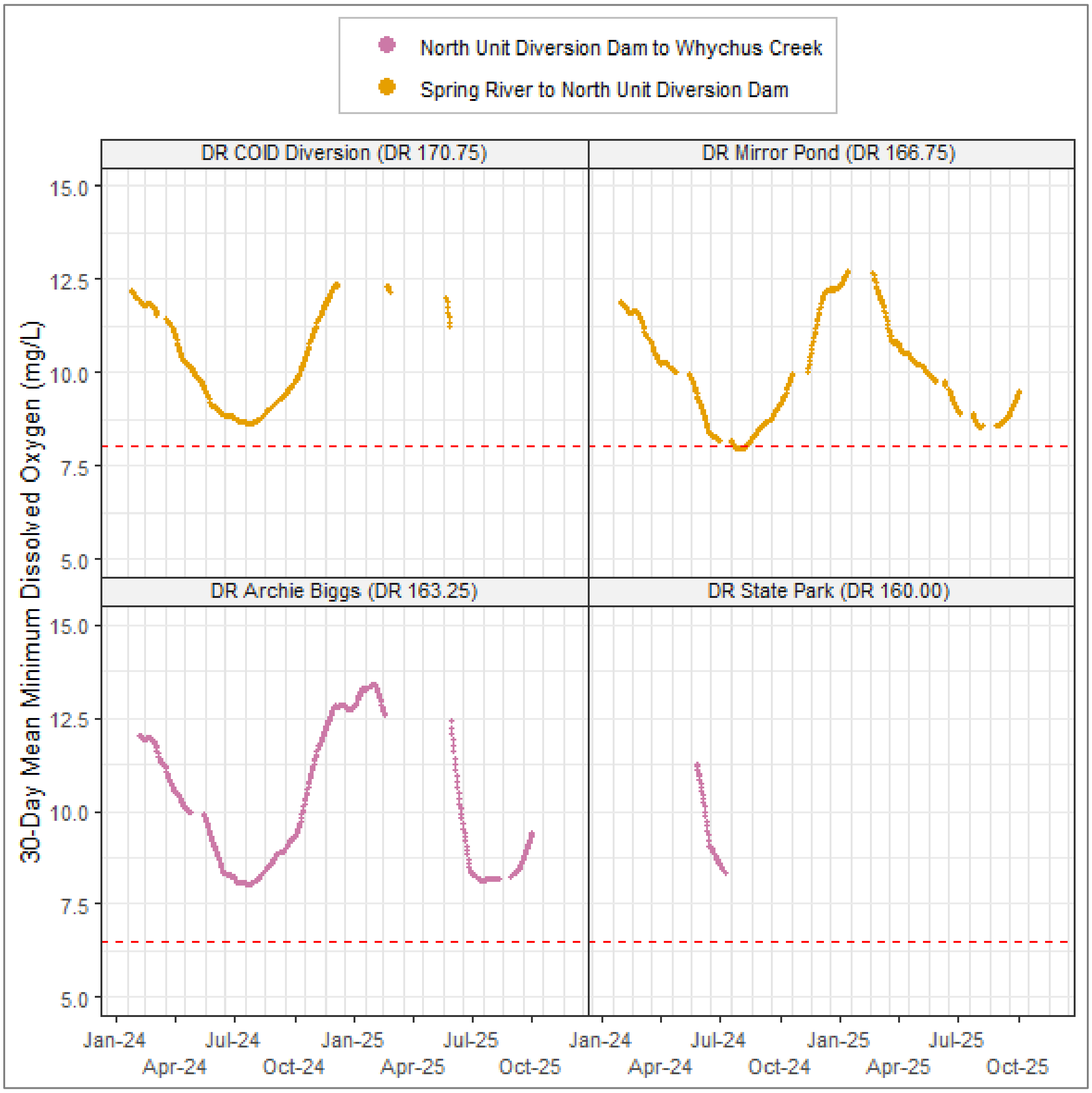

Figure 21. The 30-day mean minimum dissolved oxygen concentrations for the monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75) (orange lines) and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00) (pink lines) - City of Bend 2024 and 2025. The red line indicates the ODEQ 8.0 mg/L year-round non-spawning for the Spring River to North Unit Diversion Dam AU (top panels) and the 6.5 mg/L year- round non-spawning criteria for the North Unit Diversion Dam to Whychus Creek AU

