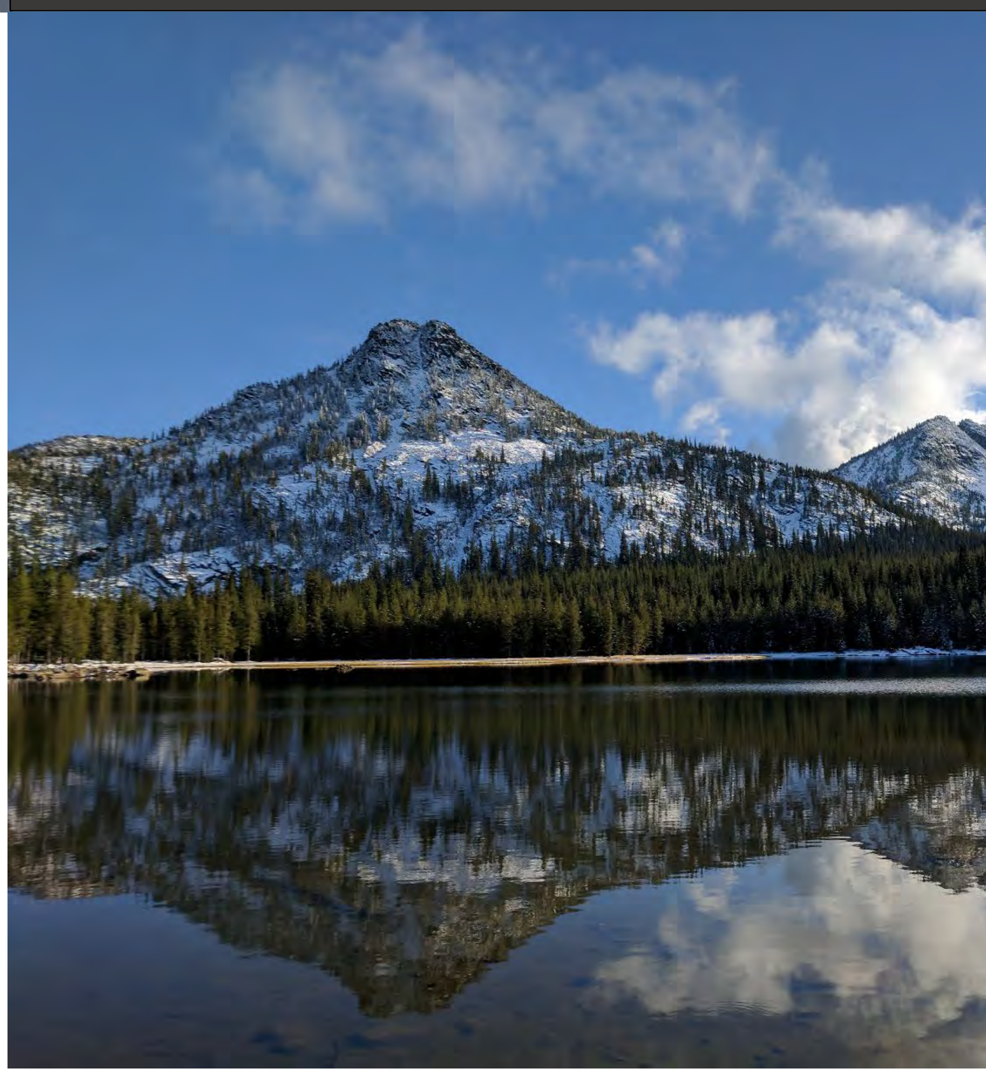
Technical Support Document

Powder River Basin TMDL for *E. coli*

May 2024



State of Oregon
Department of Environmental Quality

This document was prepared by:
Daniel Sobota, John Dadoly, Vanessa Rose, Michele Martin

Oregon Department of Environmental Quality
Watersheds Management
700 NE Multnomah Street, Suite 600
Portland Oregon, 97232

Contact: Daniel Sobota
Senior Water Quality Analyst
503-229-5138
www.oregon.gov/deq

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1. Introduction

1.1 Document purpose and organization

This draft document provides supporting information on technical analyses completed for the Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) addressing fecal contamination of surface waters in the Powder River Basin documented in DEQ's approved 303(d) list of impaired waters needing a TMDL. Included here are TMDL concepts and analyses, results used to support TMDL conclusions, and requirements for the Powder River Basin TMDL and WQMP, which will be proposed for adoption by Oregon's Environmental Quality Commission, by reference, into rule [OAR 340-042-0090(2) (a) and (b)].

This document is organized into sections with titles reflective of the TMDL elements required by OAR 340-042-0040(4) in the Powder River Basin TMDL for *Escherichia coli (E. coli)*, which is a bacteria that indicates fecal contamination from human or other warm-blooded animal sources. The TMDL may be referred to as either the Powder River Basin Bacteria TMDL or the Powder River Basin TMDL for *E. coli*. This organization is intended to assist readers to readily access the information relied on for TMDL element-specific determinations.

1.2 Overview of TMDL elements

According to OAR 340-042-0030(15), TMDL means a written quantitative plan and analysis for attaining and maintaining water quality standards and includes the elements described in OAR 340-042-0040(4). Determinations on each element are presented in the Powder River Basin Bacteria TMDL. Technical and policy information supporting those determinations are presented in this report at the section headings that correspond to the TMDL elements for which complex analysis was undertaken.

In plain language, a TMDL is a water quality restoration plan to ensure that the receiving water body can attain water quality standards that protect designated beneficial uses. The budget assigns pollutant loads for discharges of point (effluent discharge requiring a permit) and non-point (land surface and non-permitted inputs) sources into surface waters, in consideration of natural background levels, along with determination of a margin of safety (MOS) and reserve capacity (RC).

A MOS considers the uncertainty in predicting how well pollutant reductions will result in meeting water quality standards and can be expressed either explicitly, as a portion of the loading capacity, or implicitly, by incorporating conservative assumptions in the analyses. RC sets aside some portion of the loading capacity for use for pollutant discharges that may result from future growth and new or expanded sources.

A key element of analysis is the loading capacity, which refers to the amount of pollutant that a waterbody can receive and still meet the applicable water quality standard. Because the loading capacity must not be exceeded by pollutant loads from all existing sources plus the MOS and RC, it can be considered the maximum allowable load. Hence, the loading capacity is often referred to as the TMDL.

Another key element of the TMDL analysis is allocating portions of the loading capacity to known sources. Allocations are quantified measures that assure water quality standards will be met and may distribute the pollutant loads between nonpoint and point sources. Load allocations (LAs) are portions of the loading capacity that are attributed to: 1) non-point source sectors such as urban areas, agriculture, rural residential or forestry activities; and 2) background sources such as soils or wildlife. Wasteload allocations (WLAs) are portions of the total load that are allotted to point sources of pollution, such as permitted discharges from sewage treatment plants, industrial wastewater, or stormwater. As noted above, allocations can also be reserved for future uses in the RC.

This general TMDL concept is represented by the following equation:

(1) $TMDL = \sum WLAs + \sum LAs + RC + MOS$

Together, these elements establish the pollutant loads necessary to meet the applicable water quality standards for impaired pollutants and protect beneficial uses.

2. Location

Per Oregon Administrative Rule 340-042-0040(a), this element describes the geographic area where the TMDL applies. This Powder River Basin TMDL covers all freshwater perennial and intermittent streams in the Powder River Basin and a small portion of the Malheur Basin (Moore's Hollow assessment unit).

The Powder River Basin makes up one of 20 drainage basins in Oregon with basin-specific water quality standards described in OAR 340-041-0260 (originally described as the Powder/Burnt Basins) and mapped in Figure 260A. The US Geological Survey (USGS) refers to the basin as a six-digit Hydrologic Unit Code (HUC) numbered 170502 and as the Middle-Snake Powder Basin. Subbasins (eight-digit HUCs) include the Oregon portion of the Brownlee Subbasin (17050201), Burnt River Subbasin (17050202), and Powder River Subbasin (17050203) (Table 1; Figure 1).

Table 1: Powder River Basin subbasins

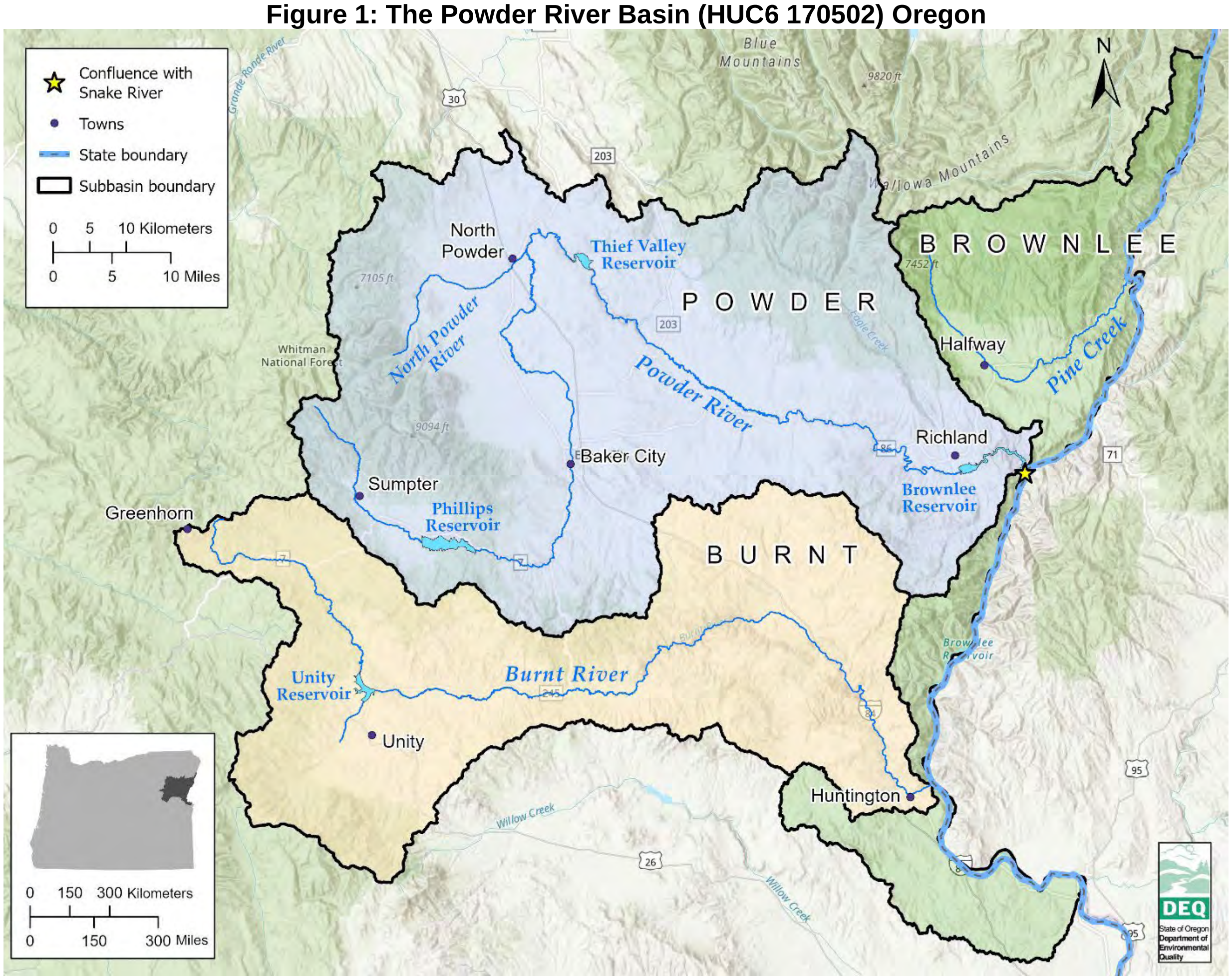
HUC8 Code	Subbasin Name
17050201	Brownlee Subbasin
17050202	Burnt River Subbasin
17050203	Powder River Subbasin

The basin forms a portion of the border of Oregon with Idaho and lies mostly within Baker County, with small portions in Union, Wallowa, and Malheur Counties. A portion of the Brownlee Subbasin also lies in Idaho and is not covered by the TMDL. The Oregon portion of the basin drains 3,444 square miles (8,925 square kilometers). Elevation ranges from 1,640 feet (500 meters) above sea level at the junction with the Snake River to 9,563 feet (2,914 meters) above sea level in the Wallowa Mountains. The average elevation is 4,237 feet (1,291 meters) above sea level (Figure 1). The entire Powder River Basin falls within the Blue Mountains Level III Ecoregion (Omernik, 1987).

In 1988, two river reaches in the basin were designated as Scenic under the federal Wild and Scenic Rivers Act of 1968. These reaches include a 6.4-mile reach of the North Powder River from its headwaters in the Elkhorn Mountains to the Wallowa-Whitman National Forest boundary and an 11.7-mile reach of the Powder River from Thief Valley Dam to the Highway 203 bridge (National Wild and Scenic River System, 2024).

A summary of basin characteristics relevant for water quality assessment is compiled in DEQ's November 2013 Powder Basin Status Report and Action Plan (DEQ 2013), available on DEQ's website.

Figure 1: The Powder River Basin (HUC6 170502) Oregon



2.1 Climate

The climate of the Powder Basin is influenced by the Cascade Mountains located approximately 200 miles to the west. This mountain range forms a barrier against the modifying effects of warm, moist fronts from the Pacific Ocean. As a result, the climate of the Powder River Basin falls under the Temperate Continental-Cool Summer Phase in the Köppen-Geiger Climate Classification System (Kottek et al, 2006). Light precipitation, low relative humidity, rapid evaporation, abundant sunshine, and large fluctuations of temperature and precipitation characterize this climate. Over the past 30 years (1991 – 2020), mean annual temperature in the basin was 45.3°F (7.4°C), with a mean annual minimum temperature of 33.3°F (0.8°C) and a mean annual maximum temperature of 64.9°F (18.3°C) (PRISM Climate Group, 2022).

Most annual precipitation falls as snow during winter. Over the past 30 years (1991 – 2020), annual precipitation has averaged 22.0 inches (56.0 cm) across the Powder Basin, with an average of 10.2 inches (25.9 cm) in the valleys and foothills an average of 78.2 inches (198.6 cm) at the highest elevations of the Elkhorn, Wallowa, and Blue Mountains (PRISM Climate Group, 2022). Portions of the basin can experience rain-on snow events, which reduce the snowpack and may cause brief localized flooding.

2.2 Hydrology

Major drainages in the Powder River Basin originate in mountainous areas in the western portion of the basin and flow east into Brownlee, Oxbow, or Hells Canyon Reservoirs on the Snake River (Figure 1). The two major rivers in the basin, the Powder and Burnt Rivers, begin in the Blue Mountains and flow for 144 and 100 miles, respectively, until the confluence with Brownlee Reservoir on the Snake River. Southern and middle drainages in the Brownlee Subbasin also drain to Brownlee Reservoir while ones north of Brownlee dam, including Pine Creek, drain into Oxbow or Hells Canyon Reservoirs on the Snake River.

The Powder River headwaters originate in the Blue Mountains (Elkhorn Range) west of Baker City near the town of Sumpter. Cracker Creek and McCully Fork join to form the Powder River. The river flows southwest before entering Phillips Reservoir. Downstream of the reservoir, the river turns north through the Baker Valley and enters Thief Valley Reservoir to the east of the town of North Powder. Downstream of Thief Valley, the river turns southeast and flows the Keating Valley, eventually entering Brownlee Reservoir on the Snake River near the town of Richland. Major tributaries include the North Powder River and Eagle Creek (Figure 1).

The headwaters of the Burnt River include the North, West, Middle, and South Forks of the Burnt River that headwater in the southern Blue Mountains (Figure 1). The forks flow into Unity Reservoir; the mainstem Burnt River begins immediately downstream. The Burnt River flows east/southeast to join the Snake River downstream of the town of Huntington. Major tributaries include Clarks Creek, Lawrence Creek, and Dixie Creek (Figure 1).

The Brownlee Subbasin includes all the streams that drain directly to the Snake River from just north of the Wallowa County-Baker County line south to the town of Ontario. The largest stream in the Brownlee Subbasin, Pine Creek, is located in the northern portion near the town of Halfway and was used to set loading capacity and allocations for the subbasin (Figure 1).

The timing and magnitude of stream flows in the Powder River Basin depend on seasonal patterns of temperature and precipitation. Generally, most precipitation occurs from late fall through early spring (November-April) in the basin as snow, although thunderstorms with intense, localized rainfall can occur during the summer months. Except for periodic summertime storms, dry and warm conditions persist from late spring through early fall (May-October) in the basin. Stream flows typically peak in spring for rivers in the basin with significant winter snowpacks and decline throughout the summer through late fall. From late spring through early fall, a portion of stream flow and water stored in reservoirs enters the irrigation conveyance system within the basin.

Plots of flow over time, monthly summaries for the period of record, and flow duration intervals based on available flow data for the largest streams draining each subbasin within the Powder

River Basin are shown in Figures 2-10. Flow duration curves describe the probability that a measured flow will be equal to or greater than that flow over the period of record for a specific stream or river. The exceedance probability (EP) for each flow was computed by:

(1) EP = rank/(n+1)

where n is the number of flow measurements and rank is the ranking of the flow measurement in the period of recorded ordered from highest to lowest. The flow duration interval is EP multiplied by 100 (Figures 4, 7, and 10).

DEQ used categories to define flow duration intervals to define in basin streams and rivers: High Flows (flows equal or greater 0% to 10% of the time); Medium-High Flows (flows equal or greater 10% to 40% of the time); Medium Flows (flows equal or greater 40% to 60% of the time); Medium-Low Flows (flows equal or greater 60% to 90% of the time); and Low Flows (flows equal or greater 90% to 100% of the time) (Section 4.4). Flow duration intervals in all three subbasins show flows typical of winter rain and snowmelt with peak flows in the spring and low flows typically in late summer through early fall. However, the highest flows during the periods of record reflect rain on snow events occurring during winter months.

Figure 2: Flow over time for Pine Creek, Oregon from 1990-2017

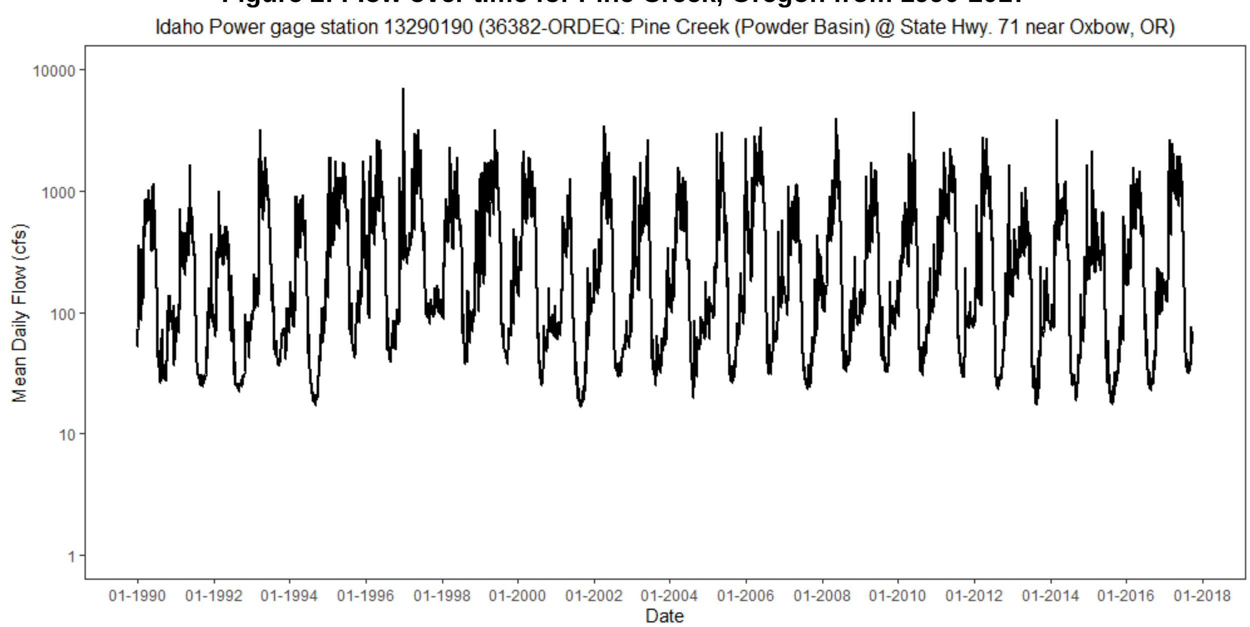


Figure 3: Monthly mean flow (± minimum or maximum) for Pine Creek, Oregon from 1990-2017

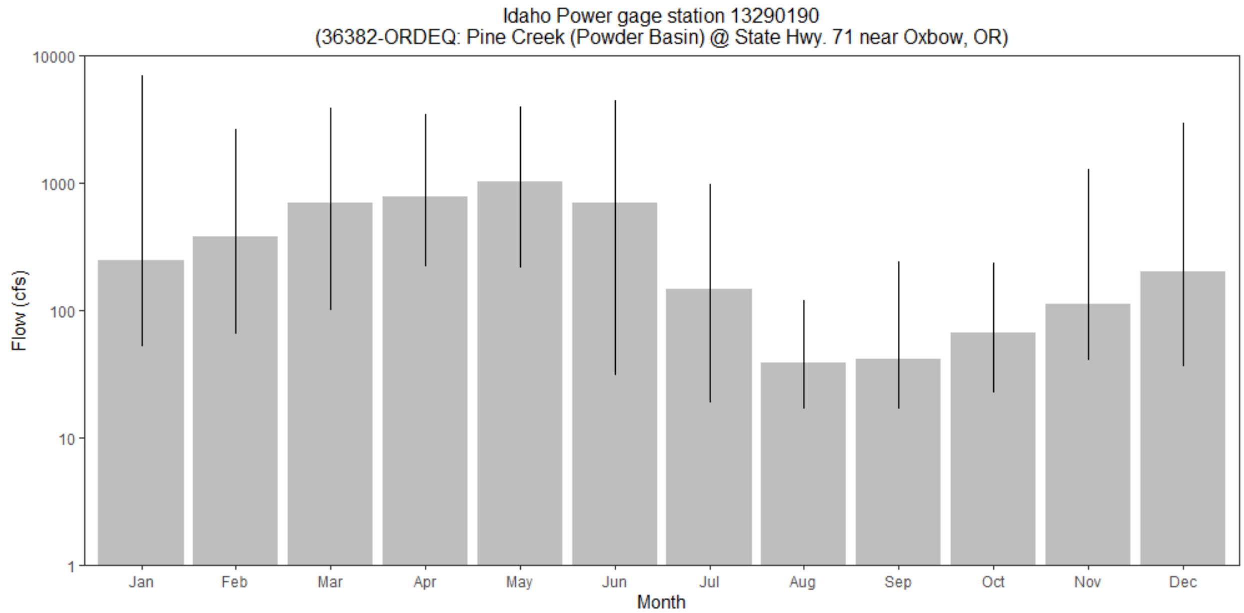
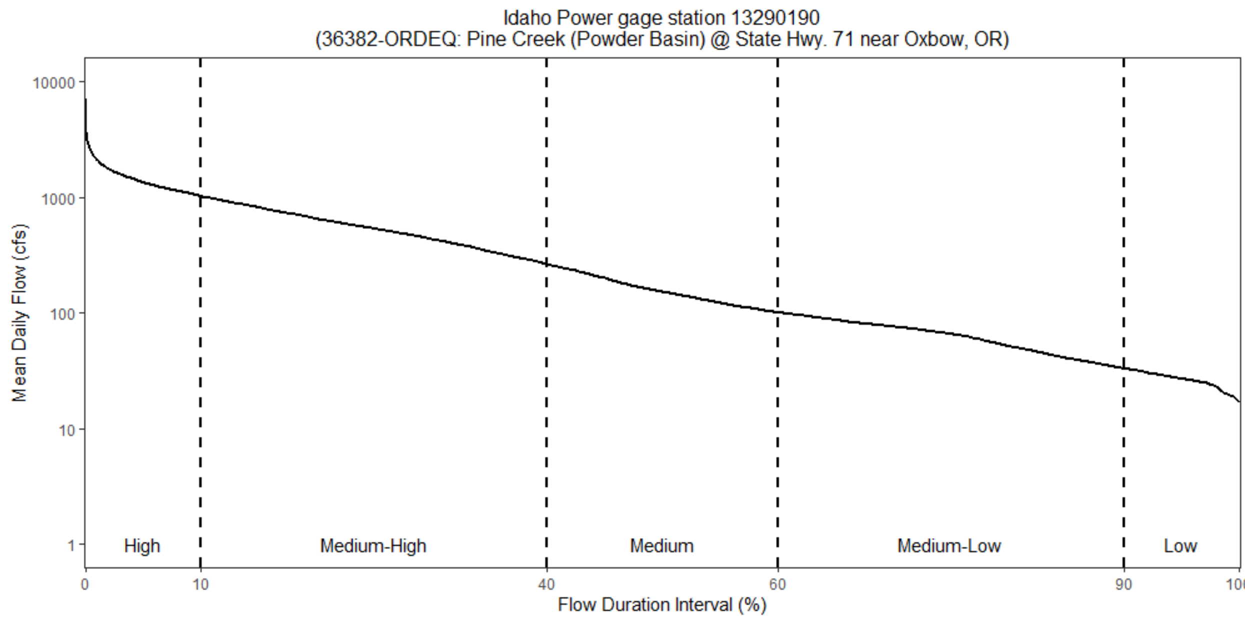


Figure 4: Flow duration intervals for Pine Creek, Oregon from 1990-2017



Figures 2-4 represent flows in Pine Creek (Brownlee Subbasin) just upstream from the confluence with Hells Canyon Reservoir based on data from 1/1/1990 to 9/30/2017. Low flows in Pine Creek ranged from 10.0 to 34.6 cfs, medium-low flows ranged from 34.7 to 100.0 cfs, medium flows ranged from 101.0 to 250.0 cfs, medium-high flow ranged from 251.0 to 977.0 cfs, and high flows ranged from 978.0 to 7000.0 cfs from 1990-2017.

Figure 5: Flow over time for the Powder River, Oregon from 1994-2017

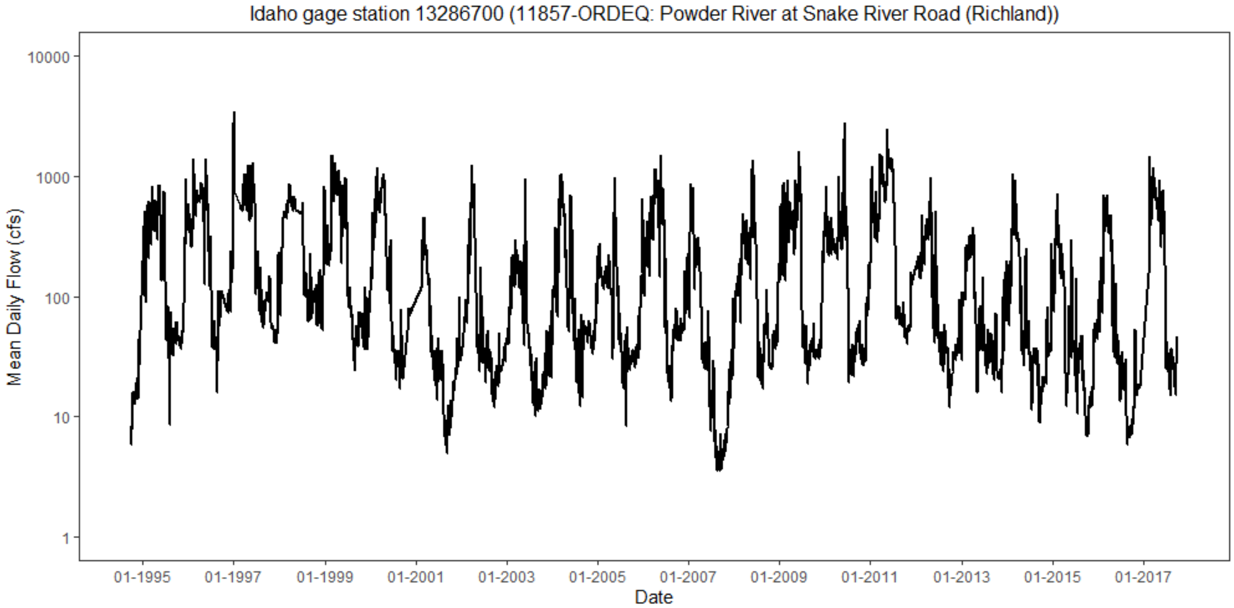


Figure 6: Monthly mean flow (± minimum or maximum) for the Powder River, Oregon from 1994-2017

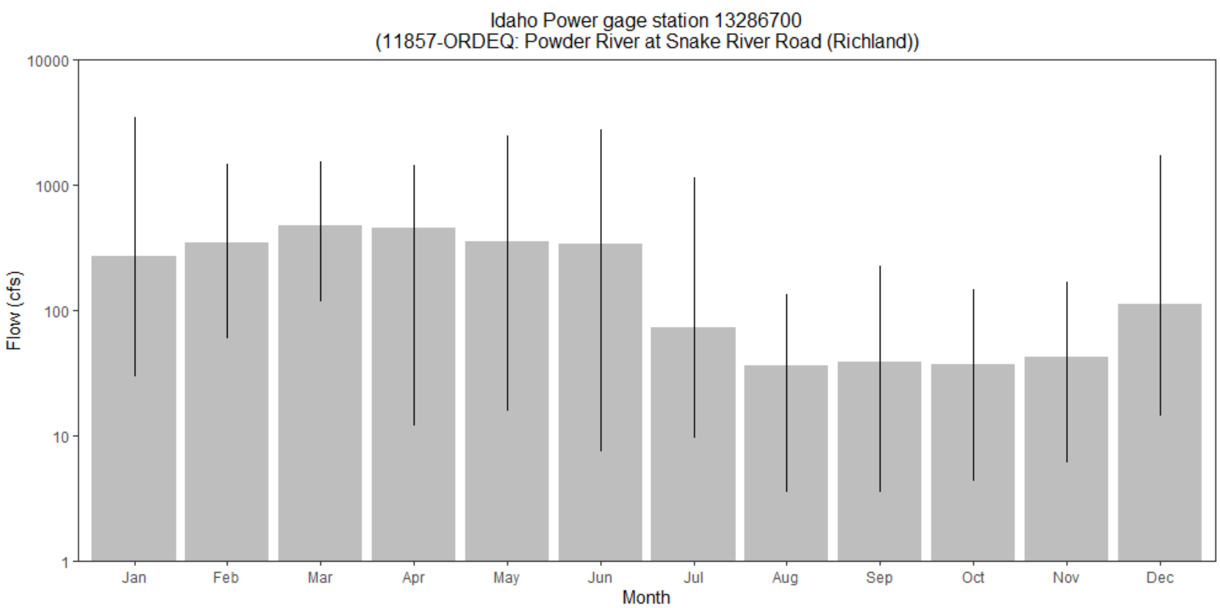
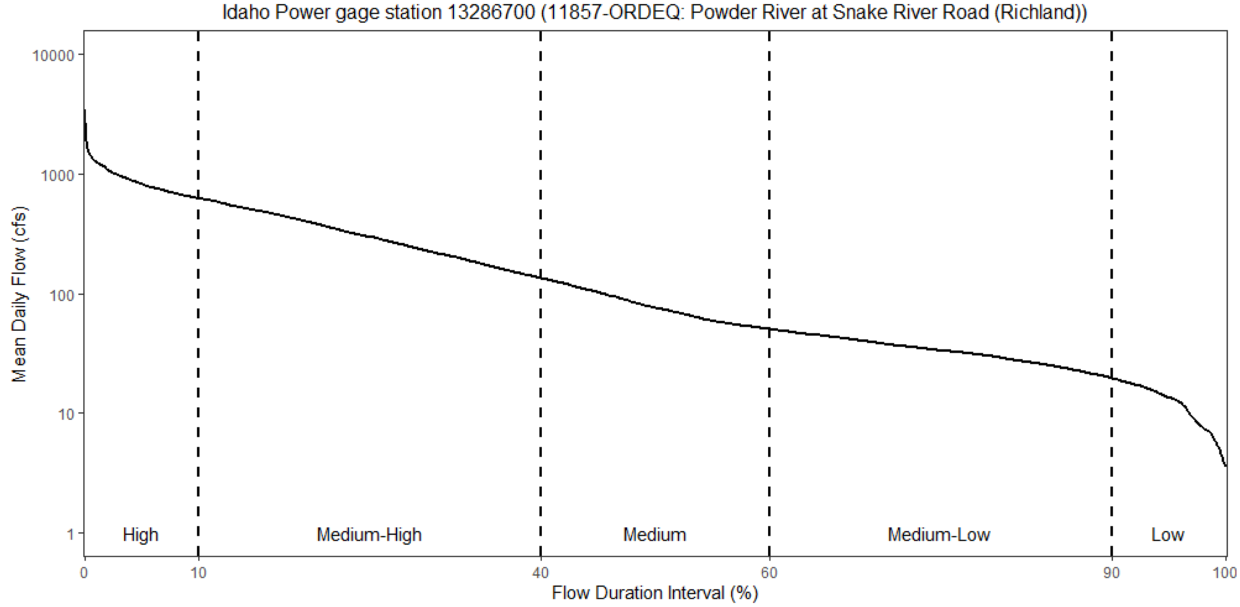


Figure 7: Flow duration intervals for the Powder River, Oregon from 1994-2017

Idaho Power gage station 13286700 (11857-ORDEQ: Powder River at Snake River Road (Richland))



Figures 5-7 represent flows in the Powder Watershed just upstream from the confluence with Brownlee Reservoir based on data from 10/1/1994 to 9/30/2017. Based on DEQ flow categories, low flows in the Powder River just before entering Brownlee Reservoir on the Snake River ranged from 2.5 to 17.8 cfs, medium-low flows ranged from 17.9 to 46.1 cfs, medium flows ranged from 46.2 to 120.0 cfs, medium-high flow ranged from 121.0 to 563.0 cfs, and high flows ranged from 564.0 to 9255.0 cfs from 1994-2017.

Figure 8: Flow over time for the Burnt River, Oregon from 1990-2017

Idaho Power gage station 13275000 (11494-ORDEQ: Burnt River at Snake River Road (Huntington))

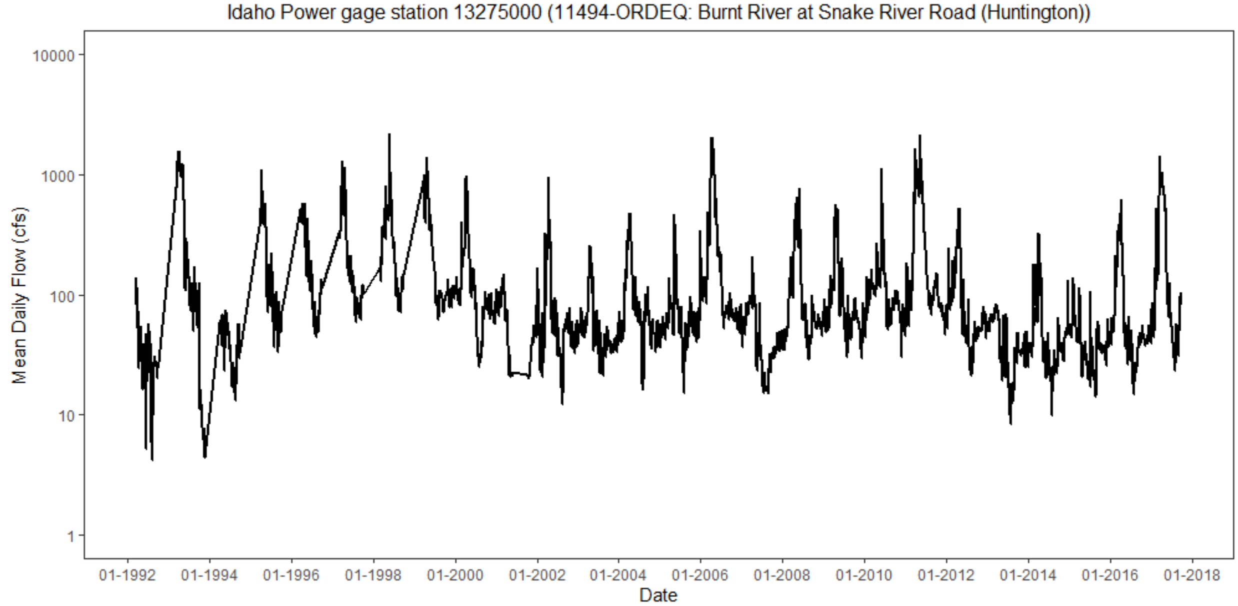


Figure 9: Monthly mean flow (± minimum or maximum) for the Burnt River, Oregon from 1990-2017

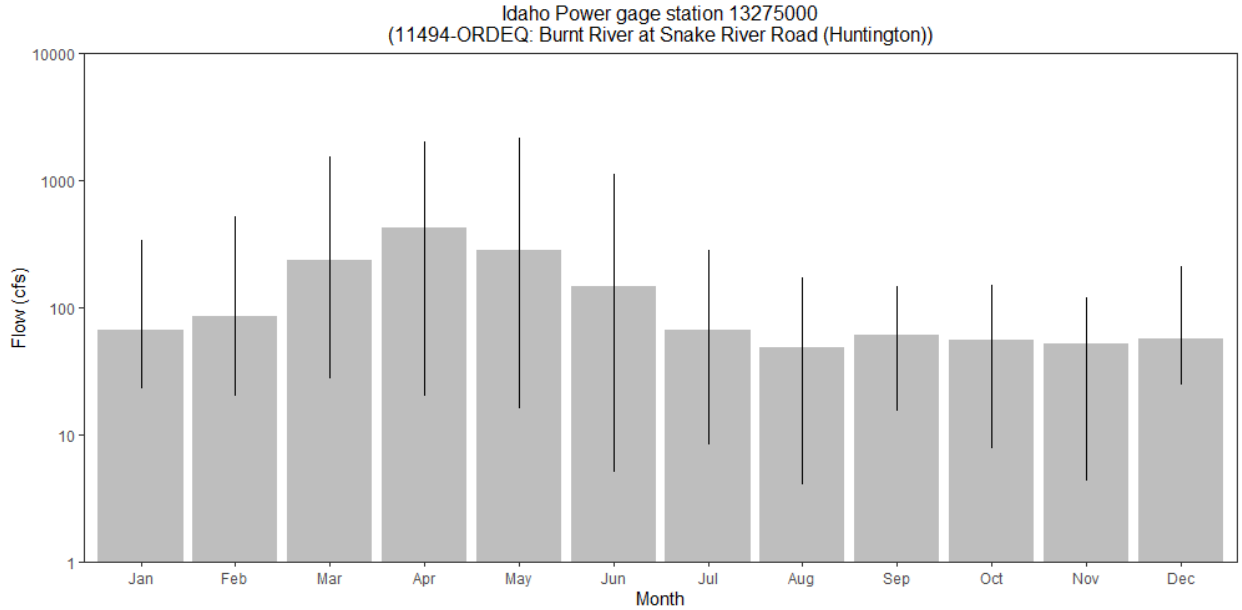
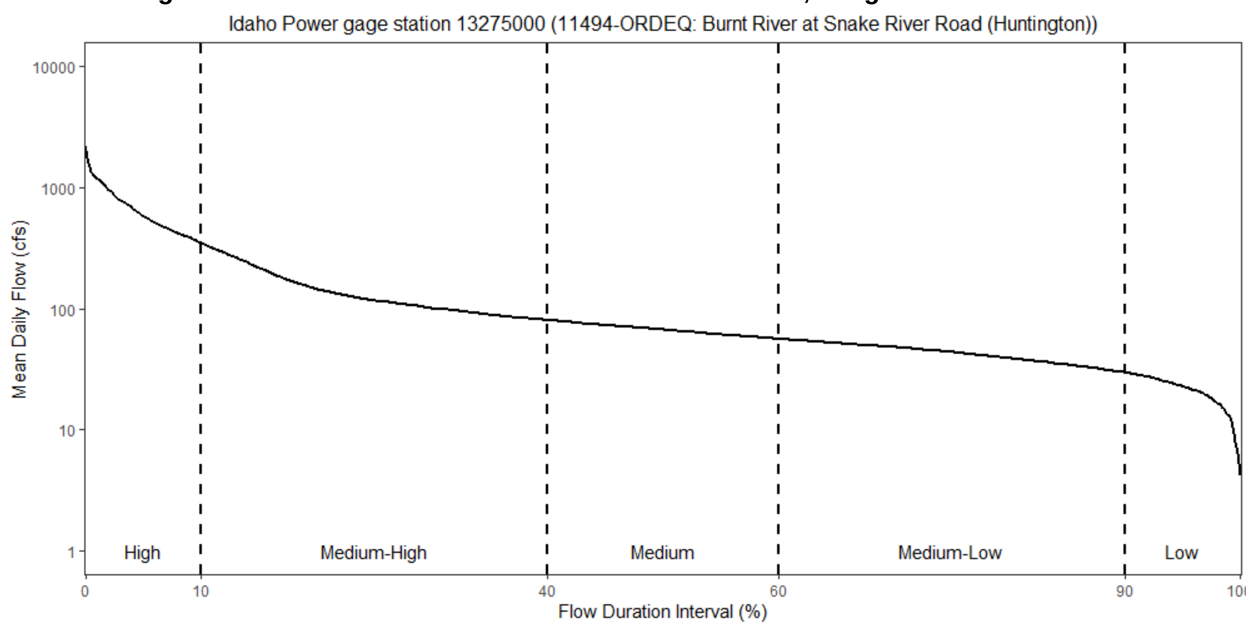


Figure 10: Flow duration intervals for the Burnt River, Oregon from 1990-2017



Figures 8-10 represent flows in the Burnt Subbasin just upstream from the confluence with Brownlee Reservoir based on data from 1/1/1990 to 9/30/2017. Low flows in the Burnt River just before entering Brownlee Reservoir on the Snake River ranged from 4.0 to 31.0 cfs, medium-low flows ranged from 31.1 to 58.0 cfs, medium flows ranged from 58.1 to 82.0 cfs, medium-high flow ranged from 82.1 to 304.0 cfs, and high flows ranged from 305.0 to 2180.0 cfs from 1990-2017. Low flows and medium-low flows in the Burnt River are modulated below the City of Huntington by effluent released by the wastewater treatment plant. Upstream of Huntington reflects a similar hydrologic regime to that of the Powder River and Pine Creek.

Reservoir operations and irrigation systems in the basin further influence the timing, amount/rate, and duration of flows in the Powder River Basin. According to the Oregon Water Resources Department (OWRD), 69 dams greater than 10 feet in height exist in the Powder River Basin. OWRD documents that most of the water stored in reservoirs enters irrigation conveyance systems. Three districts manage irrigation water in the Powder Subbasin: the Baker Valley Irrigation District, the Lower Powder Irrigation District, and the Powder Valley Water Control District (divided into the Wolf Creek and Pilcher Creek sub-districts). The Burnt River Irrigation District manages irrigation water in the Burnt River Subbasin. Formal irrigation or water control districts do not exist in the Brownlee Subbasin; individuals or informal user groups manage irrigation water there. Available water is fully appropriated in the Powder River Basin. During drought, some users may not receive water supplies identified in water rights despite managers drawing reservoirs down to minimum levels.

The Powder River Basin contains five reservoirs with storage capacities greater than 5,000 acre-feet. These include one (Unity) in the Burnt Subbasin and four (Thief Valley, Phillips, Pilcher Creek, and Wolf Creek) in the Powder Subbasin. The U.S. Bureau of Reclamation constructed Unity, Thief Valley, and Phillips Reservoirs; all are now operated by local irrigation districts. Pilcher Creek and Wolf Creek Dams are owned and operated by the Powder Valley Water Control District.

2.2.1 Burnt River Irrigation Project

Unity Reservoir is located on the Burnt River about 40 miles southwest of Baker City (Figure 1). Lands served by the irrigation project are scattered along the Burnt River downstream from Unity Reservoir near the towns of Hereford, Bridgeport, Durkee, Weatherby, Dixie, Lime, and Huntington. In addition, some lands upstream from the reservoir are included in the project.

Unity Dam is a zoned earth fill dam 82 feet high and 694 feet long. The maximum reservoir capacity is 25,800 acre-feet with a surface area of 926 acres. Unity Dam was completed in 1937 and the reservoir has since been operated and maintained by the Burnt River Irrigation District.

2.2.2 Baker Irrigation Project

The Upper Division of the Baker Project furnishes irrigation water from Phillips Reservoir to 18,500 acres of land along both sides of the Powder River just north of Baker City. The Lower Division provides a supplemental water supply from Thief Valley Reservoir to about 7,300 acres of land along the Powder River in the Keating Valley about 10 miles northeast of Baker City.

Mason Dam on the Powder River near Sumpter, OR, is a zone earth and rockfill embankment dam measuring 173 feet high and 895 feet long. Mason dam creates Phillips Reservoir, which has a maximum capacity of 95,500 acre-feet and a surface area of 2,235 acres. Stored water is released into the Powder River for diversion downstream into existing distribution canals and laterals. Operation and maintenance of Upper Division facilities was transferred to the Baker Valley Irrigation District on August 23, 1968.

Thief Valley Dam is a concrete slab and buttress dam 390 feet long and 73 feet high with a maximum reservoir capacity of 17,600 acre-feet and a surface area of 740 acres. Water stored in Thief Valley Reservoir is released for diversion downstream into existing distribution canals and laterals. The operation of Thief Valley Dam and facilities of the Lower Division were taken over by the Lower Powder River Irrigation District on June 1, 1932.

2.2.3 Powder Valley Water Control District

The Powder Valley Water Control District owns and operates Wolf Creek and Pilcher Creek Reservoirs. These systems provide irrigation water to land located in the North Powder and Baker valleys in the vicinity of the City of North Powder (Figure 1 for general location). Completed in 1974, the reservoir behind Wolf Creek dam is approximately 220 acres in area and stores approximately 12,000 acre-feet. Pilcher Creek Reservoir was completed in 1984 and is approximately 222 acres in area and stores approximately 5,900 acre-feet. Operated as one pool, Wolf Creek Reservoir usually draws down quicker than Pilcher Creek Reservoir, so to balance out the system, water is transferred via a canal between the two sites. Additional water from Pilcher Creek Reservoir is also put instream via the North Powder River for irrigation both to the north and south of the river. Due to the connectivity of the system, the project is often referred to as the Wolf Creek Reservoir Complex.

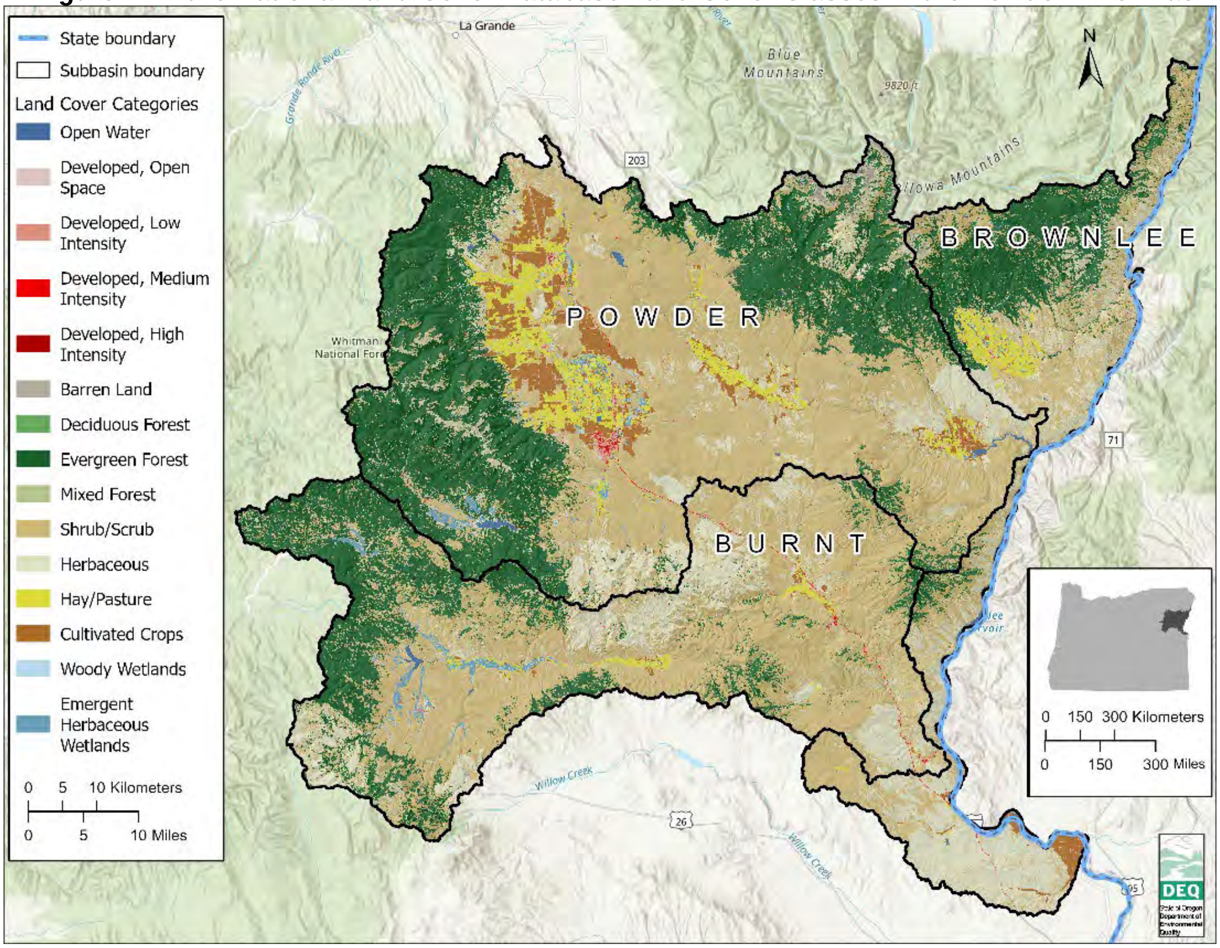
2.3 Land use/land cover

The largest percentage of land use/land cover in Powder River Basin consists of scrub-shrub, followed by forest and grasslands (Table 2). Developed urban areas are minimal, with the largest being Baker City (population approximately 9,700). Land ownership is divided almost equally between private and federal. Areas of irrigated agriculture are found along the Burnt River; the North Powder River; the Powder River north of Baker City, in the Keating Valley, and near Richland, and along Pine Creek near Halfway (Figure 11). Grassland/shrub areas occur in the valley plains and foothill areas while forested areas are concentrated in the mountains.