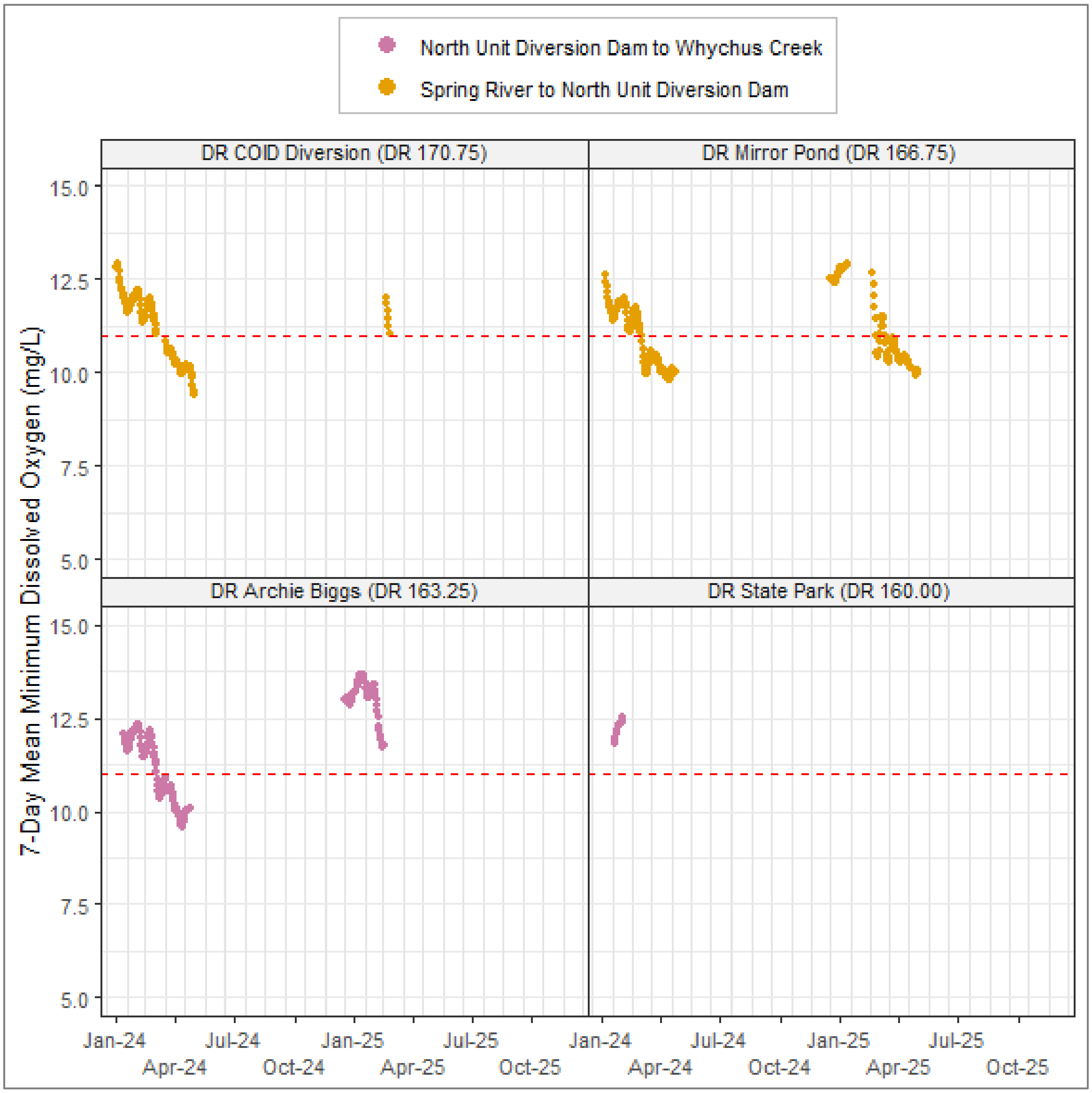

Figure 22. The seven-day mean minimum dissolved oxygen concentrations during designated spawning periods for the monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75) (top panels in orange) and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00) (bottom panels in pink) - City of Bend 2024 and 2025. The dashed red line indicates the ODEQ 11.0 mg/L spawning criteria for January 1 to May 15

Specific Conductance

The specific conductance of water is highly correlated to the concentration of major ions in the water such as calcium, magnesium, and sodium. Natural sources of these major ions are weathering of soil and rock in the watershed, the atmosphere, and regional climate, but pollutant discharges can also lead to notable changes in conductance due to the high concentrations of chloride, phosphate or nitrate which would appreciably raise conductance above ambient concentrations.

Presented are specific conductance results from continuously logging multi-parameter sondes in 2024 and 2025 deployed at four sites in the Deschutes River and set at 15-minute intervals (**Table 4**; **Figure 23**). Specific start and end times varied by site and between years.

Specific conductance across the three sites with a near complete data record averaged 65.1 µS/cm during 2024. Averages were 64.7 µS/cm at COID Diversion (DR 170.00), and 65.4 µS/cm at both the DR Mirror Pond (DR 166.75) and DR Archie Briggs (DR 163.25) sites. Valid specific conductance data was not available for the DR State Park site (DR 160.00) during 2024 or 2025, or from the DR COID Diversion (DR 170.00) during 2025. Averages at the DR Mirror Pond (DR 166.75) and DR Archie Briggs (DR 163.25) sites during 2025 were slightly lower at 62.9 µS/cm and 63.3 µS/cm respectively. Marked seasonal trends were present across the three sites with approximately 10 µS/cm higher values in the winter than the summer (**Figure 23**). Based on a more limited number of samples taken at the same time as grab samples, average conductance in Tumalo Creek sites was lower at 36.5 µS/cm during 2024 and 36.3 µS/cm during 2025.