Table 2: 2019 Land cover classes and percentages in the Powder River Basin (Dewitz, J., and U.S. Geological Survey, 2021)

NLCD Land Cover Class	Acres	Percent of the basin
Shrub/Scrub	1016650	46.1
Evergreen Forest	593939	26.9
Herbaceous	366166	16.6
Hay/Pasture	78513	3.6
Cultivated Crops	65532	3.0
Developed, Open Space	24548	1.1
Emergent Herbaceous Wetlands	20737	0.9
Open Water	13869	0.6
Barren Land	7770	0.4
Developed, Low Intensity	6675	0.3
Woody Wetlands	5871	0.3
Developed, Medium Intensity	3527	0.2
Developed, High Intensity	215	<0.1
Deciduous Forest	103	<0.1
Mixed Forest	45	<0.1
Total:	**2204160**	**100.0**

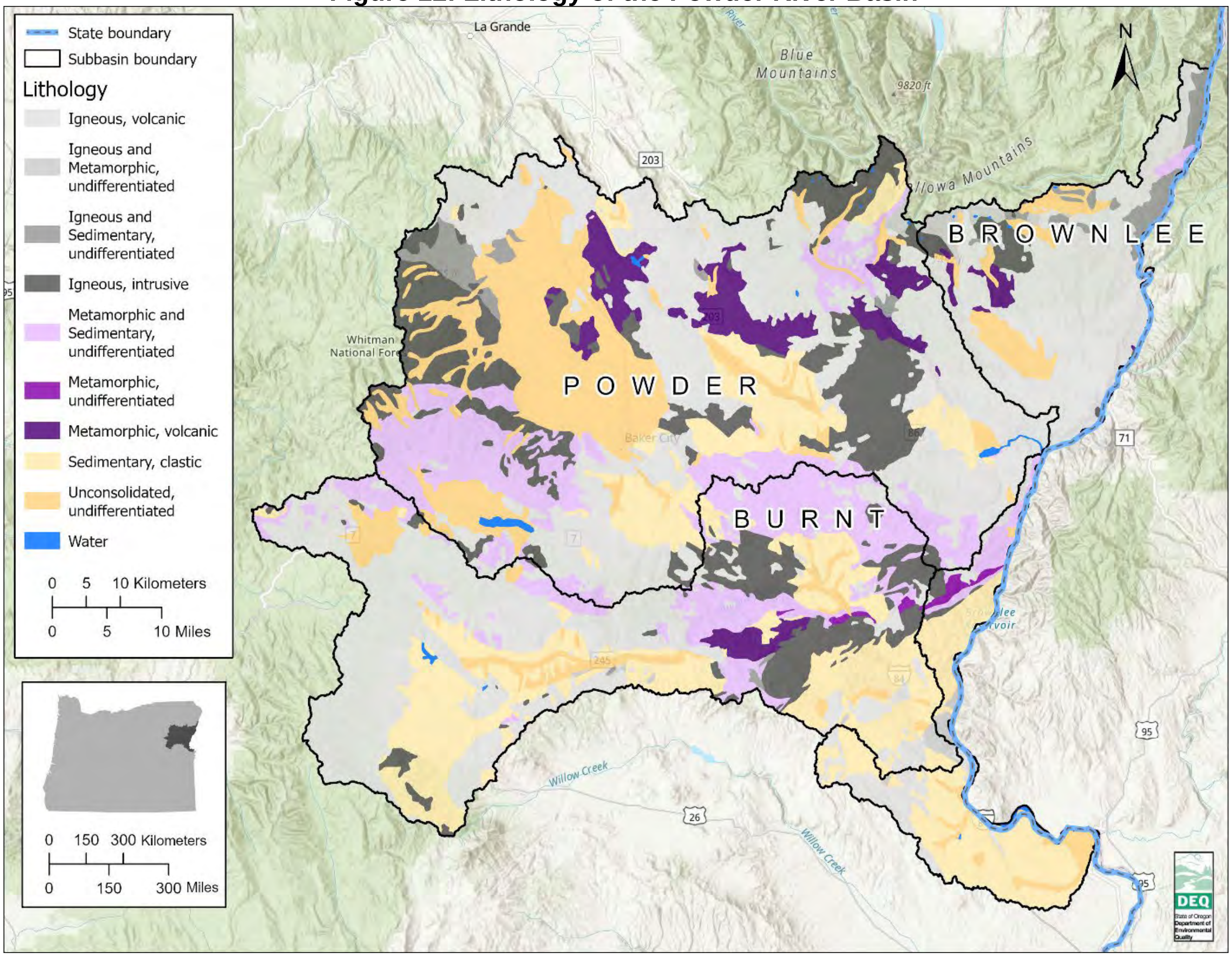
Figure 11: 2019 National Land Cover Database Land Cover Classes in the Powder River Basin



2.4 Geology and soils

The soils and geology of the Powder River Basin represent a complex history of basalt flows, uplift of continental material, sedimentary formations, glaciation, and deposition of alluvium (Walker & MacLeod, 1991). As shown in Figure 12, mountain ranges and upland areas consist of various igneous and metamorphic formations and lowland valleys largely consist of sedimentary and unconsolidated rocks. Agriculture, urban and rural residential development largely occurs in the low-relief areas underlain by sedimentary and unconsolidated formations (Figures 11 and 12).

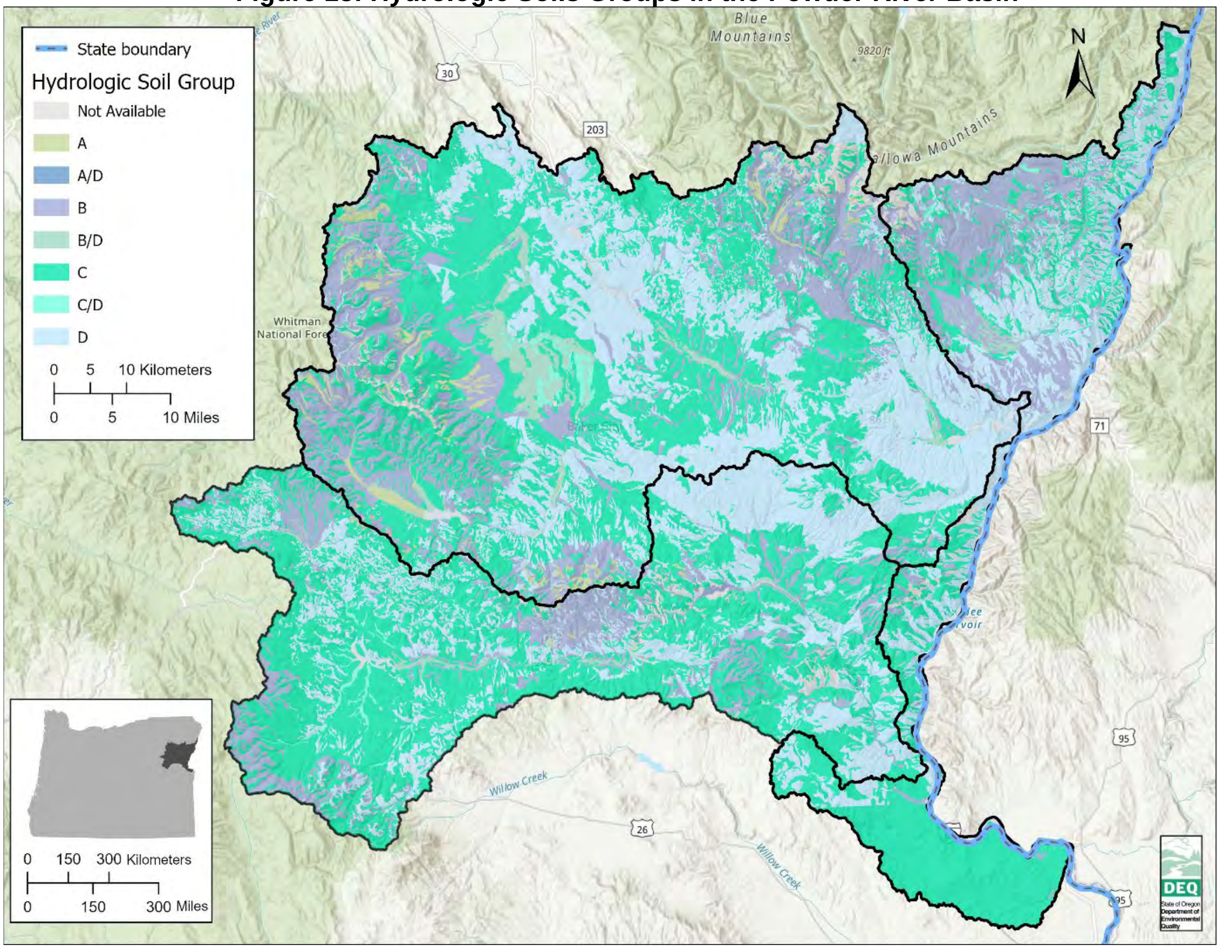
Figure 12: Lithology of the Powder River Basin



Surface and shallow subsurface runoff can transport fecal material into surface waters in these subbasins. Flow over the soil surface occurs when the precipitation rate is higher than the infiltration rate of the underlying soil; subsurface flow occurs when the reverse occurs. Moisture, temperature, and organic matter content all can influence fecal material transport in overland and subsurface flow.

The Powder River Basin contains 767 soil series, according to the 2017 SSURGO/STATSGO2 database from the USDA NRCS (NRCS, 2022). Translating these soils into USDA NRCS Hydrologic Groups shows the portions of the basin susceptible to overland runoff versus portions where water infiltration dominates (Figure 13). Much of the basin is characterized by soils with moderately high to high runoff potential. Soils with the highest runoff potentials tend to be found in the lower portions of the Powder River Basin and in the divide between the Powder and Burnt subbasins (Figure 13). Soils with the lowest runoff potentials (and hence highest infiltration rates) tend to be found north of Baker City in the Baker Valley (Figure 13).

Figure 13: Hydrologic Soils Groups in the Powder River Basin



3. *E. coli* water quality standards and beneficial uses

Fecal indicator bacteria are used as a surrogate for potential fecal pathogen contamination in waterbodies. In Oregon freshwaters, the primary fecal indicator bacteria is *Escherichia coli* (*E. coli*). Fecal contamination of waterbodies originates from both point and nonpoint sources containing feces from humans and other warm-blooded animals, including wildlife, pets, and livestock. Examples of point sources include wastewater treatment plants (WWTPs), stormwater conveyance systems, and combined sewer overflows. Nonpoint sources of fecal contamination include direct deposition of fecal matter into waterbodies, transport of fecal material in runoff from the watershed, and leaching from failing on-site septic systems.

Recreational use of waters contaminated by fecal material can lead to mild to severe illnesses in humans. Recreational uses include swimming and other activities that could result in ingestion of water through incidental contact, such as fishing, water sports, or recreating on banks and beaches. Water with high levels of fecal bacteria can also pose a disease risk to livestock and wildlife, such as Johne's disease (caused by the ingestion of *Mycobacterium avium spp*.). Fecal contamination of irrigation water also raises the contamination risk of *Listeria monocytogenese* in fresh produce crops (Weller, Wiedmann, & Strawn, 2015).

Tables 3 and 4 identify designated beneficial uses of surface waters in the Powder River Basin specified in OAR 340-041-0260. Table 260A, applicable numeric and narrative water quality standards addressed by the TMDL, and the most sensitive beneficial use related to each standard. Elevated *E. coli* concentrations in surface waters indicate impairments of water contact recreation (the most sensitive beneficial use) in the basin. The TMDL sets acceptable levels of *E. coli* in surface waters that allow water contact recreation use to be supported. Therefore, the TMDL protects all beneficial uses in the basin related to fecal contamination.

Table 3: Powder River Basin designated beneficial uses (from OAR 340-041-0260 Table 260A)

All streams and tributaries thereto
Public Domestic Water Supply
Private Domestic Water Supply
Industrial Water Supply
Irrigation
Livestock Watering
Fish and Aquatic Life
Wildlife and Hunting
Fishing
Boating
Water Contact Recreation
Aesthetic Quality

Table 4: Applicable water quality standards and most sensitive beneficial uses

Parameter	Citation	Summary of applicable standards	Applicable water	Most sensitive beneficial use
Bacteria	OAR 340-041-0009(1)(a)	(A) 90-day geometric mean (of 5 or more samples) of 126 *E. coli* organisms per 100 mL (B) No single sample may exceed 406 *E. coli* organisms per 100 mL	Fresh water	Water contact recreation
Statewide Narrative Criteria	OAR 340-041-0007(1)	The highest and best practicable treatment and/or control of wastes, activities, and flows must in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.	All waters of the state	Fish and aquatic life

DEQ has also designated irrigation and livestock watering as beneficial uses in the Powder River Basin. However, meeting water quality standards for the most sensitive beneficial use in the basin-water contact recreation-will ensure achievement of these uses as well.

DEQ uses the Integrated Report to document condition and quality of Oregon's surface waters by assigning a status category. Oregon uses four of EPA's recommended reporting categories to classify water quality status for a particular pollutant or parameter. Table 5 and Figure 14 presents stream and watershed assessment units in the Powder River Basin listed as impaired and needing a TMDL for *E. coli* on DEQ's 2022 Clean Water Act Section 303(d) List (as part of DEQ's Integrated Report; DEQ, 2022), approved by the EPA on September 1, 2022. Status category designations are prescribed by Sections 305(b) and 303(d) of the Clean Water Act and include:

- Category 1 – all designated uses are supported, no use is threatened (USEPA, 2023). DEQ does not use the Category 1 designation.
- Category 2 – available data indicate that some designated uses are supported.
- Category 3 – there is insufficient data to make a designated use support determination.
- Category 4 – available data indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed. Category 4 includes the following subcategories:
    - 4A – an EPA approved TMDL is in place.
    - 4B – other required control measures are expected to result in attainment.
    - 4C – non-attainment is not caused by a pollutant.
- Category 5 – available data indicate that at least one designated use is not being supported or is threatened and a TMDL is needed.

Regarding the freshwater AU identified as impaired for fecal coliform (OR_SR_1705020302_05_102815) in Table 5, DEQ reviewed the applicability of the Section 303(d) status for fecal coliform. Based on the 2018/2020 Integrated Report assessment methodology and the 2016 revisions to Oregon's Bacteria Standards – OAR 340-041-0009, DEQ concluded that identifying this AU as impaired for fecal coliform is a legacy of the prior bacteria standard combined with EPA's additions to Oregon's Section 303(d) list in 2010. DEQ's Standards and Assessment Program confirmed that 1) fecal coliform is not currently the applicable criterion for the designated freshwater water contact recreation beneficial use (*A. Borok, personal communication*) and 2) because sufficient *E. coli* data is available for assessment which show attainment of the applicable criterion, the legacy fecal coliform listing for this AU will be recommended for removal from the 303(d) list in the 2024 Integrated Report (*L. Merrick, personal communication*). Because *E. coli* data were used in the 2018-2020 and 2022 assessments and Integrated Reports to determine category status for the AU, the Section 303(d) listings for fecal coliform (Table 5) is not addressed in the Powder River Basin Bacteria TMDL.

For assessment unit OR_WS_170502010101_05_103097 (Moores Hollow), identified as Category 4A for *E. coli* in Table 5, DEQ determined that the assessment unit was incorrectly associated with the Malheur Basin Bacteria TMDL for the 2022 Integrated Report. Because the assessment unit is not addressed by the Malheur TMDL, it should be listed as Category 5. As such, DEQ included this unit in the Powder River Basin Bacteria TMDL. Although lack of observed flow data did allow the development of load duration curves for assessment unit, DEQ concluded that allocations made for the Powder Basin Bacteria TMDL apply there. Thus, DEQ will correct the TMDL associated with this assessment unit in the 2024 Integrated Report.

Figure 14: Bacteria (*E. coli*/fecal coliform) listings in the Powder River Basin

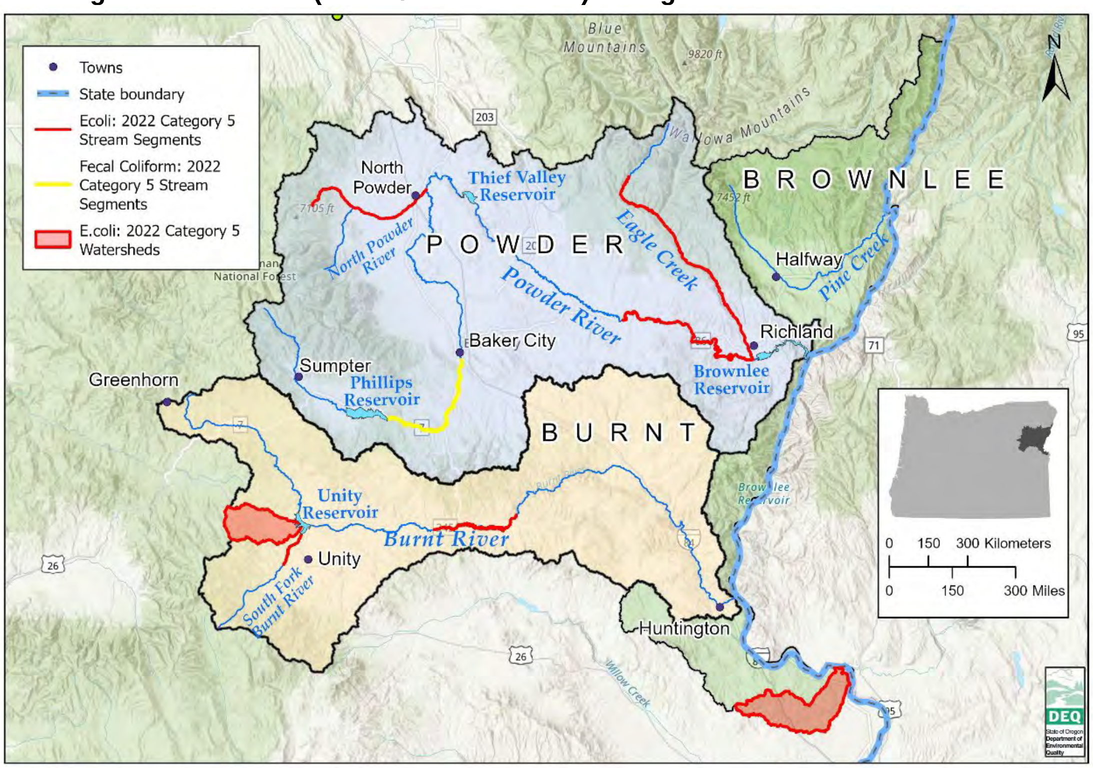


Table 5: Powder River Basin fecal indicator bacteria assessment units and status on Oregon's 2022 Integrated Report

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
Brownlee Subbasin				
OR_LK_1705020102_05_100576	Love Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020102_05_100577	---	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020103_05_100578	Brownlee Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020106_05_100579	Clear Creek Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020106_05_100580	Fish Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020106_05_100581	Crow Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020107_05_100582	Hells Canyon Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020107_05_100583	Oxbow Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_SR_1705020101_02_103229	Snake River	River and stream	*E. coli*	Unassessed
OR_SR_1705020102_05_102789	Birch Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020106_05_102790	Pine Creek	River and stream	*E. coli*	2
OR_SR_1705020106_05_102791	Lake Fork Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020106_05_102792	North Pine Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020106_05_102793	Pine Creek	River and stream	*E. coli*	2
OR_SR_1705020106_05_102794	Dry Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020106_05_102795	Pine Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020106_05_102796	North Pine Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020107_05_102797	McGraw Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020107_05_102798	Spring Creek	River and stream	*E. coli*	Unassessed
OR_WS_170502010101_05_103097	HUC12 Name: Moores Hollow	Watershed Unit (1st through 4th order streams)	*E. coli*	4A[1]
OR_WS_170502010106_05_103227	HUC12 Name: Bridge Gulch-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010201_05_103226	HUC12 Name: Road Gulch-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010202_05_103098	HUC12 Name: Upper Birch Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010203_05_103099	HUC12 Name: Love Reservoir	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010204_05_103100	HUC12 Name: Lower Birch Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010205_05_103101	HUC12 Name: Benson Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010206_05_103225	HUC12 Name: Grouse Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_WS_170502010301_05_103224	HUC12 Name: Ryan Gulch-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010303_05_103223	HUC12 Name: Morgan Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010304_05_103222	HUC12 Name: Dennett Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010306_05_103221	HUC12 Name: Raft Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010307_05_103220	HUC12 Name: Jackson Gulch-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010401_05_103219	HUC12 Name: Cottonwood Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010403_05_103218	HUC12 Name: Dukes Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010601_05_103102	HUC12 Name: Headwaters Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010602_05_103103	HUC12 Name: McMullen Slough	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010603_05_103104	HUC12 Name: Clear Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010604_05_103105	HUC12 Name: Deer Creek-Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010605_05_103106	HUC12 Name: East Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010606_05_103107	HUC12 Name: Fish Creek-Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010607_05_103108	HUC12 Name: Upper North Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010608_05_103109	HUC12 Name: Lake Fork Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010609_05_103110	HUC12 Name: Lower North Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010610_05_103111	HUC12 Name: Sheep Creek-Pine Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010701_05_103228	HUC12 Name: Oxbow Dam-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010703_05_103217	HUC12 Name: Herman Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010704_05_103216	HUC12 Name: McGraw Creek-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502010705_05_103215	HUC12 Name: Hells Canyon Dam-Snake River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
Powder Subbasin				
OR_LK_1705020301_05_100588	Phillips Lake	Lake/Reservoir	*E. coli*	2
OR_LK_1705020303_05_100589	Smith Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020303_05_100590	---	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020303_05_100591	---	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020304_05_100592	Rock Creek Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020305_05_100593	Pilcher Creek Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020306_05_100594	Wolf Creek Reservoir	Lake/Reservoir	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_LK_1705020306_05_100595	Shaw Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020306_05_100596	Jimmy Creek	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020306_05_100597	Thief Valley Reservoir	Lake/Reservoir	*E. coli*	2
OR_LK_1705020307_05_100598	Fisk Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020308_05_100599	Balm Creek Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020308_05_100600	Love Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020308_05_100601	---	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020310_05_100602	Echo Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020310_05_100603	Lookingglass Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020310_05_100604	Eagle Lake	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020311_05_100605	Brownlee Reservoir	Lake/Reservoir	*E. coli*	2
OR_LK_1705020303_02_107258	Highway 203 Pond	Lake/Reservoir	*E. coli*	Unassessed
OR_SR_1705020301_05_102812	Cracker Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020301_05_102813	McCully Fork	River and stream	*E. coli*	Unassessed
OR_SR_1705020301_05_102814	Powder River	River and stream	*E. coli*	2
OR_SR_1705020302_05_102815	Powder River	River and stream	Fecal coliform	5
OR_SR_1705020302_05_102815	Powder River	River and stream	*E. coli*	2
OR_SR_1705020303_05_102816	Powder River	River and stream	*E. coli*	2
OR_SR_1705020305_05_102817	North Powder River	River and stream	*E. coli*	5
OR_SR_1705020304_05_102818	Powder River	River and stream	*E. coli*	2
OR_SR_1705020306_05_102819	Powder River	River and stream	*E. coli*	Unassessed
OR_SR_1705020306_05_102820	Antelope Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020306_05_102821	Powder River	River and stream	*E. coli*	3
OR_SR_1705020307_05_102822	Big Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020307_05_102823	Big Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020307_05_102824	Beagle Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020308_02_102825	Clover Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020308_05_102826	Powder River	River and stream	*E. coli*	2
OR_SR_1705020308_05_102827	Clover Creek	River and stream	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_SR_1705020308_05_102828	Goose Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020309_05_102829	Powder River	River and stream	*E. coli*	5
OR_SR_1705020310_05_102830	Eagle Creek	River and stream	*E. coli*	5
OR_SR_1705020311_05_102831	Powder River	River and stream	*E. coli*	Unassessed
OR_WS_170502030101_05_103151	HUC12 Name: Cracker Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030102_05_103152	HUC12 Name: McCully Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030103_05_103153	HUC12 Name: Hawley Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030104_05_103154	HUC12 Name: Clear Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030105_05_103155	HUC12 Name: Deer Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030106_05_103156	HUC12 Name: Union Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030201_05_103157	HUC12 Name: Lake Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030202_05_103158	HUC12 Name: Stices Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030203_05_103159	HUC12 Name: Beaver Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030204_05_103160	HUC12 Name: Elk Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030205_05_103161	HUC12 Name: Ebell Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030206_05_103162	HUC12 Name: Sutton Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030207_05_103163	HUC12 Name: Blue Canyon-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030301_05_103164	HUC12 Name: Upper Baldock Slough	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030302_05_103165	HUC12 Name: Lower Baldock Slough	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030303_05_103166	HUC12 Name: Old Settlers Slough	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030304_05_103167	HUC12 Name: Estes Slough-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030401_05_103168	HUC12 Name: Upper Salmon Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030402_05_103169	HUC12 Name: Lower Salmon Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030403_05_103170	HUC12 Name: Willow Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030404_05_103171	HUC12 Name: Rock Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030405_05_103172	HUC12 Name: Big Muddy Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030406_05_103173	HUC12 Name: Sand Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030407_05_103174	HUC12 Name: Warm Springs Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030408_05_103175	HUC12 Name: Gentry Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_WS_170502030501_05_103176	HUC12 Name: Upper North Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030502_05_103177	HUC12 Name: Middle North Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030503_05_103178	HUC12 Name: Upper Anthony Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030504_05_103179	HUC12 Name: Lower Anthony Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030505_05_103180	HUC12 Name: Lower North Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030601_05_103181	HUC12 Name: Upper Wolf Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030602_05_103182	HUC12 Name: Lower Wolf Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030603_05_103183	HUC12 Name: Jimmy Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030604_05_103184	HUC12 Name: Antelope Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030605_05_103185	HUC12 Name: Thief Valley Reservoir-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030606_05_103186	HUC12 Name: Magpie Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030701_05_103187	HUC12 Name: Upper Big Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030702_05_103188	HUC12 Name: Middle Big Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030703_05_103189	HUC12 Name: Beagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030704_05_103190	HUC12 Name: Lower Big Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030801_05_103191	HUC12 Name: Salt Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030802_05_103192	HUC12 Name: Crews Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030803_05_103193	HUC12 Name: Tucker Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030804_05_103194	HUC12 Name: Ruckles Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030805_05_103195	HUC12 Name: Balm Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030806_05_103196	HUC12 Name: Clover Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030807_05_103197	HUC12 Name: Goose Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030808_05_103198	HUC12 Name: Ritter Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030901_05_103199	HUC12 Name: Love Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030902_05_103200	HUC12 Name: Fivemile Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030903_05_103201	HUC12 Name: Maiden Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030904_05_103202	HUC12 Name: Hyall Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502030905_05_103203	HUC12 Name: Chalk Creek-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031001_05_103204	HUC12 Name: Headwaters Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_WS_170502031002_05_103205	HUC12 Name: West Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031003_05_103206	HUC12 Name: Bennett Creek-Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031004_05_103207	HUC12 Name: East Fork Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031005_05_103208	HUC12 Name: Paddy Creek-Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031006_05_103209	HUC12 Name: Little Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031007_05_103210	HUC12 Name: Lower Eagle Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031101_05_103211	HUC12 Name: Daly Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031102_05_103212	HUC12 Name: Immigrant Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502031103_05_103213	HUC12 Name: Foster Gulch-Powder River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
Burnt Subbasin				
OR_LK_1705020201_05_100584	Unity Reservoir	Lake/Reservoir	*E. coli*	2
OR_LK_1705020202_05_100585	Whited Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020202_05_100586	Elms Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_LK_1705020203_05_100587	Higgins Reservoir	Lake/Reservoir	*E. coli*	Unassessed
OR_SR_1705020201_05_102799	tributary to Trout Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020201_05_102800	North Fork Burnt River	River and stream	*E. coli*	Unassessed
OR_SR_1705020201_05_102801	Trout Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020201_05_102802	North Fork Burnt River	River and stream	*E. coli*	Unassessed
OR_SR_1705020202_05_103265	South Fork Burnt River	River and stream	*E. coli*	5
OR_SR_1705020202_05_103266	South Fork Burnt River	River and stream	*E. coli*	Unassessed
OR_SR_1705020203_05_103267	Camp Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020203_05_103268	Camp Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020204_05_102803	Burnt River	River and stream	*E. coli*	2
OR_SR_1705020204_05_102804	Big Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020205_05_102805	Burnt River	River and stream	*E. coli*	5
OR_SR_1705020205_05_102806	Clarks Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020205_05_102807	Auburn Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020207_05_102808	Durkee Creek	River and stream	*E. coli*	Unassessed
OR_SR_1705020206_05_102809	Burnt River	River and stream	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_SR_1705020208_05_102810	Burnt River	River and stream	*E. coli*	2
OR_SR_1705020208_05_102811	Dixie Creek	River and stream	*E. coli*	2
OR_WS_170502020101_05_103112	HUC12 Name: Headwaters North Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020102_05_103113	HUC12 Name: Camp Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020103_05_103114	HUC12 Name: Patrick Creek-North Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020104_05_103115	HUC12 Name: Trout Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020105_05_103116	HUC12 Name: Petticoat Creek-North Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020106_05_103117	HUC12 Name: West Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	2
OR_WS_170502020107_05_103118	HUC12 Name: Middle Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	5
OR_WS_170502020108_05_103119	HUC12 Name: Antelope Creek-North Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020201_05_103120	HUC12 Name: Upper South Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020202_05_103121	HUC12 Name: Middle South Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020203_05_103262	HUC12 Name: Lower South Fork Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020204_05_103122	HUC12 Name: Job Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020301_05_103123	HUC12 Name: West Camp Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020302_05_103124	HUC12 Name: East Camp Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020303_05_103125	HUC12 Name: Higgins Reservoir-Camp Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020401_05_103126	HUC12 Name: Pine Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020402_05_103127	HUC12 Name: Rock Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020403_05_103128	HUC12 Name: Upper Big Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020404_05_103129	HUC12 Name: Lower Big Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020405_05_103130	HUC12 Name: Independence Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020501_05_103131	HUC12 Name: Mill Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020502_05_103132	HUC12 Name: Clarks Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020503_05_103133	HUC12 Name: Auburn Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020601_05_103134	HUC12 Name: Dark Canyon-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020602_05_103135	HUC12 Name: Cave Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020603_05_103136	HUC12 Name: Powell Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020701_05_103137	HUC12 Name: Lawrence Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed

Assessment Unit	Assessment Unit Name	Assessment Unit Type	Pollutant	Listing Category
OR_WS_170502020702_05_103138	HUC12 Name: Upper Alder Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020703_05_103139	HUC12 Name: Lower Alder Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020704_05_103140	HUC12 Name: Durkee Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020705_05_103141	HUC12 Name: Pritchard Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020801_05_103142	HUC12 Name: Manning Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020802_05_103143	HUC12 Name: Swayze Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020803_05_103144	HUC12 Name: Shirttail Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020804_05_103145	HUC12 Name: Sisley Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020805_05_103146	HUC12 Name: North Fork Dixie Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020806_05_103147	HUC12 Name: South Fork Dixie Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020807_05_103148	HUC12 Name: Dixie Creek	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020808_05_103149	HUC12 Name: Jett Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed
OR_WS_170502020809_05_103150	HUC12 Name: Durbin Creek-Burnt River	Watershed Unit (1st through 4th order streams)	*E. coli*	Unassessed

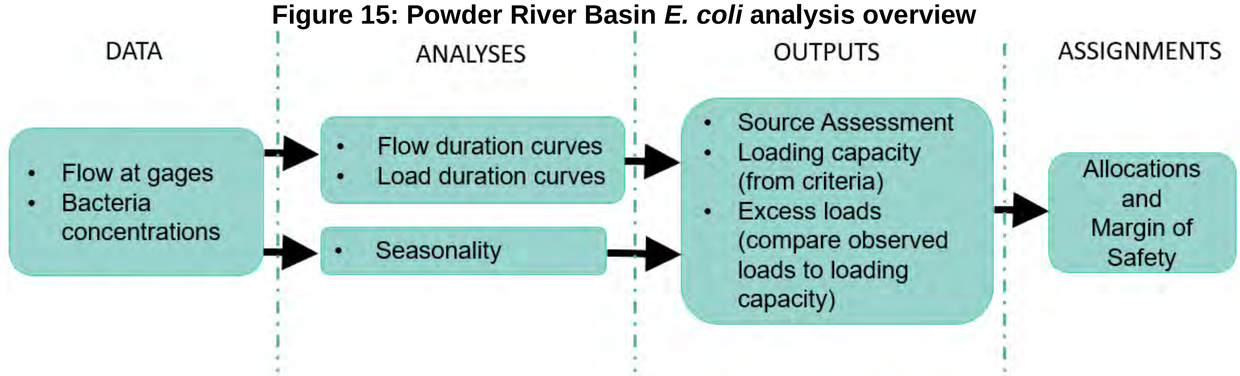
Note: [1]Listed as Category 4A under the Malheur Basin TMDL. It will be reassigned to the Powder River Basin Bacteria TMDL.

4. Water quality data evaluation and analyses

4.1 Analysis overview

An overview of the analyses undertaken is presented in Figure 15 and detailed information is presented in sections that follow in the order of flow noted in the schematic.

Figure 15: Powder River Basin *E. coli* analysis overview



DEQ and the EPA used data collected from a specialized DEQ TMDL monitoring project conducted from 2007-2013 to develop load duration curves for stream reaches in the basin. The load duration curves were used to calculate *E. coli* loads and loading capacities for the stream reaches, assign allocations between point and nonpoint sources, and identify potential management approaches (EPA 2019).

4.2 Stream reaches analyzed

EPA Region 10 and DEQ worked together to develop load duration curves for stream reaches with paired *E. coli* concentrations and flow data (EPA 2019). *E. coli* concentration data were collected as part of a TMDL specific study conducted from 2007-2013 (DEQ 2013). Reaches for the project originally corresponded to a previous stream segments listed by EPA in integrated reports (2010 and 2012). The reaches now cover assessment units described in the 2022 Integrated Report (Figure 14; DEQ, 2022).

In the Brownlee Subbasin, one load duration curve was developed that applies to the streams in the subbasin. The specific area with the associated downstream monitoring station was:

- Confluence of Brownlee Subbasin streams with Snake River.
    - 36382-ORDEQ: Pine Creek at Hwy 71 (Figure 25).

In the Powder Subbasin, load duration curves were developed for three reaches on Powder River, one reach on Eagle Creek, and two reaches of the North Powder River (EPA 2019). The specific reaches with the associated downstream monitoring stations include:

- Powder River upstream of Philips Reservoir.

    - 34250-ORDEQ: Powder River above Phillips Reservoir Dam (Figure 16).
- Powder River from Phillips Reservoir to Baker City.
    - 11490-ORDEQ: Powder River at Hwy 7 (in Baker City) (Figure 17).
- North Powder River from USFS Boundary to Miller Rd.
    - 36192-ORDEQ: North Powder River at Miller Rd. Bridge (Figure 18).
- North Powder River from Miller Road to Confluence with Powder River.
    - 36191-ORDEQ: North Powder River at Hwy 30 Bridge (Figure 19).
- Eagle Creek from New Bridge to Brownlee Reservoir.
    - 36193-ORDEQ: Eagle Creek at Snake River Rd (Figure 21).
- Powder River from Baker City to the confluence with Snake River.
    - 11857-ORDEQ: Powder River at Snake River Rd. (Richland) (Figure 20).

In the Burnt Subbasin, load duration curves were developed for three reaches along Burnt River. Although AUs in the Middle Fork and South Fork Burnt Rivers have been listed as impaired on the 2022 Integrated Report based on *E. coli* concentration data, paired concentration and flow data were not available to develop load duration curves. The specific Burnt Subbasin reaches with the associated downstream monitoring stations include:

- Burnt River upstream of Unity Reservoir Dam.
    - 36195-ORDEQ: Burnt River at Unity Reservoir Dam (Figure 22).
- Burnt River from Unity Reservoir to Clarks Creek Rd.
    - 34256-ORDEQ: Burnt River at Clarks Cr. Bridge (Figure 23).
- Burnt River from Clarks Creek Rd to confluence with Snake River.
    - 11494-ORDEQ: Burnt River at Snake River Rd (Huntington) (Figure 24).

4.3 Data

Monitoring stations for *E. coli* data collected in the 2007-2013 TMDL study (DEQ 2013) and streamflow gages paired with *E. coli* data are presented in Tables 6-8. In general, monitoring stations were located at publicly accessible points of entry. DEQ data collected data according to protocols outlined in the Sampling and Analysis Plan governing Oregon's Ambient Monitoring program (DEQ 2016) and the Powder/Burnt Quality Assurance Project Plan and amendments (DEQ 2013). Descriptions of the *E. coli* and flow data are adapted from EPA's technical memorandum (EPA 2019) and appear below:

***E. coli* Data**

The source of *E. coli* data came from DEQ water quality monitoring stations and consisted of:

- Data collected 2007 to 2013 (DEQ TMDL Project).
- Analytical methods, detailed in DEQ (2013), included:
    - 9223 B: Enzyme substrate assay for measuring total coliforms and *E. coli* (ONPG-MUG test or CPRG-MUG test)
    - Coliform/*E. coli* Enzyme substrate test; ONPG-MUG test (COLILERT)
- Data were analyzed by the DEQ Laboratory and Environmental Assessment Division or the Oregon Public Health Laboratory.
- Only data graded as "A" (approved QAPP) or "B" (minimum data acceptance criteria met) were used for the analysis (see DEQ (2013) and DEQ (2016) for details):

    - 915 of 933 samples (98%) graded as “A”; 18 of 933 graded as “B” (all from April 8-10, 2008).
- Data are reported as Most Probable Number (MPN) per 100 mL. OAR 340-041-0009(1)(a) define the *E. coli* criteria in terms of organisms/100 mL. Because MPN represents a probabilistic estimate for number of organisms, comparing sampled data to the criteria is appropriate.

Measured Stream Flow Data

Sources of flow monitoring data in the Powder River Basin include:

    - Idaho Power (2023)
    - Oregon Water Resources Department (2023)
    - US Bureau of Reclamation (2023)
- All available data from January 1, 1990 thru Sept 30, 2017 were used.
    - An exception to this was for the flow gage for Burnt River at Huntington (13275000). The record from 1990 to 2000 had several long periods of zero flow, and it was difficult to discern if this was meant to be marked as ‘no measurement’ or if it truly was zero for those periods. Thus, only data from the year 2000 and onward were used for the load duration curve developed using data from this gage.
    - The period of record for each gage consisted of at least 10 years of data; thus, the flow data used to develop the load duration curves sufficiently captured interannual variability present for each location.
- Flow units are the stream daily average discharge in cubic feet per second (cfs).
- Period of record for each US Bureau of Reclamation gage:
    - Powder River above Phillips Reservoir (PRHO): January 1, 1990-September 30, 2017
    - Powder River at Baker City (PWDO): January 1, 1990-September 30, 2017
    - Powder River near Richland (PRRO): January 1, 1990-August 29, 2017
    - Burnt River below Unity Dam (UNY): January 1, 1990-September 30, 2017
- Period of record for each Idaho Power Company gage:
    - Pine Creek near Oxbow (13290190): January 1, 1990-September 30, 2017
    - Burnt River above Clarks Creek (13274020): March 14, 2007-September 30, 2017
    - Burnt River at Huntington (13275000): October 2, 2000-September 30, 2017
- Period of record for each Oregon Water Resources Division gage:
    - Eagle Creek near Richland (13288300): April 16, 1999-September 30, 2017
    - North Powder River at Miller Road (13282550): May 22, 1999-September 30, 2017

Method Considerations

- Irrigation diversions and return flows were not directly factored into flow duration interval or load duration curve calculations.
- For censored data, the value following the qualifier (< or >) was used in calculations.
- Duplicate samples were periodically collected as a quality assurance field check. To eliminate samples taken on the same date, one value was randomly selected to be eliminated. This procedure did not result in excluding measurements that indicated exceedances of the water quality criteria.
- Occasionally, daily flows were not reported. When this occurred, those dates were removed from calculations.
- The monitoring station for North Powder River at Hwy 30 (36191-ORDEQ) is approximately six miles downstream of the North Powder River at Miller Road flow gage (13282550) that was used for the calculation of the load duration curve.

- The flow gage for the North Powder River at Miller Road flow gage (OWRD 13282550), recorded a zero flow between the 99-100th percentile. Consequently, the 100th percentile was excluded from the calculation of the TMDL loading capacity for the low flow interval on the load duration curve. When the 100th percentile was included in the calculations, the resulting geometric mean was skewed low. Load reductions would have been required although *E. coli* concentration samples never exceeded the loading capacity for days with recorded flow. With the 100th percentile included, the loading capacity (as a geometric mean in the flow interval) was 2.79E09 organisms/day and required a 64% reduction. With the 100th percentile excluded, the loading capacity was 12.54E09 organisms/day and require 0% reduction.

Table 6: Paired DEQ water quality monitoring stations, flow gages, and load duration curve reach description in the Brownlee Subbasin (4th Field HUC 17050201) (IPC = Idaho Power Company)

DEQ monitoring station	DEQ monitoring station description	Flow gage	Flow gage description	Load duration curve reach description
36382-ORDEQ	Pine Creek at Hwy 71	13290190 (IPC)	Pine Cr. near Oxbow (mouth)	Brownlee Subbasin streams confluence with Snake River

Table 7: Paired DEQ water quality monitoring stations, flow gages, and load duration curve reach description in the Powder Subbasin (4th Field HUC 17050203) (USBR = U.S. Bureau of Reclamation; IPC = Idaho Power Company; OWRD = Oregon Water Resources Division)

DEQ monitoring station	DEQ monitoring station description	Flow gage	Flow gage description	Load duration curve reach description
34250-ORDEQ	Powder River above Phillips Reservoir Dam	PRHO (USBR)	Powder River above Phillips Reservoir	Powder River upstream of Philips Reservoir
11490-ORDEQ	Powder River at Hwy 7 (in Baker City)	PWDO (USBR)	Powder River @ Baker City	Powder River from Phillips Reservoir to Baker City
36192-ORDEQ	North Powder River at Miller Rd. Bridge	13282550 (OWRD)	North Powder R. @ Miller Rd.	North Powder River from USFS Boundary to Miller Rd
36191-ORDEQ	North Powder River at Hwy 30 Bridge	13282550 (OWRD)	North Powder R. @ Miller Rd.	North Powder River from Miller Road to Confluence with Powder River
36193-ORDEQ	Eagle Creek at Snake River Rd	13288300 (IPC)	Eagle Cr. near Richland (mouth)	Eagle Creek from New Bridge to Brownlee Reservoir
11857-ORDEQ	Powder River at Snake River Rd. (Richland)	PRRO (USBR)	Powder River at Snake River Rd (Richland)	Powder River from Baker City to confluence with Snake River

Table 8: Paired DEQ water quality monitoring stations, flow gages, and load duration curve reach description in the Burnt Subbasin (4th Field HUC 17050202) (USBR = U.S. Bureau of Reclamation; IPC = Idaho Power Company)

DEQ monitoring station	DEQ monitoring station description	Flow gage	Flow gage description	Load duration curve reach description
36195-ORDEQ	Burnt River at Unity Reservoir Dam	UNY (USBR)	Burnt R. below Unity Dam	Burnt River upstream of Unity Reservoir Dam
34256-ORDEQ	Burnt River at Clarks Cr. Bridge	13274020 (IPC)	Burnt River above Clarks Cr. near Bridgeport, OR	Burnt River from Unity Reservoir to Clarks Creek Rd
11494-ORDEQ	Burnt River at Snake River Rd (Huntington)	13275000 (IPC)	Burnt River @ Huntington (mouth)	Burnt River from Clarks Creek Rd to confluence with Snake River

4.4 Flow categories

DEQ uses the flow categories described in Table 9 to be consistent in all TMDLs beginning in 2022. The exceedance probability numeric ranges describe flow duration intervals and are consistent with flow categories in EPA's Load Duration Curve Guidance (EPA 2007). Table 9 crosswalks DEQ's and EPA flow categories and includes numeric and narrative descriptions of the categories.

Table 9: Flow Categories based on flow duration intervals

DEQ Flow Category	EPA Flow Category	Exceedance Probability	Hydrologic Description
Low	Low	90-100%	Watershed soils dry, may be drought conditions, storage empty, channel levels near or below lowest (7Q10) flow, long dry and warm periods between weather events, entirely groundwater return flow as source to stream flow
Medium-Low	Dry	60-90%	Watershed soils much below saturated, storage empty, channels much less than bank-full, extended dry periods between weather events, some shallow subsurface, but mainly groundwater return flow as source to stream flow
Medium	Typical	40-60%	Watershed soils partially saturated, storage almost empty, channels less than bank-full, typical size storms or snow melt events, surface, shallow subsurface and groundwater return flow as source to stream flow
Medium-High	Transitional	10-40%	Watershed soils partially saturated, storage partially full, channels near bank-full, moderate size storms or snow melt events, mainly surface or shallow subsurface flow as source to stream flow
High	High	0-10%	Watershed soils completely saturated, storage near capacity, channels at or near flood stages, large storms or snow melt events, mainly surface or shallow subsurface flow as source to stream flow

4.5 *E. coli* load duration curves

4.5.1 Calculation of load duration curves

DEQ adapted the description of methods used for calculating load duration curves from the EPA technical memorandum (EPA 2019). Load duration curves for the Powder River Basin are presented below as Figures 16 through 25.

All load duration curves were calculated using Microsoft™ Excel. The analysis steps included:

- Calculation of the flow for each flow percentile. This was done by using the PERCENTILE function in Excel for the entire flow period of record to calculate the flow at each percentile interval. The intervals are 0, 1, 5, 10 … [increments of 5] … 95, 99, 100.

- Calculate the acceptable load for each flow percentile interval. Combining these intervals produced the load duration curve. The equation for calculating the load was:

  (3) LOAD = (86,400*28,316.85*FLOW [cfs] * CRITERION [org/100 mL])/100

- Two water quality criteria, from Oregon's Administrative Rule 340-041-0009, were used to develop individual curves for:
  - 90-day geometric mean criterion of 126 organisms/100 mL.
  - Single sample criterion of 406 organisms/100 mL.

- The load duration curves were divided into the five flow categories (Table 9):
  - High Flows (0^{th}-10^{th} percentile).
  - Medium-High Flows (10^{th}-40^{th} percentile).
  - Medium Flows (40^{th}-60^{th} percentile).
  - Medium-Low Flows (60^{th}-90^{th} percentile).
  - Low Flows (90^{th}-100^{th} percentile).

- For each measured *E. coli* concentration, an observed load was calculate using using the measured daily flow when the *E. coli* sample was collected. The equation for calculating the load is:

  (4) LOAD = (86,400*28,316.85*FLOW [cfs] * *E. COLI* CONC. [organisms/100 mL])/100

- Measured *E. coli* loads were displayed by seasonal category describing differences in hydrology, climate, and management:
  - Late spring through early fall (May-October).
  - Late fall through early spring (November-April).

Measured *E. coli* loads are displayed by seasonal category describing differences in hydrology, climate, and management:Late spring through early fall (May-October)Late fall through early spring (November-April)

- Calculated TMDL components:
  - TMDL load capacity (to meet the 126 organisms/100 mL geometric mean criterion) = geometric mean of each flow group.
  - RC = 0% of the load capacity.

  - MOS = 10% of the load capacity.
  - WLA:
    - MS4 stormwater from the Oregon Department of Transportation: 1% of the load capacity (see Section 6.1).
    - Effluent from NPDES Wastewater Treatment Plants: geometric mean criterion (126 organisms/100 mL) times the permitted effluent volume to produce a calculation in terms of organisms/day.
  - LA = TMDL-RC-MOS-WLA

- Calculated the percent reductions:
  - For the geometric mean criterion, 126 organism/100 mL:
    Calculated the geometric mean of the measured load of each flow group for each seasonal category. The percent reduction wss calculated as the reduction needed from the geometric mean of observed data to meet the LA. Specifically, the calculation was: Percent Reduction = (Measured Load - Load Capacity) / (Measured Load) * 100.

  - For the single sample criterion, 406 organism/100 mL:
    Calculated the acceptable load for the day with the highest measured value in each flow group using the flow measured on that day. The percent reduction was calculated as the reduction needed from the highest measured value to meet the acceptable load for that day.

Figure 16: *E. coli* load duration curve for Confluence of Brownlee Subbasin streams with Snake River

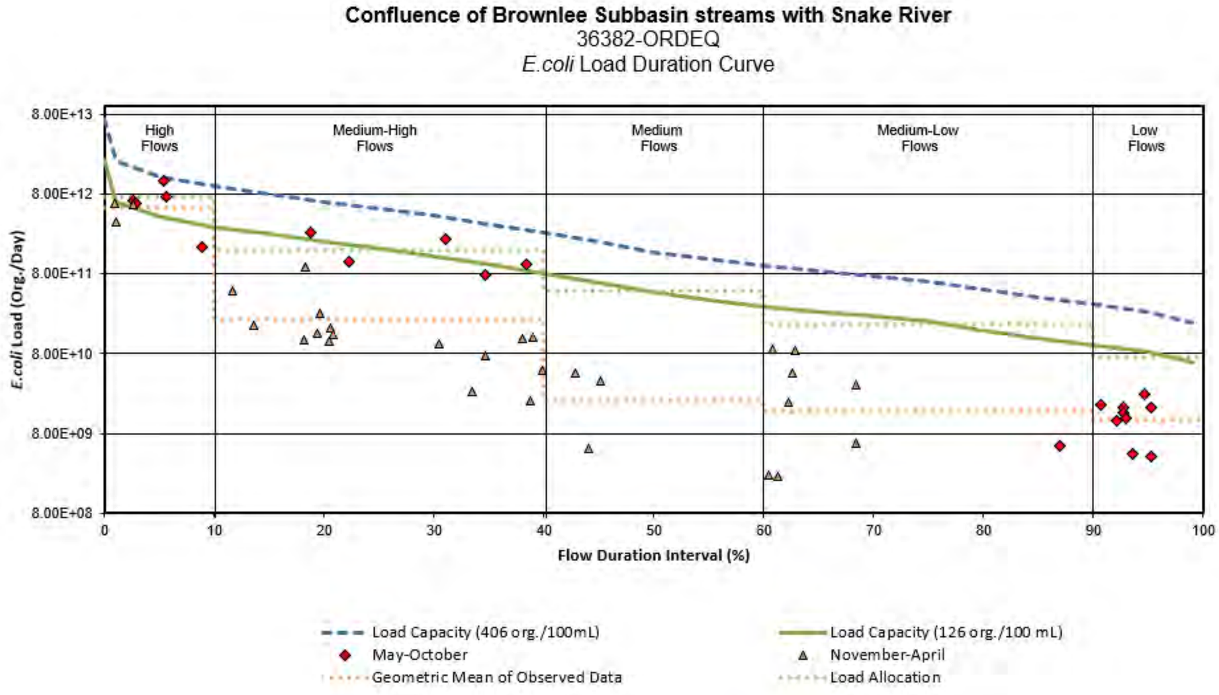


Figure 17: *E. coli* load duration curve for the Powder River upstream of Phillips Reservoir

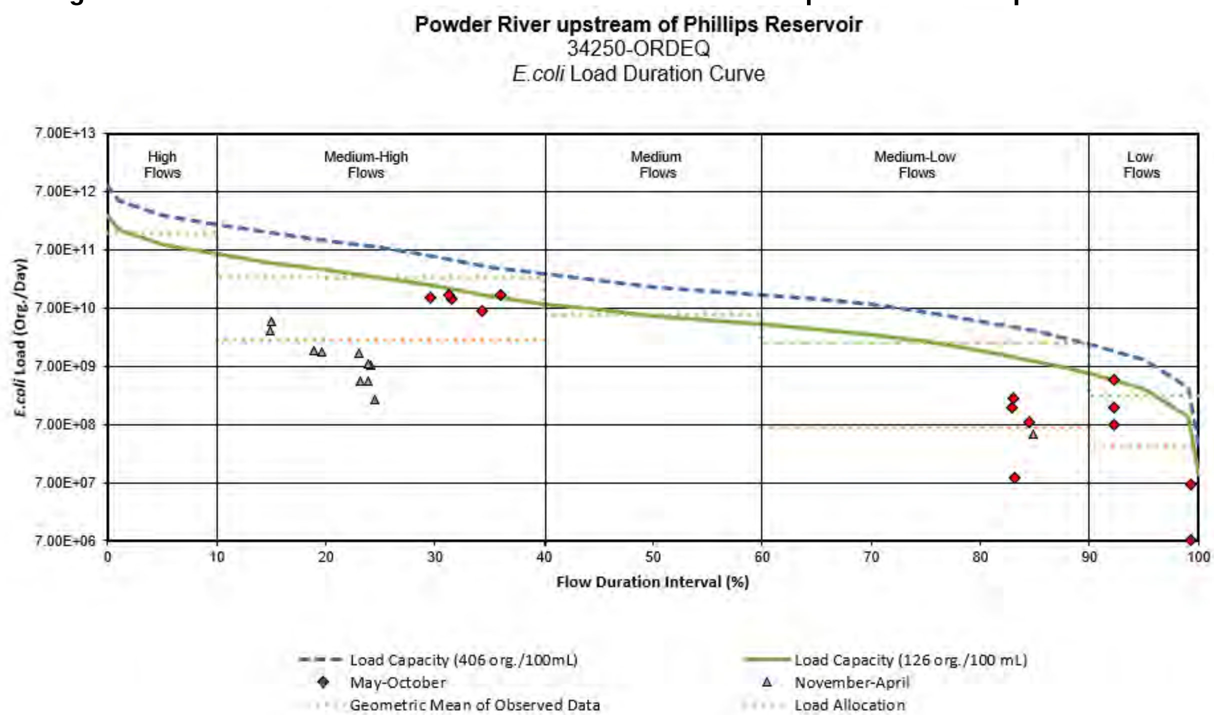


Figure 18: *E. coli* load duration curve for the Powder River from Phillips Reservoir to Baker City

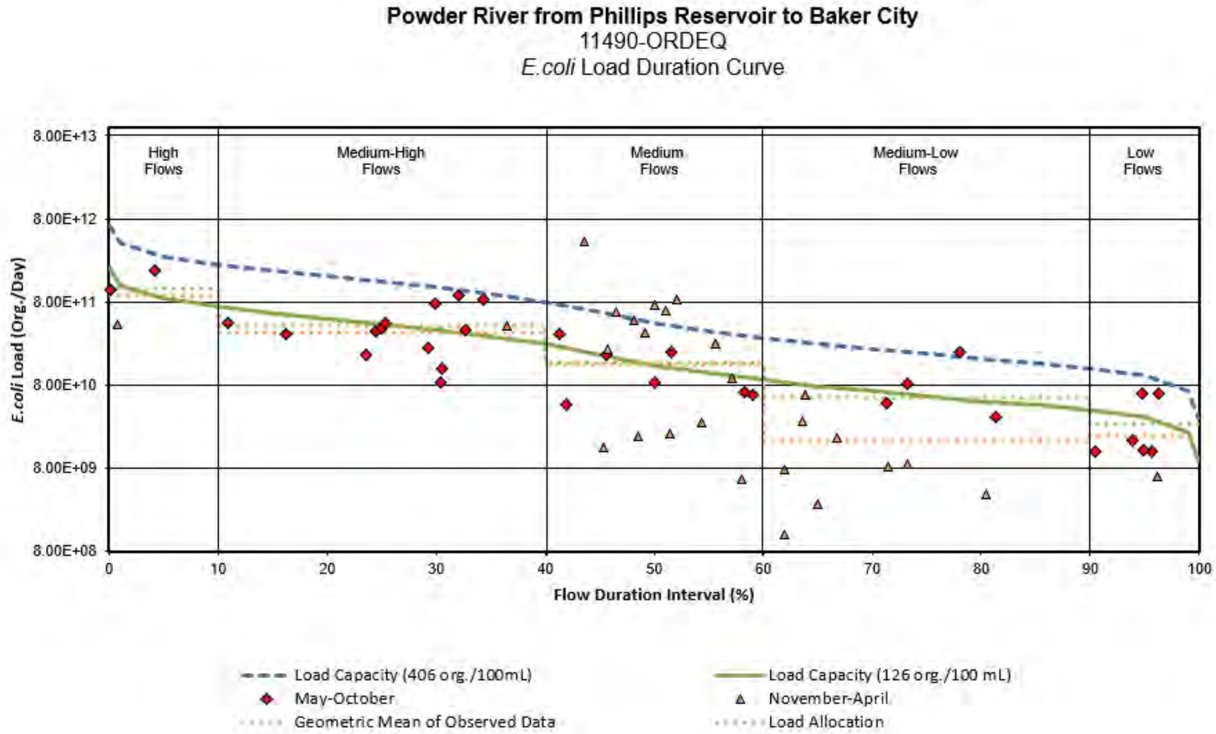


Figure 19: *E. coli* load duration curve for the North Powder River from USFS Boundary to Miller Rd.