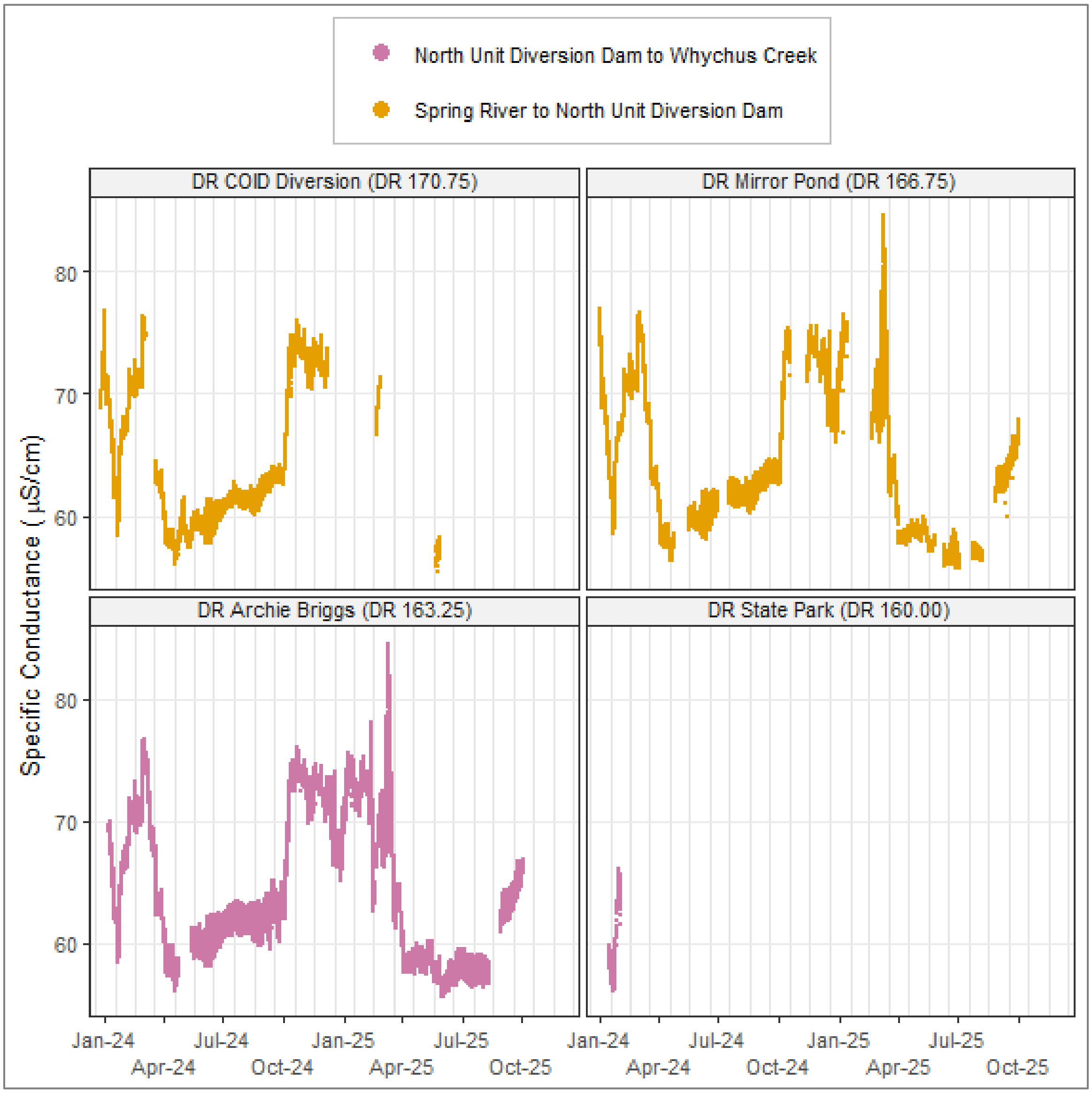

Figure 23. Continuous specific conductance measurements for the monitoring stations in the Spring River to North Unit Diversion Dam Assessment Unit (AU) (DR 170.75 to DR 166.75) (orange dots) and the North Unit Diversion Dam to Whychus Creek AU (DR 163.25 to 160.00) (pink dots) - City of Bend 2024 and 2025

Nitrate, Nitrite, and Ammonia-Nitrogen

Nitrogen is an essential nutrient for plant and animal growth. Nitrogen in water occurs in several bioavailable forms; in particular, nitrate (NO_3-N), nitrite (NO_2-N), and ammonia (NH_3^+- N). Transformation between nitrogen forms is facilitated by aerobic bacteria as a means of generating energy for growth. This process, nitrification, is a two-step bacterial mediated oxidation of ammonia, to nitrite, to nitrate (NO_3-N). In anerobic conditions, denitrification can occur where a set of different bacteria transform nitrate to nitrogen gas (N_2) to generate energy, which also results in loss of nitrogen to the atmosphere. Nitrate plus nitrite is generally measured in the lab as nitrite is readily oxidized to nitrate. Runoff from fertilizers, sewage, animal manure, and ground disturbance can lead to excessive nitrogen in surface and groundwater. Excess nitrogen in surface water can lead to problems including excessive growth of algae and aquatic plants which can lead to high pH during period of growth and DO depletion upon decomposition. The Deschutes River is known to be nitrogen-limited (Jones 2003); thus all bio-available forms of nitrogen forms are rapidly consumed by algae and aquatic plants during primary production. EPA (2000) provides guidance on total nitrogen for Ecoregion II but no other forms of nitrogen.

Grab samples were collected monthly for nitrate-nitrogen analysis in 2024 and 2025 from the Deschutes River and Tumalo Creek. Concentrations were at or below method reporting limits (0.002 mg/L) for all samples except Deschutes River samples in March 2025 when concentrations of these samples were only slightly greater than the reporting limits (up to 0.013 mg/L), thus no figures are included for nitrite. Similarly, most nitrate-nitrogen results were near the reporting limit (0.003 mg/L) and, when detected, ranged from 0.013 to 0.025 mg/L.

Ammonia-nitrogen concentrations were generally below the detection limit with very few exceptions; the most notable being on measurement of 0.67 mg/L at the DR Mirror Pond (Mirror Pond) site in March 2024.

Phosphorus

Phosphorus is essential to biological metabolism, including cellular DNA, yet it is often the nutrient most limiting to primary productivity (e.g., algae growth). Despite this, excess loading to aquatic ecosystems can result in algae blooms and subsequent cascading events such as low DO, aesthetic issues, taste and odor problems, and toxigenic harmful algae. While sources of phosphorus can be naturally occurring, excessive anthropogenic loading results from run-off (urban, pastures, croplands), streambank erosion, and sewage seepage. Phosphorus is present in organic (organic biomass) and inorganic (orthophosphate) forms. Inorganic phosphorus is the preferred form for primary productivity as it is readily available for biological uptake requiring minimal energy utilization. Total phosphorus (TP) is the combination of all organic and inorganic forms of phosphorus in the water column. **Table 7** summarizes state and federal guidance concentrations and exceedances for phosphorus as well as other evaluated parameters.