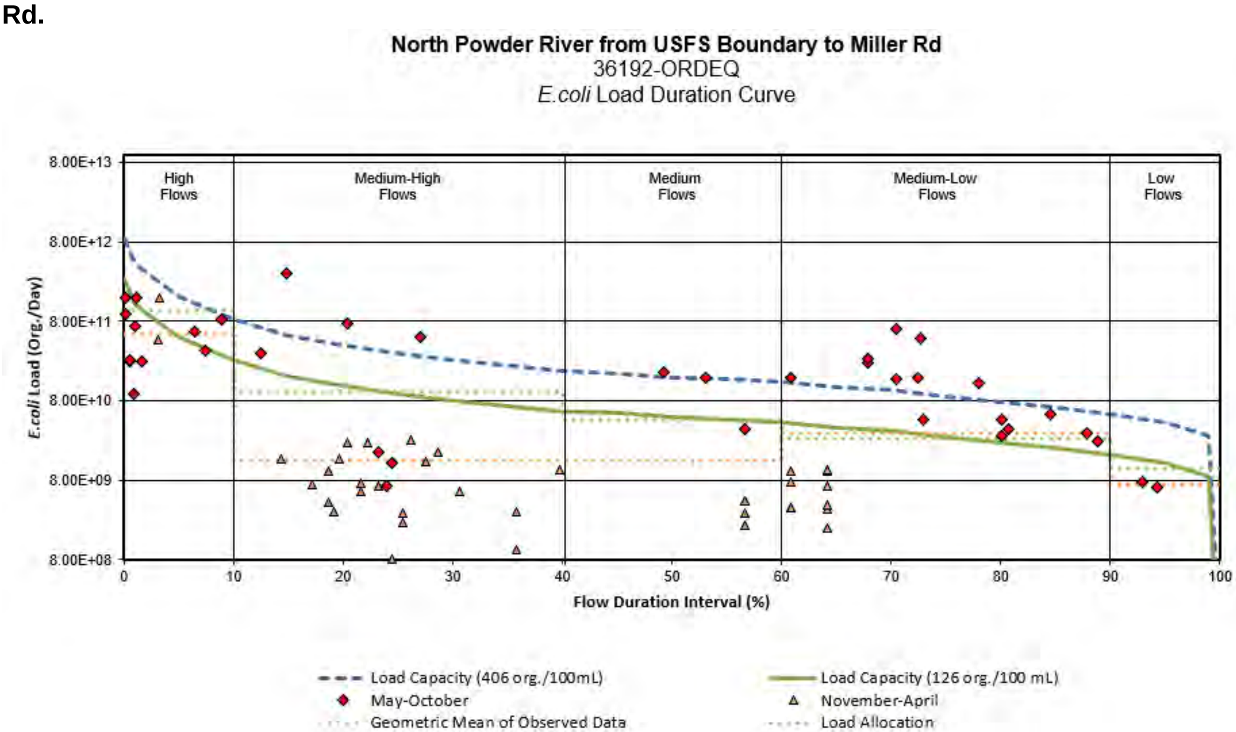


Figure 20: *E. coli* load duration curve for the North Powder River from Miller Rd. to confluence with Powder River

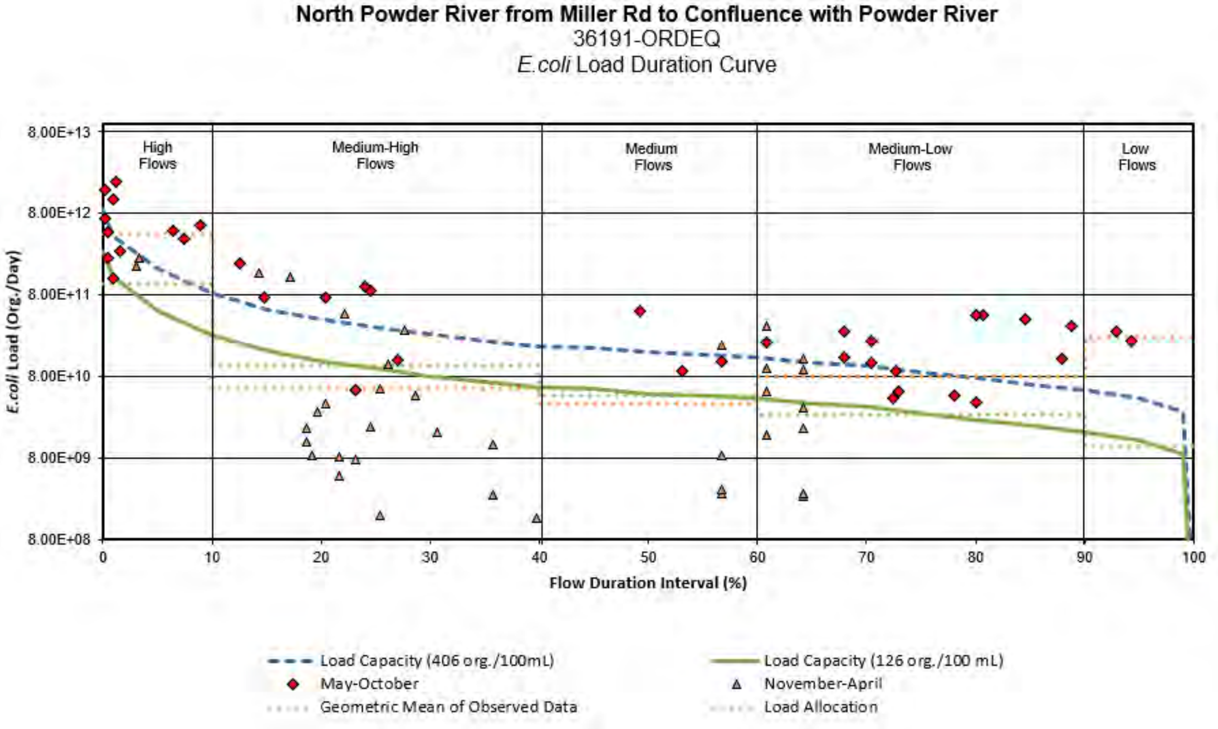


Figure 21: *E. coli* load duration curve for Eagle Creek from New Bridge to Brownlee Reservoir

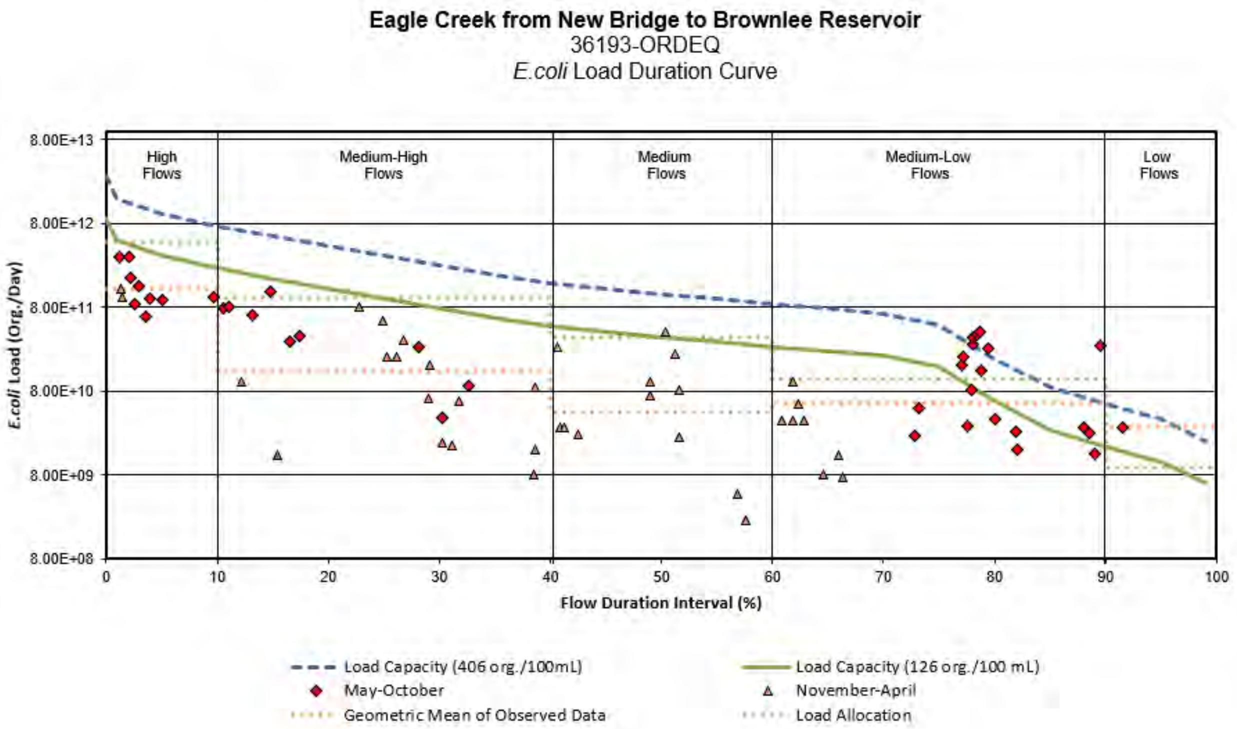


Figure 22: *E. coli* load duration curve for the Powder River from Baker City to confluence with Snake River

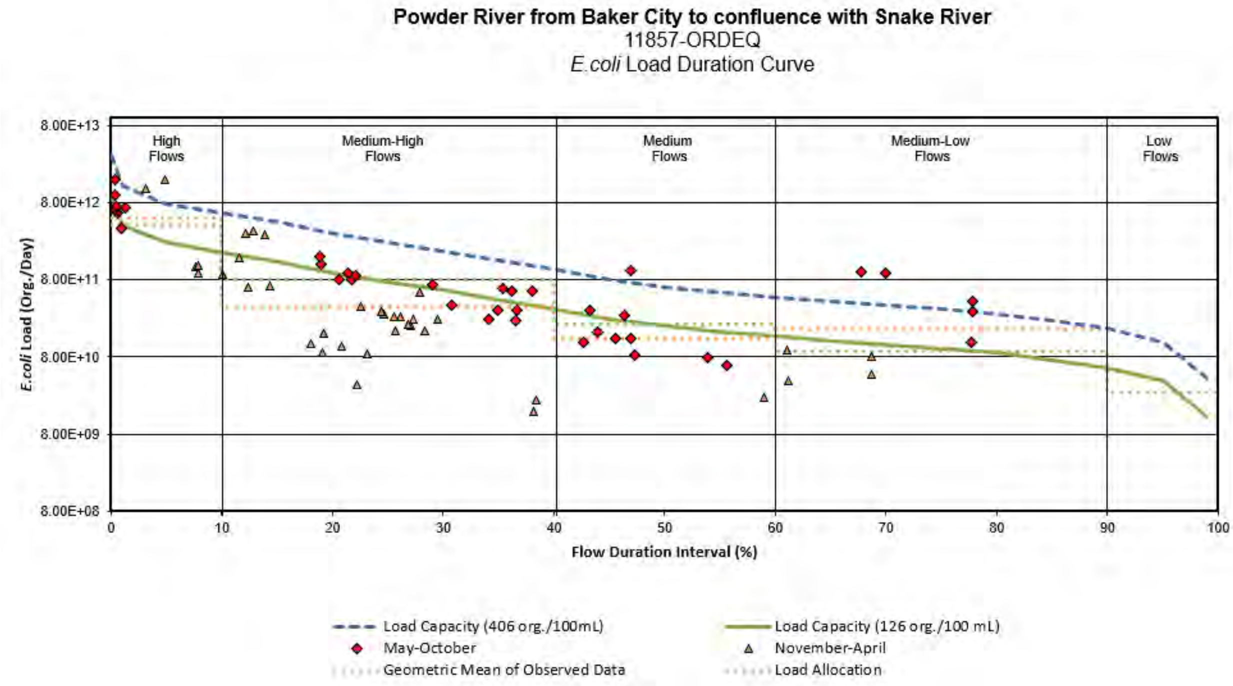


Figure 23: *E. coli* load duration curve for the Burnt River upstream of Unity Reservoir Dam

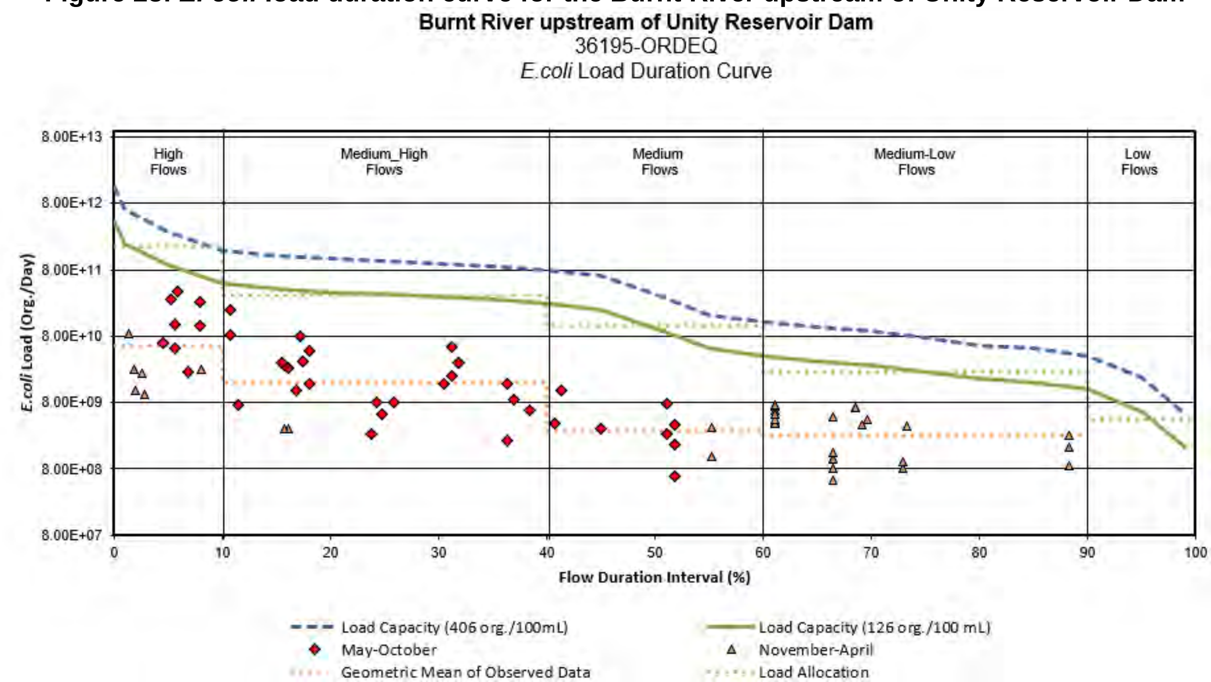


Figure 24: *E. coli* load duration curve for the Burnt River from Unity Reservoir to Clarks Creek Rd.

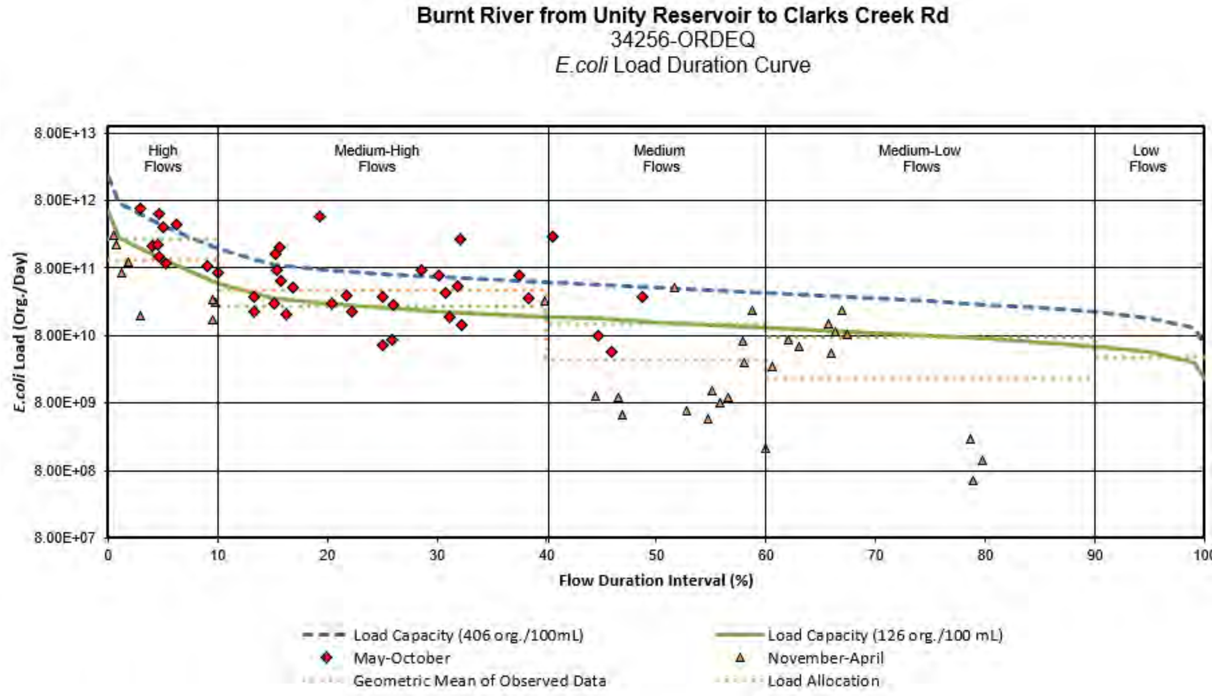
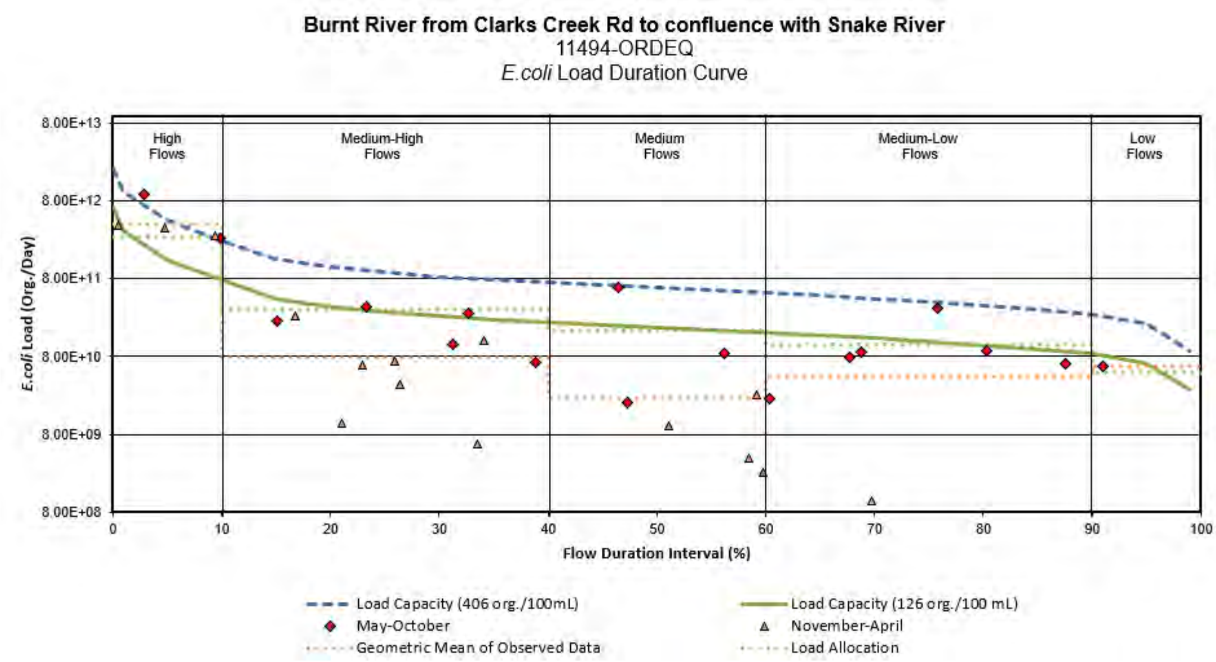


Figure 25: *E. coli* load duration curve for the Burnt River from Clarks Creek Rd. to confluence with Snake River



4.5.2 Load duration curves

DEQ used the load duration curves described in Section 4.5.1 to determine the percent reductions needed to meet loading capacity for both geometric mean and single sample criteria and allocate the loading capacity into LA, WLAs, and a MOS (RC was 0) for all flow categories in each of the 10 named stream reaches for the November-April and May-October seasonal periods (Section 4.5.1). Dividing the analysis between these two periods provides information on potential *E. coli* sources and surface water delivery mechanisms. Load duration curves were calculated for reaches where percent reductions could be calculated for both geometric mean and single sample criteria for at least three of the five flow categories in November-April and May-October.

DEQ set the excess load reduction required for achieving water quality standards to the maximum percent reduction needed to meet either geometric mean or single sample criteria within individual flow categories and seasons to all criteria, flow categories, and seasons for each of the 10 stream reaches. Using this approach ensures that both criteria will be met during all flow conditions and across seasons. This approach can also help identify sources and practices that lead to disconnect between the input of fecal bacteria to landscapes and flow processes that can mobilize it to surface waters.

Tables 10-49 display the load duration curve calculations and the allocations for *E. coli* in the Powder River Basin (EPA, 2019). The allocations include the MOS, RC, WLAs (point sources), and LAs (nonpoint source) needed to meet the applicable *E. coli* criterion.

The percent reduction represents the amount of the current load that needs to be reduced for the applicable criteria for *E. coli* to be met. Tables 50 and 51 summarize measured loads, load capacities, and percent reductions needed to meet load capacities for all flow and seasonal categories. Table 52 summarizes the maximum percent reductions across all flow and season categories. These maximum percent reductions apply across all flow categories and seasons to ensure that criteria are met.

Final allocations for each of the 10 stream reaches can be found in Tables 10-14 in the TMDL document. For allocations by stream reach and flow category (inclusive of both November-April and May-October), DEQ calculated loading capacities using the geometric mean criterion for *E. coli* (126 organisms/100 mL). Using this allocation approach ensures that both single sample and geometric mean criteria for *E. coli* will be met. Maximum percent reductions needed based on geometric mean or single sample criteria across flow categories and seasons provide an additional MOS to ensure that *E. coli* criteria are met with pollution reduction activities.

Table 10: Load duration curve calculations (organism/day) for Confluence of Brownlee Subbasin streams with Snake River (36382-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load Capacity (geometric mean of load capacity in each flow group)				
8.26E+12	1.81E+12	5.41E+11	2.06E+11	8.02E+10
MOS (10% of load capacity)				
8.26E+11	1.81E+11	5.41E+10	2.06E+10	8.02E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
8.26E+10	1.81E+10	5.41E+09	2.06E+09	8.02E+08
LA				
7.36E+12	1.61E+12	4.82E+11	1.83E+11	7.13E+10
Measured load (geometric mean of observed values in each flow group)				
5.65E+12	1.40E+12	N/A	5.53E+09	1.20E+10
Percent reduction				
0	0	N/A	0	0

Table 11: Load duration curve calculations (organism/day) for Confluence of Brownlee Subbasin streams with Snake River (36382-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
8.26E+12	1.81E+12	5.41E+11	2.06E+11	8.02E+10
MOS (10% of load capacity)				
8.26E+11	1.81E+11	5.41E+10	2.06E+10	8.02E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
8.26E+10	1.81E+10	5.41E+09	2.06E+09	8.02E+08
LA				
7.36E+12	1.61E+12	4.82E+11	1.83E+11	7.13E+10
Measured load (geometric mean of observed values in each flow group)				
5.07E+12	1.25E+11	2.04E+10	1.73E+10	N/A
Percent reduction				
0	0	0	0	N/A

Table 12: Load duration curve calculations (organism/day) for Confluence of Brownlee Subbasin streams with Snake River (36382-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.17E+13	2.65E+12	N/A	5.53E+09	2.53E+10
Flow (cfs on day with highest measured value)				
1310	692	N/A	38	27
Load capacity (on day with highest measured value)				
1.30E+13	6.87E+12	N/A	3.74E+11	2.71E+11
MOS (10% of load capacity)				
1.30E+12	6.87E+11	N/A	3.74E+10	2.71E+10
RC (0% of load capacity)				
0	0	N/A	0	0
WLA				
1.30E+11	6.87E+10	N/A	3.74E+09	2.71E+09
LA				
1.16E+13	6.12E+12	N/A	3.33E+11	2.41E+11
Percent reduction				
0	0	N/A	0	0

Table 13: Load duration curve calculations (organism/day) for Confluence of Brownlee Subbasin streams with Snake River (36382-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
6.18E+12	9.79E+11	4.52E+10	8.95E+10	N/A
Flow (cfs on day with highest measured value)				
2190	702	228	98	N/A
Load capacity (on day with highest measured value)				
2.18E+13	6.97E+12	2.26E+12	9.74E+11	N/A
MOS (10% of load capacity)				
2.18E+12	6.97E+11	2.26E+11	9.74E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
2.18E+11	6.97E+10	2.26E+10	9.74E+09	N/A
LA				
1.94E+13	6.21E+12	2.02E+12	8.67E+11	N/A
Percent reduction				
0	0	0	0	N/A

Table 14: Load duration curve calculation for the Powder River above Phillips Reservoir (34250-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.53E+12	2.64E+11	5.86E+10	1.98E+10	2.38E+09
MOS (10% of load capacity)				
1.53E+11	2.64E+10	5.86E+09	1.98E+09	2.38E+08
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.53E+10	2.64E+09	5.86E+08	1.98E+08	2.38E+07
LA				
1.36E+12	2.35E+11	5.22E+10	1.76E+10	2.12E+09
Measured load (geometric mean of observed values in each flow group)				
N/A	9.86E+10	N/A	6.44E+08	2.86E+08
Percent reduction				
N/A	0	N/A	0	0

Table 15: Load duration curve calculations (organism/day) for the Powder River above Phillips Reservoir (34250-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.53E+12	2.64E+11	5.86E+10	1.98E+10	2.38E+09
MOS (10% of load capacity)				
1.53E+11	2.64E+10	5.86E+09	1.98E+09	2.38E+08
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.53E+10	2.64E+09	5.86E+08	1.98E+08	2.38E+07
LA				
1.36E+12	2.35E+11	5.22E+10	1.76E+10	2.12E+09
Measured load (geometric mean of observed values in each flow group)				
N/A	9.05E+09	N/A	4.76E+08	N/A
Percent reduction				
N/A	0	N/A	0	0

Table 16: Load duration curve calculations (organism/day) for the Powder River above Phillips Reservoir (34250-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
N/A	1.18E+11	N/A	1.97E+09	4.15E+09
Flow (cfs on day with highest measured value)				
N/A	46	N/A	4	1
Load capacity (on day with highest measured value)				
N/A	4.58E+11	N/A	3.48E+10	1.31E+10
MOS (10% of load capacity)				
N/A	4.58E+10	N/A	3.48E+09	1.31E+09
RC (0% of load capacity)				
N/A	0	N/A	0	0
WLA				
N/A	4.58E+09	N/A	3.48E+08	1.31E+08
LA				
N/A	4.07E+11	N/A	3.09E+10	1.17E+10
Percent reduction				
N/A	0	N/A	0	0

Table 17: Load duration curve calculations (organism/day) for the Powder River above Phillips Reservoir (34250-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
N/A	4.14E+10	N/A	4.76E+08	N/A
Flow (cfs on day with highest measured value)				
N/A	130	N/A	3	N/A
Load capacity (on day with highest measured value)				
N/A	1.29E+12	N/A	3.07E+10	N/A
MOS (10% of load capacity)				
N/A	1.29E+11	N/A	3.07E+09	N/A
RC (0% of load capacity)				
N/A	0	N/A	0	N/A
WLA				
N/A	1.29E+10	N/A	3.07E+08	N/A
LA				
N/A	1.15E+12	N/A	2.73E+10	N/A
Percent reduction				
N/A	0	N/A	0	N/A

Table 18: Load duration curve calculations (organism/day) for the Powder River at Baker City (11490-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.31E+12	4.66E+11	1.64E+11	6.37E+10	3.02E+10
MOS (10% of load capacity)				
1.31E+11	4.66E+10	1.64E+10	6.37E+09	3.02E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.31E+10	4.66E+09	1.64E+09	6.37E+08	3.02E+08
LA				
1.17E+12	4.15E+11	1.46E+11	5.67E+10	2.68E+10
Measured load (geometric mean of observed values in each flow group)				
1.44E+12	3.43E+11	1.10E+11	7.22E+10	2.30E+10
Percent reduction				
9%	0%	0%	12%	0%

Table 19: Load duration curve calculations (organism/day) for the Powder River at Baker City (11490-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.31E+12	4.66E+11	1.64E+11	6.37E+10	3.02E+10
MOS (10% of load capacity)				
1.31E+11	4.66E+10	1.64E+10	6.37E+09	3.02E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.31E+10	4.66E+09	1.64E+09	6.37E+08	3.02E+08
LA				
1.17E+12	4.15E+11	1.46E+11	5.67E+10	2.68E+10
Measured load (geometric mean of observed values in each flow group)				
4.25E+11	4.12E+11	1.56E+11	8.65E+09	6.44E+09
Percent reduction				
0%	0%	0%	0%	0%

Table 20: Load duration curve calculations (organism/day) for the Powder River at Baker City (11490-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.88E+12	9.76E+11	3.25E+11	2.03E+11	6.40E+10
Flow (cfs on day with highest measured value)				
295	116	80	17	9
Load capacity (on day with highest measured value)				
2.93E+12	1.15E+12	7.91E+11	1.69E+11	9.12E+10
MOS (10% of load capacity)				
2.93E+11	1.15E+11	7.91E+10	1.69E+10	9.12E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
2.93E+10	1.15E+10	7.05E+09	1.69E+09	9.12E+08
LA				
2.60E+12	1.02E+12	6.28E+11	1.50E+11	8.12E+10
Percent reduction				
0	0	0	17%	0

Table 21: Load duration curve calculations (organism/day) for the Powder River at Baker City (11490-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
4.25E+11	4.12E+11	4.20E+12	6.05E+10	6.44E+09
Flow (cfs on day with highest measured value)				
370	97	71	24	9
Load capacity (on day with highest measured value)				
3.68E+12	9.66E+11	7.05E+11	2.42E+11	9.17E+10
MOS (10% of load capacity)				
3.68E+11	9.66E+10	7.05E+10	2.42E+10	9.17E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
3.68E+10	9.66E+09	7.05E+09	2.42E+09	9.17E+08
LA				
3.27E+12	8.60E+11	6.28E+11	2.16E+11	8.16E+10
Percent reduction				
0	0	83%	0	0

Table 22: Load duration curve calculations (organism/day) for the North Powder River at Highway 30 (36191-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
MOS (10% of load capacity)				
1.23E+11	1.19E+10	5.22E+09	3.00E+09	1.25E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.23E+10	1.19E+09	5.22E+08	3.00E+08	1.25E+08
LA				
1.10E+12	1.06E+11	4.64E+10	2.67E+10	1.12E+10
Measured load (geometric mean of observed values in each flow group)				
5.34E+12	4.90E+11	1.78E+11	1.46E+11	2.48E+11
Percent reduction				
77%	76%	71%	79%	95%

Table 23: Load duration curve calculations (organism/day) for the North Powder River at Highway 30 (36191-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
MOS (10% of load capacity)				
1.23E+11	1.19E+10	5.22E+09	3.00E+09	1.25E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.23E+10	1.19E+09	5.22E+08	3.00E+08	1.25E+08
LA				
1.10E+12	1.06E+11	4.64E+10	2.67E+10	1.12E+10
Measured load (geometric mean of observed values in each flow group)				
2.01E+12	2.72E+10	1.12E+10	3.34E+10	N/A
Percent reduction				
39%	0%	0%	10%	N/A

Table 24: Load duration curve calculations (organism/day) for the North Powder River at Highway 30 (36191-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.96E+13	1.97E+12	5.00E+11	4.56E+11	2.84E+11
Flow (cfs on day with highest measured value)				
403	67	17	8	5
Load capacity (on day with highest measured value)				
4.00E+12	6.66E+11	1.69E+11	7.65E+10	4.77E+10
MOS (10% of load capacity)				
4.00E+11	6.66E+10	1.69E+10	7.65E+09	4.77E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
4.00E+10	6.66E+09	1.69E+09	7.65E+08	4.77E+08
LA				
3.56E+12	5.92E+11	1.50E+11	6.81E+10	4.24E+10
Percent reduction				
80%	66%	66%	83%	83%

Table 25: Load duration curve calculations (organism/day) for the North Powder River at Highway 30 (36191-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
2.26E+12	1.46E+12	1.90E+11	3.36E+11	N/A
Flow (cfs on day with highest measured value)				
238	57	15	14	N/A
Load capacity (on day with highest measured value)				
2.36E+12	5.66E+11	1.49E+11	1.39E+11	N/A
MOS (10% of load capacity)				
2.36E+11	5.66E+10	1.49E+10	1.39E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
2.36E+10	5.66E+09	1.49E+09	1.39E+09	N/A
LA				
2.10E+12	5.04E+11	1.33E+11	1.24E+11	N/A
Percent reduction				
0%	61%	22%	59%	N/A

Table 26: Load duration curve calculations (organism/day) for the North Powder River at Miller Road (36192-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
MOS (10% of load capacity)				
1.23E+11	1.19E+10	5.22E+09	3.00E+09	1.25E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.23E+10	1.19E+09	5.22E+08	3.00E+08	1.25E+08
LA				
1.10E+12	1.06E+11	4.64E+10	2.67E+10	1.12E+10
Measured load (geometric mean of observed values in each flow group)				
4.97E+11	1.29E+11	9.96E+10	9.91E+10	7.05E+09
Percent reduction				
0	8%	48%	70%	0

Table 27: Load duration curve calculations (organism/day) for the North Powder River at Miller Road (36192-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
MOS (10% of load capacity)				
1.23E+11	1.19E+10	5.22E+09	3.00E+09	1.25E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.23E+10	1.19E+09	5.22E+08	3.00E+08	1.25E+08
LA				
1.10E+12	1.06E+11	4.64E+10	2.67E+10	1.12E+10
Measured load (log mean of observed values in each flow group)				
8.64E+11	6.78E+09	3.40E+09	5.38E+09	N/A
Percent reduction				
0	0	0	0	N /A

Table 28: Load duration curve calculations (organism/day) for the North Powder River at Miller Road (36192-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.60E+12	3.26E+12	1.81E+11	6.50E+11	7.63E+09
Flow (cfs on day with highest measured value)				
645	55	17	11	5
Load capacity (on day with highest measured value)				
6.41E+12	5.46E+11	1.69E+11	1.09E+11	4.77E+10
MOS (10% of load capacity)				
6.41E+11	5.46E+10	1.69E+10	1.09E+10	4.77E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
6.41E+10	5.46E+09	1.69E+09	1.09E+09	4.77E+08
LA				
5.70E+12	4.86E+11	1.50E+11	9.72E+10	4.24E+10
Percent reduction				
0	83%	7%	83%	0

Table 29: Load duration curve calculations (organism/day) for the North Powder River at Miller Road (36192-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.60E+12	2.59E+10	4.40E+09	1.10E+10	N/A
Flow (cfs on day with highest measured value)				
238	31	15	13	N/A
Load capacity (on day with highest measured value)				
2.36E+12	3.08E+11	1.49E+11	1.29E+11	N/A
MOS (10% of load capacity)				
2.36E+11	3.08E+10	1.49E+10	1.29E+10	N/A
RC (0% of load capacity)				
0	0	0	0	0
WLA				
2.36E+10	3.08E+09	1.49E+09	1.29E+09	N/A
LA				
2.10E+12	2.74E+11	1.33E+11	1.15E+11	N/A
Percent reduction				
0	0	0	0	N/A

Table 30: Load duration curve calculations (organism/day) for Eagle Creek near Richland (36193-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
5.32E+12	1.18E+12	3.84E+11	1.24E+11	1.08E+10
MOS (10% of load capacity)				
5.32E+11	1.18E+11	3.84E+10	1.24E+10	1.08E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
9.32E+10	6.41E+10	1.92E+10	1.90E+10	9.32E+10
LA				
4.73E+12	1.05E+12	3.42E+11	1.10E+11	9.62E+09
Measured load (geometric mean of observed values in each flow group)				
1.35E+12	3.38E+11	N/A	8.30E+10	2.97E+10
Percent reduction				
0	0	N/A	0	64%

Table 31: Load duration curve calculations (organism/day) for Eagle Creek near Richland (36193-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
5.32E+12	1.18E+12	3.84E+11	1.24E+11	1.08E+10
MOS (10% of load capacity)				
5.32E+11	1.18E+11	3.84E+10	1.24E+10	1.08E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
5.32E+10	1.18E+10	3.84E+09	1.24E+09	1.08E+08
LA				
4.73E+12	1.05E+12	3.42E+11	1.10E+11	9.62E+09
Measured load (geometric mean of observed values in each flow group)				
1.20E+12	7.82E+10	4.55E+10	2.62E+10	N/A
Percent reduction				
0	0	0	0	N/A

Table 32: Load duration curve calculations (organism/day) for Eagle Creek near Richland (36193-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
3.22E+12	1.24E+12	N/A	4.08E+11	2.97E+10
Flow (cfs on day with highest measured value)				
1410	575	N/A	24	5
Load capacity (on day with highest measured value)				
1.40E+13	5.71E+12	N/A	2.41E+11	5.02E+10
MOS (10% of load capacity)				
1.40E+12	5.71E+11	N/A	2.41E+10	5.02E+09
RC (0% of load capacity)				
0	0	N/A	0	0
WLA				
1.40E+11	5.71E+10	N/A	2.41E+09	5.02E+08
LA				
1.25E+13	5.08E+12	N/A	2.15E+11	4.46E+10
Percent reduction				
0	0	N/A	41%	0

Table 33: Load duration curve calculations (organism/day) for Eagle Creek near Richland (36193-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.35E+12	8.13E+11	4.13E+11	1.03E+11	N/A
Flow (cfs on day with highest measured value)				
1550	367	114	85	N/A
Load capacity (on day with highest measured value)				
1.54E+13	3.65E+12	1.13E+12	8.47E+11	N/A
MOS (10% of load capacity)				
1.54E+12	3.65E+11	1.13E+11	8.47E+10	N/A
RC (0% of LC)				
0	0	0	0	N/A
WLA				
1.54E+11	3.65E+10	1.13E+10	8.47E+09	N/A
LA				
1.37E+13	3.24E+12	1.01E+12	7.54E+11	N/A
Percent reduction				
0	0	0	0	N/A

Table 34: Load duration curve calculations (organism/day) for the Powder River from Baker City to confluence with Snake River (11857-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
4.65E+12	8.83E+11	2.31E+11	1.07E+11	3.11E+10
MOS (10% of load capacity)				
4.65E+11	8.83E+10	2.31E+10	1.07E+10	3.11E+09
RC (0% of LC)				
0	0	0	0	0
WLA				
6.08E+10	2.31E+10	1.66E+10	1.54E+10	1.46E+10
LA				
4.12E+12	7.72E+11	1.91E+11	8.07E+10	1.33E+10
Measured load (geometric mean of observed values in each flow group)				
7.10E+12	5.87E+11	1.65E+11	4.34E+11	N/A
Percent reduction				
35%	0	0	75%	N/A

Table 35: Load duration curve calculations (organism/day) for the Powder River from Baker City to confluence with Snake River (11857-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
4.65E+12	8.83E+11	2.31E+11	1.07E+11	3.11E+10
MOS (10% of load capacity)				
4.65E+11	8.83E+10	2.31E+10	1.07E+10	3.11E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
6.08E+10	2.31E+10	1.66E+10	1.54E+10	1.46E+10
LA				
4.12E+12	7.72E+11	1.91E+11	8.07E+10	1.33E+10
Measured load (geometric mean of observed values in each flow group)				
3.05E+12	2.68E+11	2.44E+10	6.21E+10	N/A
Percent reduction				
0	0	0	0	N/A

Table 36: Load duration curve calculations (organism/day) for the Powder River from Baker City to confluence with Snake River (11857-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.59E+13	1.58E+12	1.04E+12	1.02E+12	N/A
Flow (cfs on day with highest measured value)				
2110	348	74	40	N/A
Load capacity (on day with highest measured value)				
2.10E+13	3.46E+12	7.32E+11	3.96E+11	N/A
MOS (10% of load capacity)				
2.10E+12	3.46E+11	7.32E+10	3.96E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
2.24E+11	4.89E+10	2.16E+10	1.83E+10	N/A
LA				
1.86E+13	3.06E+12	6.37E+11	3.38E+11	N/A
Percent reduction				
0	0	30%	61%	N/A

Table 37: Load duration curve calculations (organism/day) for the Powder River from Baker City to confluence with Snake River (11857-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
1.59E+13	3.41E+12	2.44E+10	9.78E+10	N/A
Flow (cfs on day with highest measured value)				
795	502	50	47	N/A
Load capacity (on day with highest measured value)				
7.89E+12	4.98E+12	4.92E+11	4.65E+11	N/A
MOS (10% of load capacity)				
7.89E+11	4.98E+11	4.92E+10	4.65E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
9.32E+10	6.41E+10	1.92E+10	1.90E+10	N/A
LA				
7.01E+12	4.42E+12	4.23E+11	3.99E+11	N/A
Percent reduction				
50%	0	0	0	N/A

Table 38: Load duration curve calculations (organism/day) for the Burnt River at Unity Reservoir discharge (36195-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of Load capacity in each flow group)				
1.99E+12	3.59E+11	1.28E+11	2.54E+10	4.98E+09
MOS (10% of load capacity)				
1.99E+11	3.59E+10	1.28E+10	2.54E+09	4.98E+08
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.99E+10	3.59E+09	1.28E+09	2.54E+08	4.98E+07
LA				
1.77E+12	3.20E+11	1.14E+11	2.26E+10	4.43E+09
Measured load (geometric mean of observed values in each flow group)				
1.15E+11	1.84E+10	3.25E+09	N/A	N/A
Percent reduction				
0	0	0	N/A	N/A

Table 39: Load duration curve calculations (organism/day) for the Burnt River at Unity Reservoir discharge (36195-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of Load capacity in each flow group)				
1.99E+12	3.59E+11	1.28E+11	2.54E+10	4.98E+09
MOS (10% of load capacity)				
1.99E+11	3.59E+10	1.28E+10	2.54E+09	4.98E+08
RC (0% of load capacity)				
0	0	0	0	0
WLA				
1.99E+10	3.59E+09	1.28E+09	2.54E+08	4.98E+07
LA				
1.77E+12	3.20E+11	1.14E+11	2.26E+10	4.43E+09
Measured load (geometric mean of observed values in each flow group)				
2.35E+10	3.17E+09	2.04E+09	2.61E+09	N/A
Percent reduction				
0	0	0	0	N/A

Table 40: Load duration curve calculations (organism/day) for the Burnt River at Unity Reservoir discharge (36195-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
3.83E+11	1.97E+11	1.20E+10	0.00E+00	N/A
Flow (cfs on day with highest measured value)				
265	155	78	N/A	N/A
Load capacity (on day with highest measured value)				
2.63E+12	1.54E+12	7.75E+11	N/A	N/A
MOS (10% of load capacity)				
2.63E+11	1.54E+11	7.75E+10	N/A	N/A
RC (0% of load capacity)				
0	0	0	N/A	N/A
WLA				
2.63E+10	1.54E+10	7.75E+09	N/A	N/A
LA				
2.34E+12	1.37E+12	6.90E+11	N/A	N/A
Percent reduction				
0	0	0	N/A	N/A

Table 41: Load duration curve calculations (organism/day) for the Burnt River at Unity Reservoir discharge (36195-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
8.75E+10	3.18E+09	3.33E+09	7.25E+09	N/A
Flow (cfs on day with highest measured value)				
596	65	17	13	N/A
Load capacity (on day with highest measured value)				
5.92E+12	6.46E+11	1.69E+11	1.29E+11	N/A
MOS (10% of load capacity)				
5.92E+11	6.46E+10	1.69E+10	1.29E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
5.92E+10	6.46E+09	1.69E+09	1.29E+09	N/A
LA				
5.27E+12	5.75E+11	1.50E+11	1.15E+11	N/A
Percent reduction				
0	0	0	0	N/A

Table 42: Load duration curve calculations (organism/day) for the Burnt River at Clarks Creek Road (34256-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
2.39E+12	2.40E+11	1.33E+11	8.25E+10	4.30E+10
MOS (10% of load capacity)				
2.39E+11	2.40E+10	1.33E+10	8.25E+09	4.30E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
2.39E+10	2.40E+09	1.33E+09	8.25E+08	4.30E+08
LA				
2.12E+12	2.13E+11	1.19E+11	7.34E+10	3.83E+10
Measured load (geometric mean of observed values in each flow group)				
2.15E+12	3.77E+11	2.27E+11	N/A	N/A
Percent reduction				
N/A	36%	41%	N/A	N/A

Table 43: Load duration curve calculations (organism/day) for the Burnt River at Clarks Creek Road (34256-ORDEQ) -geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
2.39E+12	2.40E+11	1.33E+11	8.25E+10	4.30E+10
MOS (10% of load capacity)				
2.39E+11	2.40E+10	1.33E+10	8.25E+09	4.30E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
2.39E+10	2.40E+09	1.33E+09	8.25E+08	4.30E+08
LA				
2.12E+12	2.13E+11	1.19E+11	7.34E+10	3.83E+10
Measured load (geometric mean of observed values in each flow group)				
5.03E+11	2.62E+11	1.90E+10	1.88E+10	N/A
Percent reduction				
0	8%	0	0	N/A

Table 44: Load duration curve calculations (organism/day) for the Burnt River at Clarks Creek Road (34256-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
6.11E+12	4.61E+12	2.38E+12	N/A	N/A
Flow (cfs on day with highest measured value)				
483	78	49	N/A	N/A
Load capacity (on day with highest measured value)				
4.80E+12	7.74E+11	4.91E+11	N/A	N/A
MOS (10% of load capacity)				
4.80E+11	7.74E+10	4.91E+10	N/A	N/A
RC (0% of load capacity)				
0	0	0	N/A	N/A
WLA				
4.80E+10	7.74E+09	4.91E+09	N/A	N/A
LA				
4.27E+12	6.89E+11	4.37E+11	N/A	N/A
Percent reduction				
21%	83%	79%	N/A	N/A

Table 45: Load duration curve calculations (organism/day) for the Burnt River at Clarks Creek Road (34256-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
2.41E+12	2.62E+11	4.02E+11	1.93E+11	N/A
Flow (cfs on day with highest measured value)				
857	50	40	30	N/A
Load capacity (on day with highest measured value)				
8.51E+12	4.97E+11	3.97E+11	3.00E+11	N/A
MOS (10% of load capacity)				
8.51E+11	4.97E+10	3.97E+10	3.00E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
8.51E+10	4.97E+09	3.97E+09	3.00E+09	N/A
LA				
7.58E+12	4.42E+11	3.54E+11	2.67E+11	N/A
Percent reduction				
0	0	1%	0	N/A

Table 46: Load duration curve calculations (organism/day) for the Burnt River at Huntington (11494-ORDEQ) - geometric mean criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of load capacity in each flow group)				
3.10E+12	3.63E+11	1.98E+11	1.29E+11	5.51E+10
MOS (10% of load capacity)				
3.10E+11	3.63E+10	1.98E+10	1.29E+10	5.51E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
3.57E+10	8.40E+09	6.75E+09	6.06E+09	5.32E+09
LA				
2.75E+12	3.19E+11	1.71E+11	1.10E+11	4.43E+10
Measured load (geometric mean of observed values in each flow group)				
5.12E+12	1.78E+11	1.04E+11	8.31E+10	5.88E+10
Percent reduction				
40%	0	0	0	6%

Table 47: Load duration curve calculations (organism/day) for the Burnt River at Huntington (11494-ORDEQ) - geometric mean criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Load capacity (geometric mean of Load capacity in each flow group)				
3.10E+12	3.63E+11	1.98E+11	1.29E+11	5.51E+10
MOS (10% of load capacity)				
3.10E+11	3.63E+10	1.98E+10	1.29E+10	5.51E+09
RC (0% of load capacity)				
0	0	0	0	0
WLA				
3.57E+10	8.40E+09	6.75E+09	6.06E+09	5.32E+09
LA				
2.75E+12	3.19E+11	1.71E+11	1.10E+11	4.43E+10
Measured load (geometric mean of observed values in each flow group)				
3.41E+12	4.42E+10	7.24E+09	1.10E+09	N/A
Percent reduction				
9%	0	0	0	N/A

Table 48: Load duration curve calculations (organism/day) for the Burnt River at Huntington (11494-ORDEQ) - single sample criteria from May to October

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
9.79E+12	3.45E+11	6.16E+11	3.35E+11	5.88E+10
Flow (cfs on day with highest measured value)				
691	103	65	40	27
Load capacity (on day with highest measured value)				
6.86E+12	1.02E+12	6.47E+11	3.94E+11	2.68E+11
MOS (10% of load capacity)				
6.86E+11	1.02E+11	6.47E+10	3.94E+10	2.68E+10
RC (0% of load capacity)				
0	0	0	0	0
WLA				
7.34E+10	1.50E+10	1.12E+10	8.71E+09	7.45E+09
LA				
6.10E+12	9.06E+11	5.71E+11	3.46E+11	2.34E+11
Percent reduction				
30%	0	0	0	0