TABLE 7. GUIDANCE/STANDARDS SUMMARY WITHIN THE STUDY AREA

Parameter	Guidance[a]	DEQ[b]	EPA[c, d]	2021-2023 Exceedances	Max. Exceedance Observed 2021-2023
Total phosphorus (mg/L)[a]			Aggregate Nutrient Ecoregion II = 0.010	All sites monitored	Deschutes R. 0.11, Tumalo Cr. 0.26
Chloride (mg/L)[b]		860.0 (acute) 230.0 (chronic)	860.0 (acute) 230.0 (chronic)	None	
Fluoride (mg/L)	0.50			None	
Sulfate as SO_4 (mg/L)			250	None	
E. coli (MPN/100m)		126 (90-day mean); 406 (single sample)		None	

MPN = Most Probable Number

SOURCES:

a Carmago (2003)

b ODEQ (2022b)

c EPA (2000)

d EPA (2003); secondary maximum contaminant level (SMCL) based on aesthetic effects (i.e., taste and odor)

Presented are results from samples analyzed for orthophosphate and TP from monthly grab samples in 2024 and 2025 from the Deschutes River and Tumalo Creek (**Figure 24** and **Figure 25**, respectively). Orthophosphate concentrations in Deschutes River sites ranged from below reporting limits (0.05 mg/L) on multiple sites and dates to 0.071 mg/L at DR 169.00 during March 2024. Mean orthophosphate concentrations at Deschutes River sites were 0.040 mg/L in the Spring River to North Unit Diversion Dam AU and 0.038 mg/L in the North Unit Diversion Dam to Whychus Creek AU. Concentrations were lower at sites within the Tumalo Creek AU averaging 0.033 mg/L. Average concentrations at the Deschutes River sites were slightly higher during 2024 (0.044 mg/L) than 2025 (0.034 mg/L) (**Figure 24**). Temporal variability in orthophosphate availability was observed throughout the Deschutes River, with reduced concentrations in the late-spring to early-summer periods. This orthophosphate depletion may be attributed to increased primary productivity with warmer water and higher solar irradiance.

During 2024 and 2025 at the Deschutes River sites, TP concentrations ranged from 0.046 mg/L at the DR State Park site (DR 160.0) on June 4, 2024 to 0.120 mg/L at DR the Bill Healy Br. site (DR 169.00) on March 10, 2025. The average concentration in the Spring River to North Unit Diversion Dam AU was 0.073 mg/L and the average concentration in the North Unit Diversion Dam to Whychus Creek AU was 0.066 mg/L (**Figure 25**). Concentrations were lower in the Tumalo Creek sites averaging 0.044 mg/L during 2024 and 2025. All Tumalo Creek concentrations were lower than 0.066 mg/L except one 0.110 mg/L sample collected from the TC Canal site (TC 3.25) on November 4, 2024. There were no clear differences between TP concentrations measured in 2024 and 2025 across any of the AUs.

All measurements at the Deschutes River and Tumalo Creek sites exceeded total phosphorus guidance values 0.01 mg/L for EPA Aggregate Nutrient Ecoregion II (**Table 7**; **Figure 25**). Elevated phosphorous values are likely derived primarily from natural sources, due to weathering of phosphorous-rich volcanic rocks (mostly basalt). In addition, relatively low concentrations of nitrogen result in nitrogen limitation of algal growth and excess availability of phosphorus. This process drives naturally high phosphorous measurements across much of central and eastern Oregon. Bedrock geology has been mapped for the entire Pacific Northwest and it documents the importance of basalt and other rocks of volcanic origin for this region (Johnson and Raines 1995). The weathering products from basalts are well known and show a disproportionately high rate of weathering of phosphorus from these rocks by hydrolysis (Krauskopf 1979; Colman 1982). The weathering of phosphorus is readily apparent in the three major tributaries to Lake Billy Chinook, including from the Deschutes River (Eilers and Vache 2020). As previously mentioned, excess TP, and nitrogen concentrations can lead to cascading environmental events such as depleted DO due to algae growth followed by decomposition.

The UDWC (2010) report indicated exceedances in 91 percent of reported values (354 exceedances out of 389 total observation) of the TP ecoregion thresholds, with the highest concentrations (0.40 mg/L) measured at a site further downriver than was evaluated in this report.

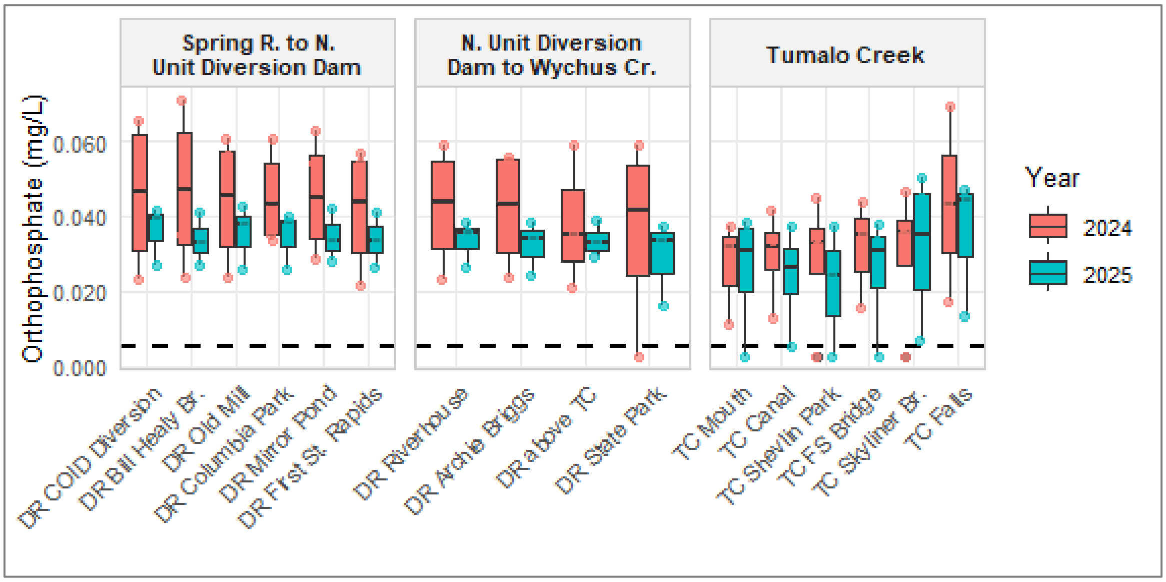

Figure 64. Boxplots of Deschutes River and Tumalo Creek orthophosphate concentrations in grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam to Wychus Creek, and Tumalo Creek AU sites in 2024 and 2025. The dashed line is the laboratory reporting limit

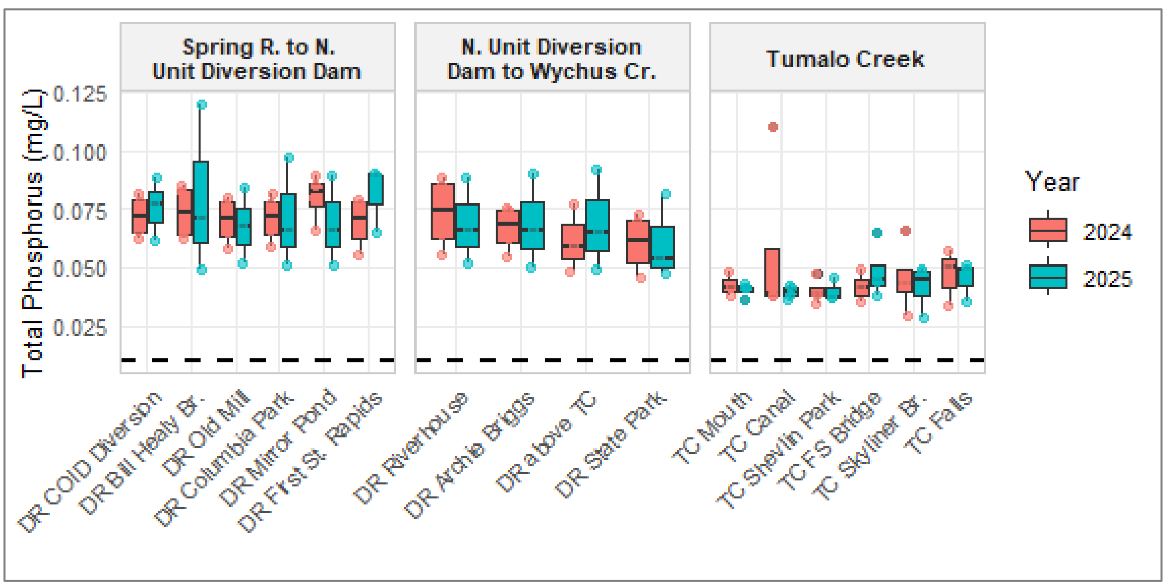

Figure 25. Boxplots of Deschutes River and Tumalo Creek total phosphorus concentrations in grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam to Wychus Creek, and Tumalo Creek AU sites in 2024 and 2025. The dotted line is the EPA guidance criteria for aggregate Nutrient Ecoregion II and the dashed line is the laboratory reporting limit

Chloride, Fluoride, and Sulfate

Chloride is not generally a dominant anion in freshwater environments except for waterbodies near marine areas where wind can transport saltwater spray to adjacent freshwaters. Additional anthropogenic sources including run-off from road de-icing and wastewater discharge can harm aquatic life by disrupting osmoregulation (the process by which biological organisms maintain proper levels of salt). Presented are results from grab samples collected in 2024 and 2025 and analyzed for chloride (**Figure 26**). Measurements in Deschutes River sites ranged from 0.44 mg/L to 1.72 mg/L and averaged 1.05 mg/L in the Spring River to North Unit Diversion Dam AU and 0.99 mg/L in the North Unit Diversion Dam to Whychus Creek AU. Concentrations in the Tumalo Creek AU averaged 0.37 mg/L and ranged from 0.18 mg/L to 0.63 mg/L. In general, chloride concentrations have been higher during from November through March in all AUs, with less annual variation in the Tumalo Creed AU (**Figure 27**). This may be due to factors including seasonal changes in the relative contribution of surface and ground water and application of magnesium chloride for road deicing during the winter.

Fluoride is naturally occurring through geologic processes but can also be released directly to the environment through human activities, including industrial manufacturing processes, the use of fluoride-containing pesticides, and the addition of fluoride to drinking water (though fluoride is not provided in the City of Bend’s drinking water). Naturally occurring concentrations of fluoride in fresh surface waters is generally less than 1 mg/L. Substantially higher concentrations can be found in groundwater. Presented are results from grab samples collected monthly in 2024 and 2025 and analyzed for fluoride (**Figure 26**). Measurements in Deschutes River sites ranged from 0.05 mg/L to 0.13 mg/L and averaged 0.08 mg/L both the Spring River to North Unit Diversion Dam AU the North Unit Diversion Dam to Whychus Creek AU. Concentrations in Tumalo Creek sites ranged from below the laboratory detection limit to 0.11 mg/L and averaged 0.45 mg/L.

Sulfate also naturally occurs from the breakdown of organic material, geological processes, and atmospheric deposition. Specific anthropogenic sources include runoff from pulp mills or agricultural areas. Living organisms utilize forms of sulfur, depending on the redox status of the cycle (sulfate being bonded with oxygen), including bacteria responsible for decomposing organic matter which contributes to the cycling of other nutrients in ecosystems (Wetzel 2001). Presented are results from grab samples collected in 2024 and 2025 and analyzed for sulfate (**Figure 26**). Measurements ranged from 0.28 mg/L to 1.36 mg/L in the Deschutes River and averaged 0.6 mg/L in both the Spring River to North Unit Diversion Dam AU and the North Unit Diversion Dam to Whychus Creek AU. Concentrations in Tumalo Creek sites ranged from 0.21 mg/L to 0.69 mg/L and averaged 0.45 mg/L.

No exceedances have been reported for the subject parameters, and all were within EPA guidance (**Table 7**).