Table 49: Load duration curve calculations (organism/day) for the Burnt River at Huntington (11494-ORDEQ) - single sample criteria from November to April

High	Medium-High	Medium	Medium-Low	Low
Measured load (highest value)				
3.90E+12	2.70E+11	2.59E+10	1.10E+09	N/A
Flow (cfs on day with highest measured value)				
1340	133	53	45	N/A
Load capacity (on day with highest measured value)				
1.33E+13	1.32E+12	5.26E+11	4.47E+11	N/A
MOS (10% of load capacity)				
1.33E+12	1.32E+11	5.26E+10	4.47E+10	N/A
RC (0% of load capacity)				
0	0	0	0	N/A
WLA				
1.38E+11	1.80E+10	1.00E+10	9.24E+09	N/A
LA				
1.18E+13	1.17E+12	4.64E+11	3.93E+11	N/A
Percent reduction				
0	0	0	0	N/A

Table 50: Compiled *E. coli* loading capacity and excess load by stream reach - geometric mean criterion

Station	Caclulation	Flow category by seasonal period									
		May-October					November-April				
		High	Medium-High	Medium	Medium-Low	Low	High	Medium-High	Medium	Medium-Low	Low
Confluence of Brownlee Subbasin streams with Snake River	Measured Load (organisms/day)	5.65E+12	1.40E+12	N/A	5.53E+09	1.20E+10	5.07E+12	1.25E+11	2.04E+10	1.73E+10	N/A
	Load Capacity (organsims/day)	8.26E+12	1.81E+12	5.41E+11	2.06E+11	8.02E+10	8.26E+12	1.81E+12	5.41E+11	2.06E+11	8.02E+10
	Excess Load (% reduction)	0	0	N/A	0	0	0	0	0	0	N/A
Powder River upstream of Philips Reservoir	Measured Load (organisms/day)	N/A	9.86E+10	N/A	6.44E+08	2.86E+08	N/A	9.05E+09	N/A	4.76E+08	N/A
	Load Capacity (organsims/day)	1.53E+12	2.64E+11	5.86E+10	1.98E+10	2.38E+09	1.53E+12	2.64E+11	5.86E+10	1.98E+10	2.38E+09
	Excess Load (% reduction)	N/A	0	N/A	0	0	N/A	0	N/A	0	N/A
Powder River from Phillips Reservoir to Baker City	Measured Load (organisms/day)	1.44E+12	3.43E+11	1.10E+11	7.22E+10	2.30E+10	4.25E+11	4.12E+11	1.56E+11	8.65E+09	6.44E+09
	Load Capacity (organsims/day)	1.31E+12	4.66E+11	1.64E+11	6.37E+10	3.02E+10	1.31E+12	4.66E+11	1.64E+11	6.37E+10	3.02E+10
	Excess Load (% reduction)	9	0	0	12	0	0	0	0	0	0
North Powder River from USFS Boundary to Miller Rd	Measured Load (organisms/day)	4.97E+11	1.29E+11	9.96E+10	9.91E+10	7.05E+09	8.64E+11	6.78E+09	3.40E+09	5.38E+09	N/A
	Load Capacity (organsims/day)	1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10	1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
	Excess Load (% reduction)	0	8	48	70	0	0	0	0	0	N/A
North Powder River from Miller Rd to Confluence with Powder River	Measured Load (organisms/day)	5.34E+12	4.90E+11	1.78E+11	1.46E+11	2.48E+11	2.01E+12	2.72E+10	1.12E+10	3.34E+10	N/A
	Load Capacity (organsims/day)	1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10	1.23E+12	1.19E+11	5.22E+10	3.00E+10	1.25E+10
	Excess Load (% reduction)	77	76	71	79	95	39	0	0	10	N/A
Eagle Creek from New Bridge to Brownlee Reservoir	Measured Load (organisms/day)	1.35E+12	3.38E+11	N/A	8.30E+10	2.97E+10	1.20E+12	7.82E+10	4.55E+10	2.62E+10	N/A
	Load Capacity (organsims/day)	5.32E+12	1.18E+12	3.84E+11	1.24E+11	1.08E+10	5.32E+12	1.18E+12	3.84E+11	1.24E+11	1.08E+10
	Excess Load (% reduction)	0	0	N/A	0	64	0	0	0	0	N/A
Powder River from Baker City to confluence with Snake River	Measured Load (organisms/day)	7.10E+12	5.87E+11	1.65E+11	4.34E+11	N/A	3.05E+12	2.68E+11	2.44E+10	6.21E+10	N/A
	Load Capacity (organsims/day)	4.65E+12	8.83E+11	2.31E+11	1.07E+11	3.11E+10	4.65E+12	8.83E+11	2.31E+11	1.07E+11	3.11E+10
	Excess Load (% reduction)	35	0	0	75	N/A	0	0	0	0	N/A
Burnt River upstream of Unity Reservoir Dam	Measured Load (organisms/day)	1.15E+11	1.84E+10	3.25E+09	N/A	N/A	2.35E+10	3.17E+09	2.04E+09	2.61E+09	N/A
	Load Capacity (organsims/day)	1.99E+12	3.59E+11	1.28E+11	2.54E+10	4.98E+09	1.99E+12	3.59E+11	1.28E+11	2.54E+10	4.98E+09
	Excess Load (% reduction)	0	0	0	N/A	N/A	0	0	0	0	N/A
Burnt River from Unity Reservoir to Clarks Creek Rd	Measured Load (organisms/day)	2.15E+12	3.77E+11	2.27E+11	N/A	N/A	5.03E+11	2.62E+11	1.90E+10	1.88E+10	N/A
	Load Capacity (organsims/day)	2.39E+12	2.40E+11	1.33E+11	8.25E+10	4.30E+10	2.39E+12	2.40E+11	1.33E+11	8.25E+10	4.30E+10
	Excess Load (% reduction)	0	36	41	N/A	N/A	0	8	0	0	N/A
Burnt River from Clarks Creek Rd to confluence with Snake River	Measured Load (organisms/day)	5.12E+12	1.78E+11	1.04E+11	8.31E+10	5.88E+10	3.41E+12	4.42E+10	7.24E+09	1.10E+09	N/A
	Load Capacity (organsims/day)	3.10E+12	3.63E+11	1.98E+11	1.29E+11	5.51E+10	3.10E+12	3.63E+11	1.98E+11	1.29E+11	5.51E+10
	Excess Load (% reduction)	39	0	0	0	6	9	0	0	0	N/A

Table 51: Compiled *E. coli* loading capacity and excess load by stream reach - single sample criterion

Station	Caclulation	May-October High	May-October Medium-High	May-October Medium	May-October Medium-Low	May-October Low	November-April High	November-April Medium-High	November-April Medium	November-April Medium-Low	November-April Low
Confluence of Brownlee Subbasin streams with Snake River	Measured Load (organisms/day)	1.17E+13	2.65E+12	N/A	5.53E+09	2.53E+10	6.18E+12	9.79E+11	4.52E+10	8.95E+10	N/A
	Load Capacity (organsims/day)	1.30E+13	6.87E+12	N/A	3.74E+11	2.71E+11	2.18E+13	6.97E+12	2.26E+12	9.74E+11	N/A
	Excess Load (% reduction)	0	0	N/A	0	0	0	0	0	0	N/A
Powder River upstream of Philips Reservoir	Measured Load (organisms/day)	N/A	1.18E+11	N/A	1.97E+09	4.15E+09	N/A	4.14E+10	N/A	4.76E+08	N/A
	Load Capacity (organsims/day)	N/A	4.58E+11	N/A	3.48E+10	1.31E+10	N/A	1.29E+12	N/A	3.07E+10	N/A
	Excess Load (% reduction)	N/A	0	N/A	0	0	N/A	0	N/A	0	N/A
Powder River from Phillips Reservoir to Baker City	Measured Load (organisms/day)	1.88E+12	9.76E+11	3.25E+11	2.03E+11	6.40E+10	4.25E+11	4.12E+11	4.20E+12	6.05E+10	6.44E+09
	Load Capacity (organsims/day)	2.93E+12	1.15E+12	7.91E+11	1.69E+11	9.12E+10	3.68E+12	9.66E+11	7.05E+11	2.42E+11	9.17E+10
	Excess Load (% reduction)	0	0	0	17	0	0	0	83	0	0
North Powder River from USFS Boundary to Miller Rd	Measured Load (organisms/day)	1.60E+12	3.26E+12	1.81E+11	6.50E+11	7.63E+09	1.60E+12	2.59E+10	4.40E+09	1.10E+10	N/A
	Load Capacity (organsims/day)	6.41E+12	5.46E+11	1.69E+11	1.09E+11	4.77E+10	2.36E+12	3.08E+11	1.49E+11	1.29E+11	N/A
	Excess Load (% reduction)	0	83	7	83	0	0	0	0	0	N/A
North Powder River from Miller Rd to Confluence with Powder River	Measured Load (organisms/day)	1.96E+13	1.97E+12	5.00E+11	4.56E+11	2.84E+11	2.26E+12	1.46E+12	1.90E+11	3.36E+11	N/A
	Load Capacity (organsims/day)	4.00E+12	6.66E+11	1.69E+11	7.65E+10	4.77E+10	2.36E+12	5.66E+11	1.49E+11	1.39E+11	N/A
	Excess Load (% reduction)	80	66	66	83	83	0	61	22	59	N/A
Eagle Creek from New Bridge to Brownlee Reservoir	Measured Load (organisms/day)	3.22E+12	1.24E+12	N/A	4.08E+11	2.97E+10	1.35E+12	8.13E+11	4.13E+11	1.03E+11	N/A
	Load Capacity (organsims/day)	1.40E+13	5.71E+12	N/A	2.41E+11	5.02E+10	1.54E+13	3.65E+12	1.13E+12	8.47E+11	N/A
	Excess Load (% reduction)	0	0	N/A	41	0	0	0	0	0	N/A
Powder River from Baker City to confluence with Snake River	Measured Load (organisms/day)	1.59E+13	1.58E+12	1.04E+12	1.02E+12	N/A	1.59E+13	3.41E+12	2.44E+10	9.78E+10	N/A
	Load Capacity (organsims/day)	2.10E+13	3.46E+12	7.32E+11	3.96E+11	N/A	7.89E+12	4.98E+12	4.92E+11	4.65E+11	N/A
	Excess Load (% reduction)	0	0	30	61	N/A	50	0	0	0	N/A
Burnt River upstream of Unity Reservoir Dam	Measured Load (organisms/day)	3.83E+11	1.97E+11	1.20E+10	0.00E+00	N/A	8.75E+10	3.18E+09	3.33E+09	7.25E+09	N/A
	Load Capacity (organsims/day)	2.63E+12	1.54E+12	7.75E+11	N/A	N/A	5.92E+12	6.46E+11	1.69E+11	1.29E+11	N/A
	Excess Load (% reduction)	0	0	0	N/A	N/A	0	0	0	0	N/A
Burnt River from Unity Reservoir to Clarks Creek Rd	Measured Load (organisms/day)	6.11E+12	4.61E+12	2.38E+12	N/A	N/A	2.41E+12	2.62E+11	4.02E+11	1.93E+11	N/A
	Load Capacity (organsims/day)	4.80E+12	7.74E+11	4.91E+11	N/A	N/A	8.51E+12	4.97E+11	3.97E+11	3.00E+11	N/A
	Excess Load (% reduction)	21	83	79	N/A	N/A	0	0	1	0	N/A
Burnt River from Clarks Creek Rd to confluence with Snake River	Measured Load (organisms/day)	9.79E+12	3.45E+11	6.16E+11	3.35E+11	5.88E+10	3.90E+12	2.70E+11	2.59E+10	1.10E+09	N/A
	Load Capacity (organsims/day)	6.86E+12	1.02E+12	6.47E+11	3.94E+11	2.68E+11	1.33E+13	1.32E+12	5.26E+11	4.47E+11	N/A
	Excess Load (% reduction)	30	0	0	0	0	0	0	0	0	N/A

Table 52: Compiled percent reduction needed for reaches in the Powder Basin

Stream reach	Percent reduction	Criterion based upon	Season based upon	Flow category based upon
Brownlee Subbasin				
Brownlee Subbasin streams confluence with Snake River	0	Geometric Mean & Single Sample	May-October & November-April	All
Powder Subbasin				
34250-ORDEQ: Powder River above Phillips Reservoir	0	Geometric Mean & Single Sample	May-October & November-April	All
Powder River from Phillips Reservoir to Baker City	83	Single Sample	November-April	Medium
North Powder River from USFS Boundary to Miller Rd	83	Single Sample	May-October	Medium-High & Medium-Low
North Powder River from Miller Road to Confluence with Powder River	95	Geometric Mean	May-October	Low
Eagle Creek from New Bridge to Brownlee Reservoir	64	Geometric Mean	May-October	Low
Powder River from Baker City to confluence with Snake River	75	Geometric Mean	May-October	Medium-Low
Burnt Subbasin				
Burnt River upstream of Unity Reservoir Dam	0	Geometric Mean & Single Sample	May-October & November-April	All
Burnt River from Unity Reservoir to Clarks Creek Rd	83	Single Sample	May-October	Medium High
Burnt River from Clarks Creek Rd to confluence with Snake River	40	Geometric Mean	May-October	High

5. Source assessment and load Contributions

Fecal indicator bacteria, such as *E. coli*, and associated pathogens originate from human and other warm-blooded animal feces. The pathways by which *E. coli* and associated fecal pathogens enter waterbodies depends on the specific sources, transport mechanisms, and landscape management practices.

5.1 Summary of DEQ *E. coli* monitoring data

This section presents *E. coli* sample data collected by DEQ in the River between 2000 and 2024, including data collected approximately every two months as part of the statewide DEQ ambient monitoring program and data from the DEQ TMDL project from 2007-2013 (DEQ 2013; DEQ 2016). Samples are grouped according to May-October and November-April seasonal periods.

E. coli data for the Brownlee, Powder, and Brownlee subbasins are summarized in Table 53 and sample locations are shown on Figures 26, 28, 29, and 31.

Table 53: Brownlee, Powder River, and Burnt Subbasins *E. coli* data and percent of samples exceeding the single sample criterion (406 organisms/day) from 2007-2013 (DEQ TMDL Project; DEQ 2013)

DEQ Monitoring Station	Sample years	May-October			November-April		
		n	Geometric mean (organisms/day)	%> 406 organisms/ 100 mL	*n*	Geometric mean (organisms/day)	%> 406 organisms/ 100 mL
Brownlee Subbasin							
36382-ORDEQ: Pine Creek (Powder Basin) @ State Hwy. 71 near Oxbow, OR	2011-13	30	33	0	21	9	0
Powder Subbasin							
34249-ORDEQ: Cracker Creek above Wind Creek confluence at bridge crossing	2007	19	4	0	5	1	0
34250-ORDEQ: Powder River at Dredge Loop Road above Phillips Reservoir Dam	2007-08	25	14	0	8	6	0
26601-ORDEQ: Powder River at RM 131.1 (Snake), 0.25 miles d/s of Mason Dam, at WRD gauging station	2007-08	28	1	0	22	1	0
10725-ORDEQ: Powder River 3 miles south of Baker	2007-08	22	138	14	5	135	20
11490-ORDEQ: Powder River at Hwy 7 (in Baker City)	2007-13	38	72	10	21	51	10
34252-ORDEQ: Powder River upstream of North Powder confluence	2007-08	21	224	38	24	54	8
12624-ORDEQ: Powder River at Deane Bidwell Road	2011-12	1	NA	0	10	39	0
36191-ORDEQ: North Powder River at Hwy. 30 Bridge	2010-13	45	372	47	30	61	27
36192-ORDEQ: North Powder River at Miller Rd. Bridge	2010-13	45	84	16	32	20	12
10724-ORDEQ: Powder River at Hwy 86 (east of Baker City)	2007-13	18	107	11	13	61	8
36193-ORDEQ: Eagle Creek at Snake River Road	2010-13	45	34	11	30	17	0
11857-ORDEQ: Powder River at Snake River Road (Richland)	2010-13	45	148	18	30	36	0
36194-ORDEQ: - Powder River Arm of Brownlee Reservoir @ Hewitt Pk. Boat Ramp	2010	25	19	4	8	110	0

DEQ Monitoring Station	Sample years	May-October			November-April		
		n	Geometric mean (organisms/day)	%> 406 organisms/ 100 mL	*n*	Geometric mean (organisms/day)	%> 406 organisms/ 100 mL
Burnt Subbasin							
36198-ORDEQ: West Fork Burnt River at Rice Road Bridge	2010-13	43	24	2	19	33	0
36197-ORDEQ: Middle Fork Burnt River at Rice Road Bridge	2010-13	43	97	14	32	17	0
36196-ORDEQ: So. Fork Burnt River at Rouse Lane Bridge	2010-13	43	410	56	31	40	16
36195-ORDEQ: Burnt River at Unity Reservoir Dam	2010-13	43	6	0	35	9	0
34256-ORDEQ: Burnt River at Clarks Creek bridge	2010-13	43	193	26	32	29	3
36384-ORDEQ: Dixie Creek (Burnt Basin) near mouth at Hwy. 30.	2011-12	3	150	33	4	14	0
36385-ORDEQ: Burnt River @ Hwy. 30 upstream of Huntington, OR	2011-12	4	63	0	4	22	0
11494-ORDEQ: Burnt River at Snake River Road (Huntington)	2011-12	18	85	17	15	20	0

5.1.1 Upper Powder River to Baker City

E. coli monitoring locations in the Powder River Subbasin from its headwaters to Baker City are shown in Figure 26. Land cover/land use in this area consists of forest interspersed with pastures used for livestock grazing. *E. coli* concentrations above Phillips Reservoir (34249-ORDEQ and 34250-ORDEQ) had no exceedances of geometric mean or single sample criteria during the DEQ TMDL project from 2007-13. Irrigated pastures and hay fields are present downstream of Phillips Reservoir. The DEQ monitoring station on the Powder River 14 miles downstream of Phillips Reservoir (10725-ORDEQ) had exceedances of both geometric mean and single sample criteria year round during the DEQ TMDL project from 2007-13 (Table 53).

Exceedances of criteria were less frequent at the monitoring station 11490-ORDEQ (Powder River at Hwy 7 (in Baker City); Table 53). Using a Seasonal Mann-Kendall Test (Meals et al., 2011) to examine interannual trends in DEQ ambient monitoring data, *E. coli* concentrations significantly increased (p = 0.028; slope = 1.31) between 2000 and 2024 after accounting for seasonal differences (November-April vs. May-October) (Figure 27). Two exceedances of the *E. coli* single sample criterion have been observed between 2020 and 2024.

Based on data collected in the DEQ TMDL project from 2007-13, the highest percent reduction needed to meet criteria at monitoring station 11490-ORDEQ occurred during November-April (Table 53). This station is located downstream of several public parks and residential areas in Baker City and upstream of the discharge point for the Baker City Wastewater Treatment Plant. In addition to nonpoint source inputs from rural areas upstream of the city boundary, inputs from sources such as pet waste, waterfowl, and other urban wildlife, and failing septic systems may be contributing to excess *E. coli* loading in this reach.

Figure 26**: DEQ *E. coli* monitoring location in the upper portion of the Powder Subbasin**

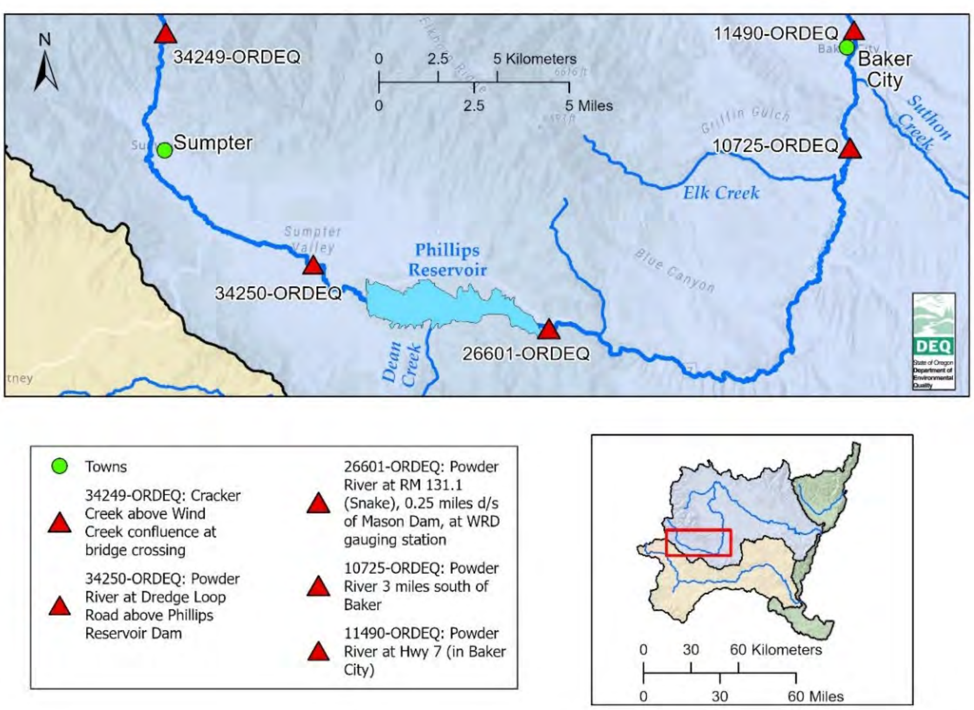
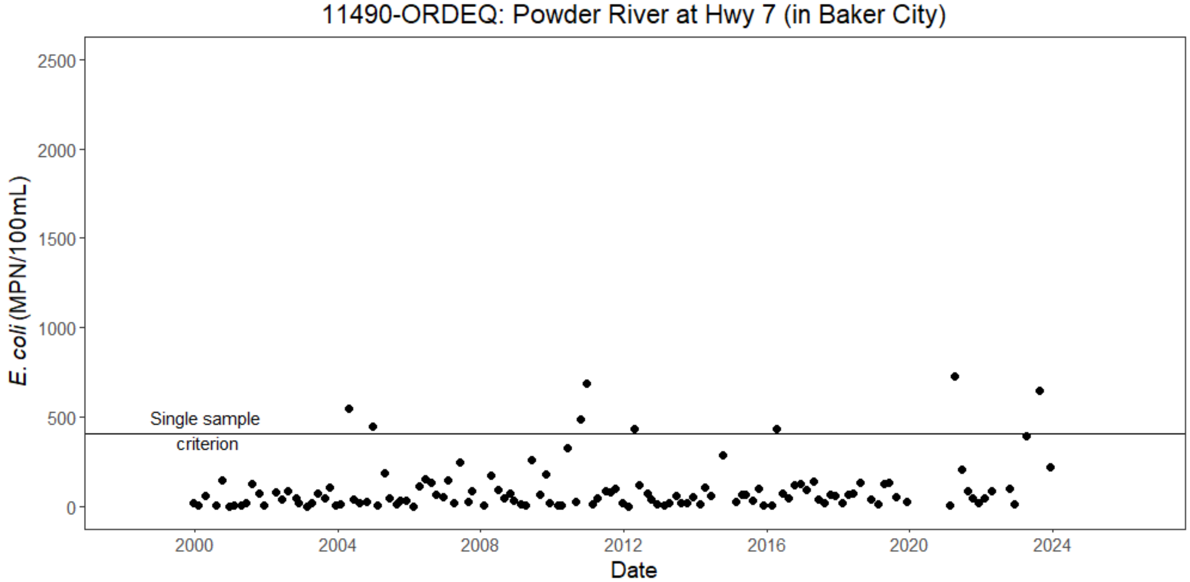


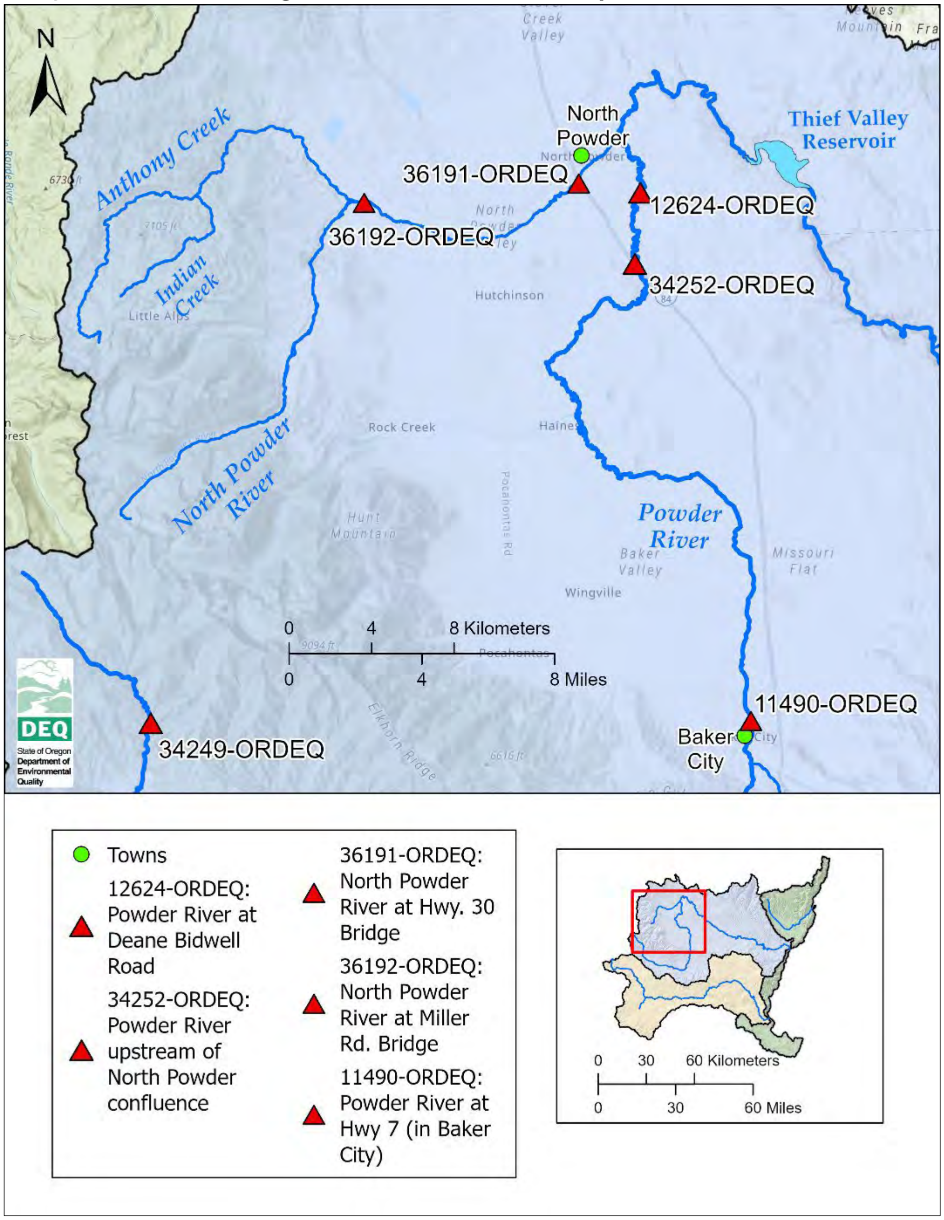
Figure 27: *E. coli* data for Powder River at Highway 7 (11490-ORDEQ; AU ID: OR_SR_1705020303_05_102816) from the DEQ Ambient Monitoring Program, 2000-2024



5.1.2 Powder River from Baker City to Thief Valley Reservoir and North Powder River

Data collected in the TMDL project from 2007-13 and as part of the DEQ ambient monitoring network suggest that *E. coli* concentrations increase in the Powder River downstream of Baker City as it flows through the Baker Valley (Table 53 and Figure 28). *E. coli* concentrations at the Powder River at I-84 (34252-ORDEQ) and the North Powder River at the Hwy 30 (36191-ORDEQ) exceeded both the geometric mean and single sample criteria during May-October and the single sample criterion in November-April based data collected from the TMDL project during 2007-13. *E. coli* load reductions to this reach of the Powder River and lower North Powder River should be a high priority for restoration activities.