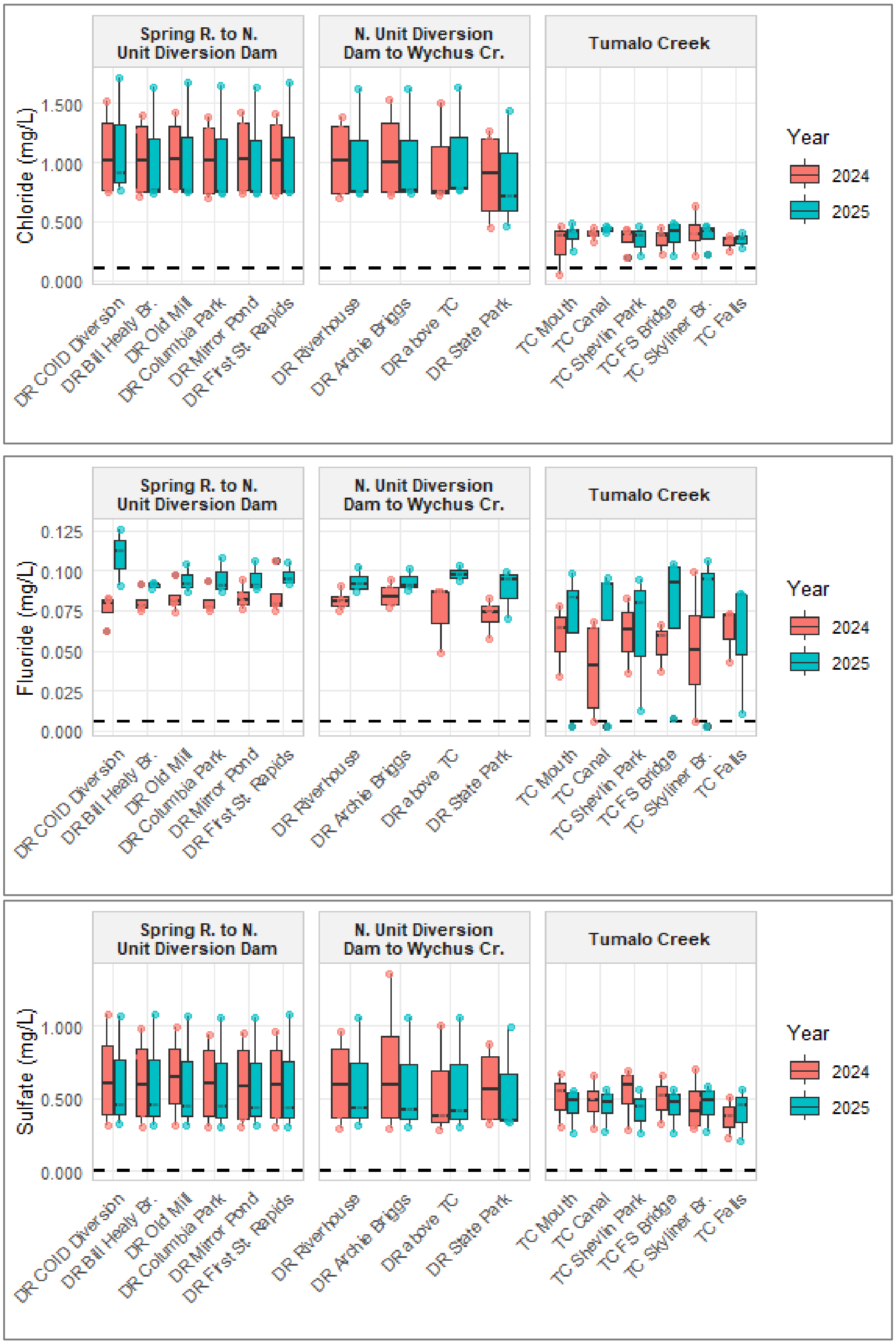

Figure 26. Boxplots of Deschutes River and Tumalo Creek chloride, fluoride, and sulfate concentrations in grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam to Wychus Creek, and Tumalo Creek AU sites in 2024 and 2025. Dashed lines indicate the laboratory reporting limits

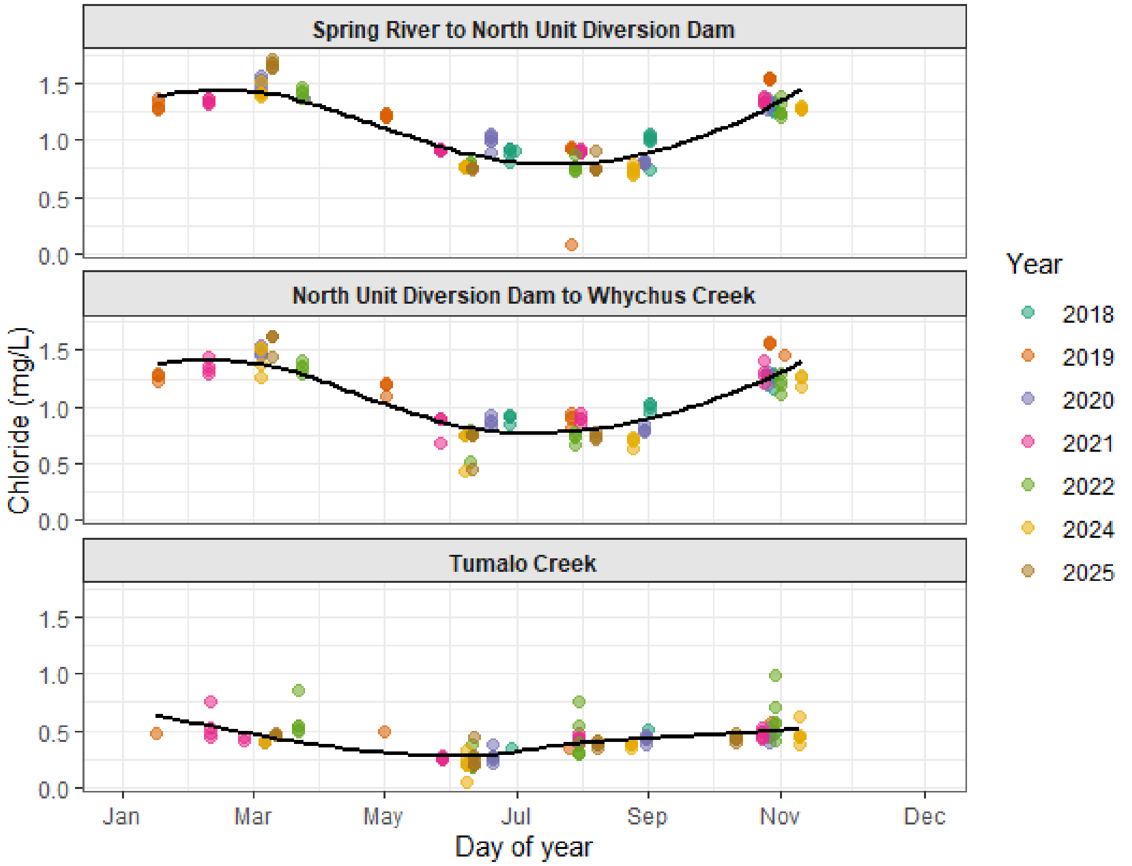

Figure 27. Deschutes River and Tumalo Creek chloride concentration by day of the year in grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam, and Tumalo Creek AUs from 2008 to 2025

Total Coliform and *E. coli*

Total coliforms are a group of bacteria that exist in soil and water and are used as an indicator for other potential pathogens because they are relatively easy to identify, commonly occur in large numbers and generally respond to the environment in the same way as more detrimental pathogens. *Escherichia coli* (*E. coli*) is a major species that make up total coliforms and is found in the large intestines of humans and other warm-blooded animals. *E. coli* is used as an indicator for fecal contamination and subsequently whether pathogenic or disease-causing organisms may also be present.

In 2024 and 2025, total coliform in the Deschutes River ranged from 25 MPN/100 mL (most probably number per 100 mL) to 1,733 MPN/100 mL and averaged 341 MPN/100 mL in the Spring River to North Unit Diversion Dam AU and 405 MPN/100 mL in the North Unit Diversion Dam to Wychus Creek AU (**Figure 28**). Total coliform in Tumalo Creek ranged from 3 to 613 MPN/100 mL and averaged 159 MPN/100 mL. *E. coli* ranged greatly from less than one detection to 122.3 MPN/100 in the Deschutes River and from one detection to 24.1 MPN/100 mL in Tumalo Creek (**Figure 29**). The numeric criteria for *E. coli* for freshwater contact recreation is a 90-day geometric mean of 126 organisms/100 mL and a single sample of 406 organisms/100 mL (ODEQ 2018) (**Table 7**). Thus, no exceedances of *E. coli* were observed in the Deschutes River or Tumalo Creek in 2024 and 2025.

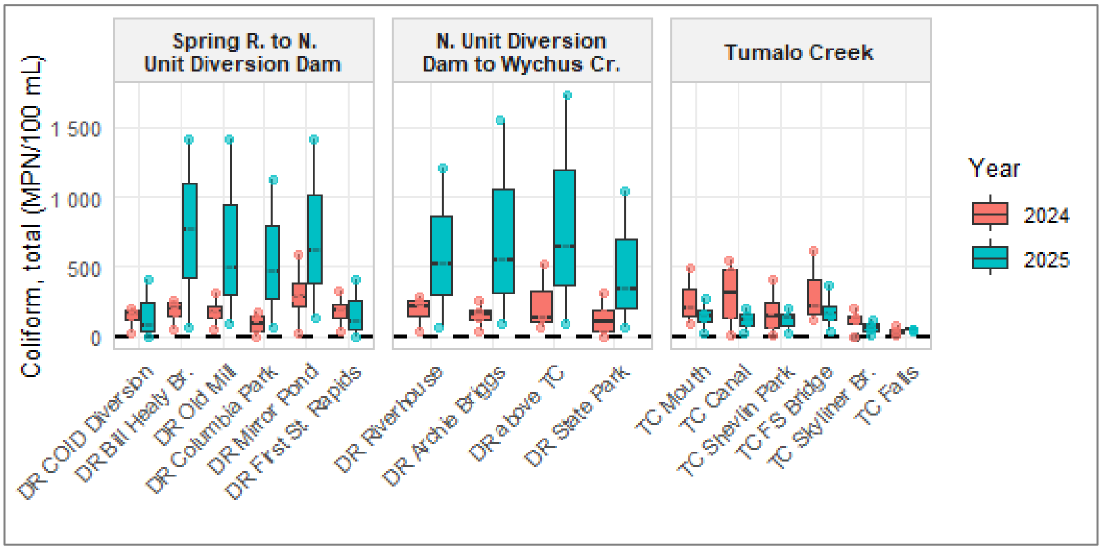

Figure 28. Boxplots of Deschutes River and Tumalo Creek total coliform concentrations (most probable number, MPN per 100 mL) grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam to Wychus Creek, and Tumalo Creek AU sites from 2024 and 2025.

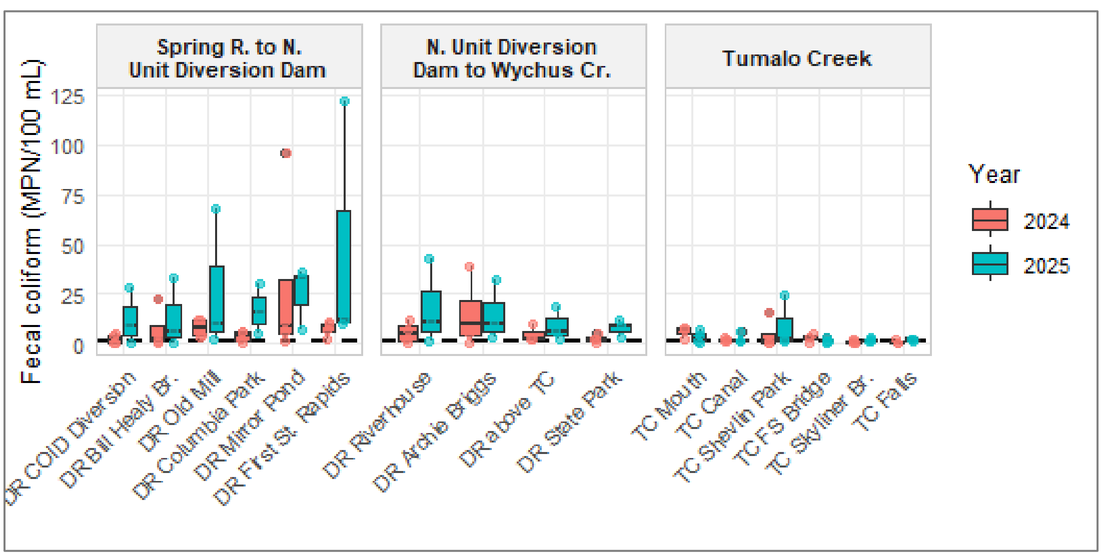

Figure 29. Boxplots of Deschutes River and Tumolo Creek *E. coli* concentrations (most probably number, MPN per 100 mL) in grab samples collected from the Spring River to North Unit Diversion Dam, North Unit Diversion Dam to Wychus Creek, and Tumalo Creek AU sites from 2024 and 2025

Summary

The City of Bend has collected ambient water quality data from the Deschutes River since 2004 and from Tumalo Creek since 2018. This report summarizes the results of grab sample and continuous in situ monitoring conducted in 2024 and 2025. Over the course of the program, refinements in monitoring locations, analytical methods, and instrumentation have steadily improved data quality: reducing sensor drift, lowering detection limits, and limiting data loss from fouling. The resulting dataset provides valuable insight into water quality conditions during a period of rapid population growth, ongoing restoration activity, and evolving water management practices in the Deschutes Basin.

Key findings from the 2024–2025 monitoring period are consistent with previous reporting:

- Water temperature frequently exceeded Oregon's year-round (non-spawning) 18°C 7-day average daily maximum (7DADM) criterion at all monitored Deschutes River sites during summer months, with the longest periods of exceedance generally occurring at downstream locations. Tumalo Creek also exceeded temperature criteria (18°C in lower Tumalo Creek and 12°C in upper Tumalo Creek) at least once in each Assessment Unit, reflecting strong seasonal warming and downstream increases in temperature.

- pH exceeded the upper criterion of 8.5 at one or more Deschutes River sites each year, particularly in slow moving reaches such as Mirror Pond and Archie Briggs Crossing where photosynthetic activity drives pronounced diel fluctuations. These exceedances align with the 2022 Integrated Report listing for the Spring River to North Unit Diversion Dam AU but do not support the delisting of the North Unit Diversion Dam to Whychus Creek AU. No low pH exceedances (<6.5) were observed, and grab samples in Tumalo Creek did not show pH impairment.

- Turbidity and Total Suspended Solids (TSS) remained low across both waterbodies. Tumalo Creek exhibited lower turbidity than the Deschutes River, and continuous turbidity measurements showed seasonal increases during spring and fall high flow periods.

- Dissolved oxygen (DO) met the applicable year-round (non-spawning) 30 day mean minimum criteria at all monitored Deschutes River sites during 2024 and 2025. The 7 day spawning criterion of 11.0 mg/L was also attained at all Deschutes River sites early in the season, with exceedances beginning in early spring and persisting through mid-May. Grab samples from Tumalo Creek consistently exceeded minimum DO criteria.

- Specific conductance in the Deschutes River continued to show a predictable seasonal pattern, with higher values in winter and lower values in summer, while Tumalo Creek exhibited lower and less variable conductance overall.

- Nutrients showed patterns typical of the Upper Deschutes Basin. Most nitrogen species were at or near detection limits, underscoring long recognized nitrogen limitation in the river system. Total phosphorus and orthophosphate concentrations exceeded EPA's Ecoregion II guidance values across all sites, a result consistent with natural weathering of phosphorus rich volcanic geology in central Oregon rather than local anthropogenic loading.

- Chloride, fluoride, and sulfate remained within EPA guidance levels at all sites.

- Total coliform and E. coli levels showed wide seasonal variability but remained below state recreation criteria throughout the monitoring period.

Recommendations

There are several ambient water quality monitoring program improvements we recommend to better achieve the City of Bend's goals:

- The City of Bend data should incorporate their water quality data into a comprehensive water quality database. A comprehensive database will streamline data quality assurance, increase data transparency, and facilitate data sharing. Regardless of the database structure, it should include all data, including data that does not meet quality assurance criteria. Standardized DEQ data qualifiers should be applied, and justification for qualifiers provided. With the utilization of data qualifiers, data users would be able to include/exclude data based upon the type of analysis completed.

- All original files should be archived as read-only files. The files should be referenced in the water quality database along with information on file location, date of creation, file originator, and data steward. Any changes or modifications to the files should be saved with a different, versioned filename.

- Standardized field reporting and instrument calibration forms should be used and referenced in the database. Field forms should include common fields such as date, time, site, parameters, and crews. Forms should also include detailed narrative of conditions encountered, equipment problems, or conditions prior to field visits that may affect measurements. Data recording apps such as ESRI's Field Maps and Survey 123 or the Fulcrum App are recommended to streamline field recording and ensure completeness.

- Comprehensive water quality monitoring programs such as the one that the City of Bend implements provide an extensive amount information. This data can be difficult to present to interested stakeholders and residents. An interactive online map that draws data from a comprehensive database, for example an ESRI Story Map, is recommended as a platform to present technical information in a streamlined, easy to understand manner. This improvement will better connect the watershed users with the natural resources they interact with on a daily basis.

- Interest in potential harmful algal blooms (HABs) remains high among both staff and the public. Given that HABs can occur in slow moving waters such as Mirror Pond, the City should continue to rely on DEQ for basin-wide HAB surveillance and should consider expanded nutrient and chlorophyll a monitoring if bloom observations increase.

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CITY OF BEND

Appendix A:

City of Bend Water Quality Monitoring Plan

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