Figure 28: DEQ *E. coli* monitoring locations in the middle portion of the Powder River Subbasin



5.1.3 Lower Powder River Subbasin and the Brownlee Subbasin

The Powder River below Thief Valley Reservoir flows through an area with high topographic relief interspersed with agricultural areas in valley bottoms (Figure 29). The most prominent of these is the Keating Valley midway between Thief Valley Reservoir and the city of Richland. Irrigated hay fields and seasonal usage of cattle characterize these agricultural areas. DEQ ambient monitoring data at 10724-ORDEQ (Powder River at Hwy 86 (east of Baker City)) suggests consistent, and possibly increasing (p = 0.0793; slope = 2.82), *E. coli* concentrations in this area from 2000-2024 based on a seasonal Mann-Kendall test (Figure 30).

Near Richland and the confluence with Eagle Creek, the Powder River flows through a broad valley with extensive irrigated pastures and hay fields before joining the Brownlee Reservoir on the Snake River (Figure 29). Exceedances of single sample criteria occurred during May-

October at 11857-ORDEQ (Powder River at Snake River Rd (Richland)) during the DEQ TMDL project of 2010-13 (Table 53). There were no exceedances of criteria in November-April during this period. Monitoring data at 36193-ORDEQ (Eagle Creek at Snake River Road) from the DEQ TMDL project indicate that *E. coli* loading contributed to periodic single sample criterion exceedances during May-October from 2010-13 (Table 53).

Pine Creek drains a portion of the Brownlee Subbasin that enters directly into Hells Canyon Reservoir on the Snake River below Oxbow Dam (Figure 29). The upper portion of the catchment near Halfway contains irrigated pastures and hay fields. The lower portion flows through an area of high topographic relief with minimal development. Monitoring data for 36382-ORDEQ (Pine Creek (Powder Basin) @ State Hwy. 71 near Oxbow, OR) from 2011-2013 do not indicate exceedances of geometric mean or single sample criteria throughout the year (Table 53).

Figure 29: DEQ *E. coli* monitoring locations in the lower portion of the Powder River Subbasin and the northern portion of the Brownlee Subbasin

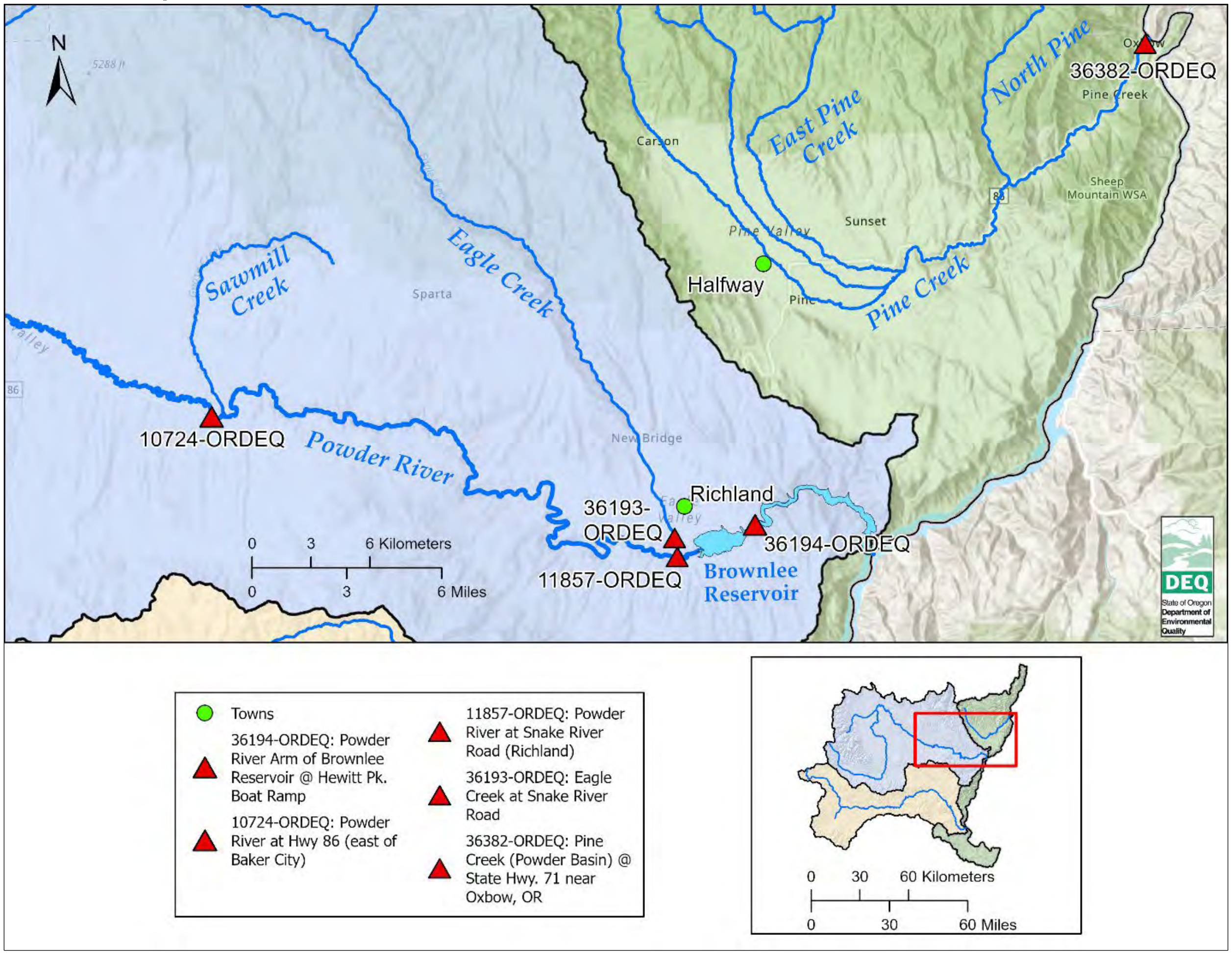
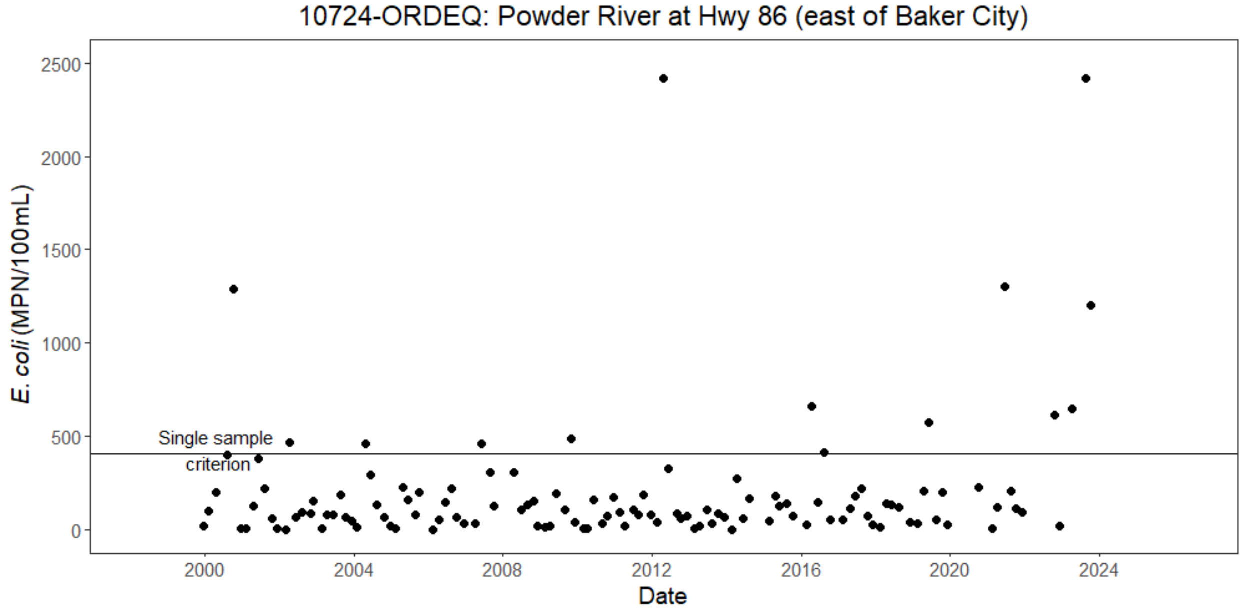


Figure 30: *E. coli* for the Powder River at Hwy 86 (10724-ORDEQ; AU ID: OR_SR_1705020308_05_102826) from the DEQ Ambient Monitoring Program from 2000 to 2024

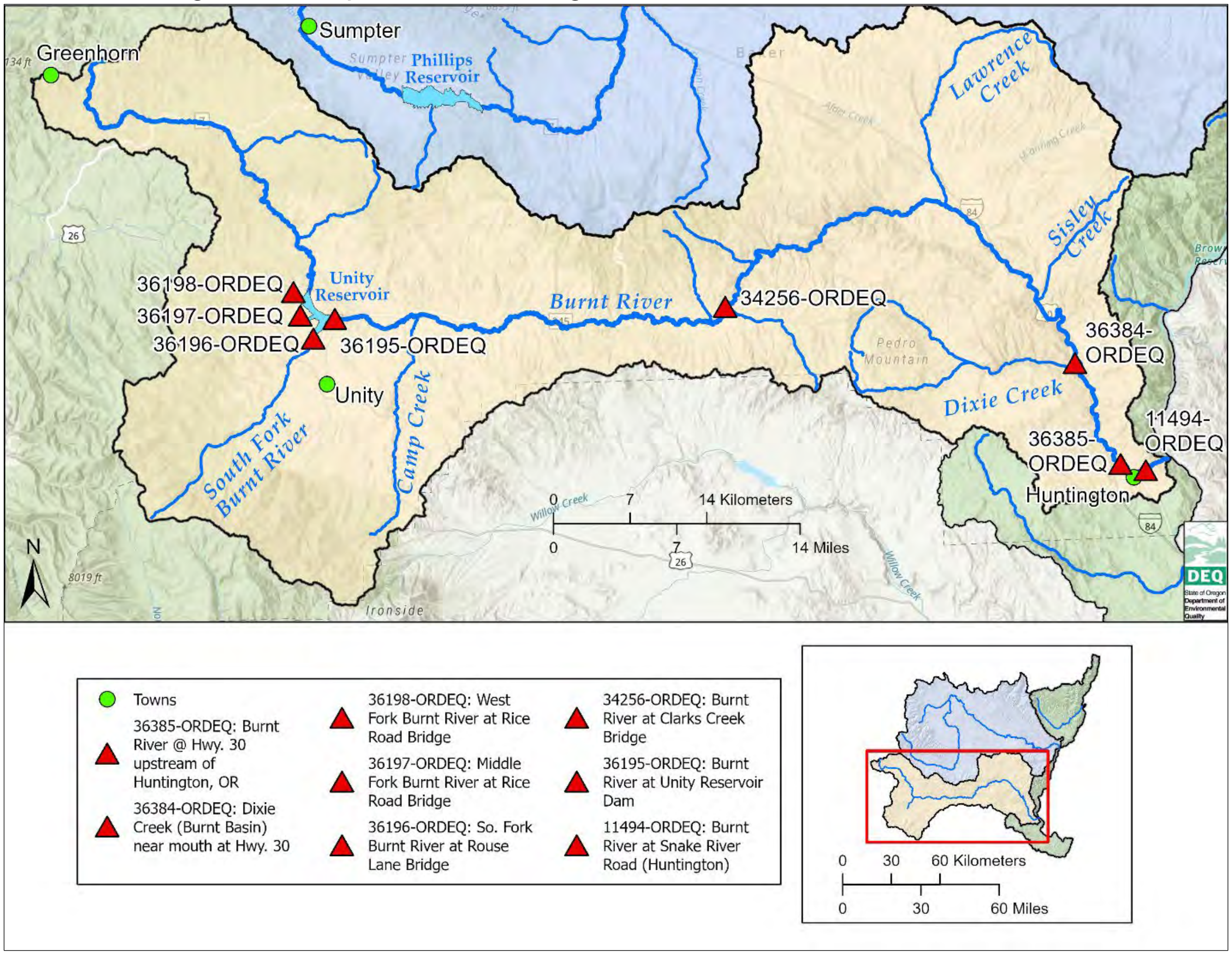


5.1.4 Upper Burnt Subbasin above Unity Reservoir

The upper Burnt Subbasin above Unity Reservoir contains a mixture of managed and unmanaged land uses/land covers. The upper portions of the forks are mostly forested. The North and West Forks of Burnt River contains pasturelands along a portion of the rivers just upstream of Unity Reservoir. The Middle and South Forks contain irrigated pastures and hayfields near the reservoir.

E. coli data were collected in the West, Middle, and South Forks of the Burnt River from 2010-13 as part of the DEQ TMDL project (Table 54). The North Fork was not sampled due to lack of public access in the vicinity of the reservoir (Figure 31). Based on available data, the South Fork had frequent exceedances of both the geometric mean and single sample criteria during May-October and several single sample criterion exceedances in November-April from 2010-2013 (Table 54). The Middle and West Forks had several exceedances of the single sample criterion during May-October during 2010-13 (Table 54). Percent reductions were not calculated for monitoring stations on the Middle, West and South Forks of the Burnt River because measure flow data were not available. The nearest location with flow data occurs below Unity Dam. Despite the lack of flow data, concentration data suggest that the South Fork Burnt River should be the highest priority for *E. coli* load reductions in the tributaries upstream of Unity Reservoir.

Figure 31: DEQ *E. coli* monitoring locations in the Burnt River Subbasin



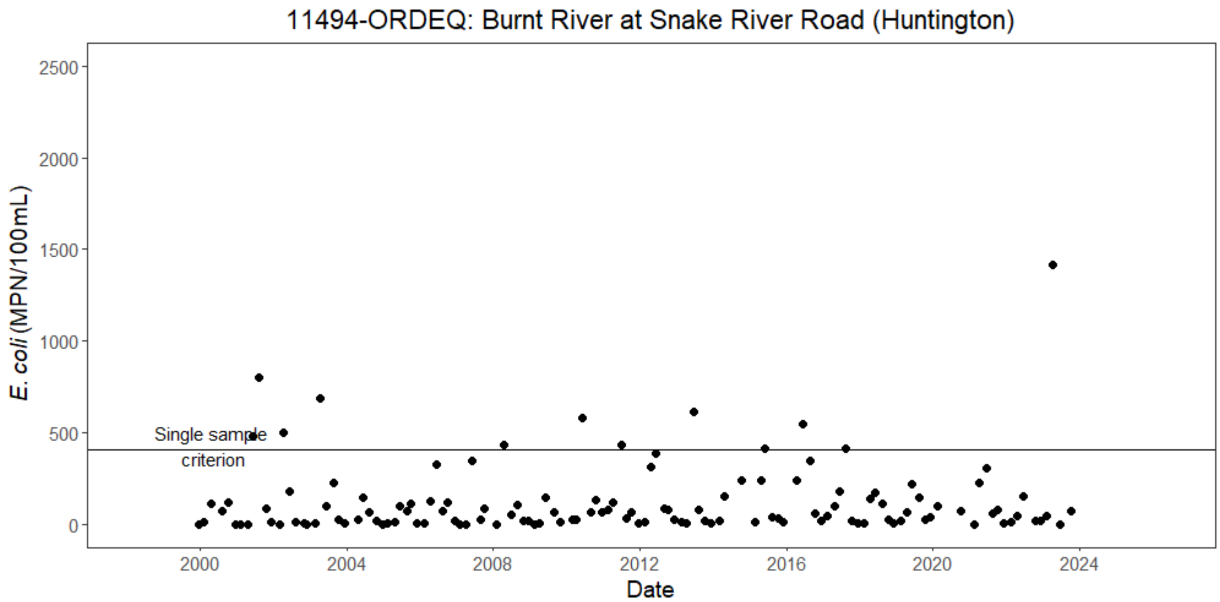
5.1.5 Burnt River from Unity Reservoir to Huntington

The Burnt River below Unity Reservoir flows through a 30-mile-long valley with irrigated pastures and cultivated hay and through the communities of Hereford and Bridgeport. Below the DEQ monitoring station 34256-ORDEQ (Burnt River at Clark Creek bridge), the Burnt River enters a steep, 15-mile-long canyon. Most of the area is managed by the Bureau of Land Management. Below the canyon, the Burnt River flows through fields and scattered cottonwood gallery forests in the Durkee Valley followed by another canyon reach before flowing into Brownlee Reservoir on the Snake River below the City of Huntington (Figure 31). Dixie Creek enters the Burnt River upstream of Huntington. The Huntington wastewater treatment plant (DEQ# 40981, EPA# OR0020052) discharges into the Burnt River below Huntington and is reflected in samples collected at 11494-ORDEQ.

Monitoring for 36195-ORDEQ (Burnt River at Unity Reservoir Dam) from 2010-2013 suggest no criteria exceedances of *E. coli* concentrations entering the river from the outlet of the dam (Table 54). *E. coli* monitoring for 34256-ORDEQ (Burnt River at Clarks Creek bridge) from 2010-2013 suggest exceedances of geometric mean and single sample criteria during May-October and of the single sample criterion during November-April (Table 54).

Monitoring data from 36384-ORDEQ (Dixie Creek (Burnt Basin) near mouth at Hwy. 30) indicate exceedances of geometric mean and single sample criteria during May-October of 2011-12. There were no exceedances of criteria during November-April. At 36385-ORDEQ (Burnt River @ Hwy. 30 upstream of Huntington, OR), no exceedances of *E. coli* were observed during all seasons from 2010-2013. Exceedances of the single sample criterion were observed during irrigation season downstream of 11494-ORDEQ (Burnt River at Snake River Road (Huntington)) over the same time period (Table 54). Significantly increasing ($p = 0.0236$; slope 1.23) *E. coli* concentrations were also observed at this station from 2000-2024 (Figure 32). Although this site is located downstream of the wastewater treatment plant outfall, calculations based on permitted limits suggest that nonpoint sources still contribute most of the *E. coli* present in water samples (Tables 46-49).

Figure 32: *E. coli* data for the Burnt River at Snake River Road (11494-ORDEQ; AU ID: OR_SR_1705020208_05_102810) from the DEQ Ambient Monitoring Program from 2000 to 2024



5.2 *E. coli* sources

In this section, DEQ describes potential sources and transport mechanisms of *E. coli* to surface waters. Based on the analysis of monitoring data presented in Section 5.1 and information presented below, DEQ concludes that nonpoint sources contribute the largest share of excess loads causing violations of Oregon's water quality standards for *E. coli* in the Power River Basin. Two of the monitoring locations receive potential influences from wastewater treatment plant discharges. Based on permit effluent limits for these facilities, the potential contributions to instream loads are less than contributions from nonpoint sources (Section 4.5.2).

DEQ did not have access to Bacteria Source Tracking (BST) or DNA data for identifying the presence or absence of specific sources or estimating the relative proportion of sources to specific areas of the basin. DEQ instead relied on publicly available information land use/land cover, agricultural statistics, population statistics, permit limits and conditions, and available information on wildlife in the basin to identify source categories. The lack of BST information does not affect the calculation of percent reductions in loads needed to meet criteria or the allocation of sources between point and nonpoint source categories (section 6). Collection of BST information could be useful for TMDL implementation and adaptive management in the basin (USEPA, 2011).

5.2.1 Agricultural practices

Stream reaches downstream of areas with agricultural practices, including areas used for livestock production, tended to have exceedances of *E. coli* criteria in the Powder River Basin. Surface runoff from these areas may contribute *E. coli* loads to surface waters through agricultural stormwater discharge (USEPA, 2023b), irrigation return water, and stormwater originating from mixed land uses/land covers.

Agricultural statistics from data from Baker County (representing the majority of the Powder and Burnt subbasins) shows that cattle/calves make up the majority of livestock present on an annual basis. Based on the 2017 USDA Census of Agriculture for Baker County, 71,187 cattle/calves were recorded in 2012 and 75,187 were recorded in in 2017. It is important to note that the census records inventories as of December 31st of the census year (USDA-NASS 2019). Thus, the actual number of livestock of a particular type present in the basin at any one time throughout the year may be less than that recorded on the census due to birthing, sales, or other factors.

Cattle/calves may occupy pastures, free range areas, confined animal feeding operations (CAFOs),or leave the basin entirely during the year. CAFOs require a permit for waste management and are discussed in the next section.

5.2.1.2 Confined Animal Feeding Operations (CAFOs)

CAFOs are defined as the concentrated confined feeding or holding of animals in buildings, pens, or lots where the surface is prepared to support animals in wet weather or where there are wastewater treatment facilities for livestock (e.g., manure lagoons). CAFO wastes include but are not limited to manure, silage pit drainage, wash down waters, contaminated runoff, milk wastewater, and bulk tank wastewater.

The CAFO permit program began in the early 1980s to prevent CAFO wastes from contaminating groundwater and surface water. There are 12 CAFOs operating in the Powder River Basin, (Table 54), which are permitted under general permits in either Oregon’s federally delegated NPDES or state Water Pollution Control Facility (WPCF) programs. CAFO permits are administered by the Oregon Department of Agriculture (ODA), guided by a Memorandum of Understanding with DEQ. Neither the NPDES or WPCF CAFO permits allow point source discharge of wastewater or wastes from regulated activities to surface water or groundwater, except during a 25-year, 24-hour rainfall event. Therefore, no numeric point source WLAs are appropriate. However, a permittee’s failure to fully comply with all permit conditions could allow contribution of excess *E. coli* to the nonpoint source general loads, thus a narrative requirement for appropriate management measures to be applied is required, which also supports implementation of nonpoint source LAs throughout the basin.

Table 54: Permits for Confined Animal Feeding Operations (CAFOs) in the Powder River Basin (as of April 2024)

ODA permit number	Permit type	City	Designation
62653	NPDES	BAKER CITY	Medium Concentrated
173037	NPDES	BAKER CITY	Medium Concentrated
180694	NPDES	BAKER CITY	Medium Concentrated
180848	NPDES	BAKER CITY	Medium Concentrated
180868	NPDES	HAINES	Medium Concentrated
181161	NPDES	RICHLAND	Medium Concentrated
181194	NPDES	BAKER CITY	Large Tier 1 Concentrated
181215	WPCF	BAKER CITY	Medium Confined
182744	NPDES	BAKER CITY	Medium Concentrated
186190	NPDES	BAKER CITY	Medium Concentrated
186660	NPDES	BAKER CITY	Medium Concentrated
1000275	NPDES	BAKER CITY	Large Tier 2 Concentrated

CAFO permittees are prohibited from discharging manure, litter, or process wastewater to surface waters and ground waters of the state, except as allowed under conditions of an extreme rainfall event, defined in the permit as greater than the 25-year, 24-hour rainfall. The CAFO extreme weather event is similar to, but applied differently than, an “upset” and “overflow” event identified for NPDES permitted WWTPs.

Each permitted CAFO receives a routine inspection from their ODA area Livestock Water Quality Inspector once a year, on average. During this inspection, the operator and inspector discuss the operation, and the inspector reviews the entire operation and recordkeeping to ensure compliance with permit terms and water quality rules and laws. Inspection reports detail permit compliance in the following areas: permitted number of animals, animal confinement requirements, manure and silage containment requirements, manure application requirements, Animal Waste Management Plan, and record keeping. Problems in any of these areas can result in the issuance of a water quality advisory or a notice of noncompliance. In the event a violation is found, the ODA requires the operator to develop a solution to the problem and a schedule to complete the corrective actions. Surface water quality samples are taken when visual or anecdotal evidence of discharge is present.

CAFO permits also regulate land applications of animal and other waste and require that these discharges do not exceed a designated *E. coli* effluent limit. Types of discharge that are prohibited include, but are not limited to:

- contaminated runoff from confinement or waste accumulation areas,
- overflow or discharges from waste storage facilities,
- discharges due to improper land application activities from seepage below the root zone,
- surface drainages or field tile outlets,
- dry-weather discharges,
- discharges due to equipment failure,
- leakage or seepage from facilities in the production area in excess of approved designs, and
- discharges to underground injection control systems.

All land application of manure and process wastewater must be done in accordance with an ODA approved Animal Waste Management Plan.

Having adequate manure storage can be difficult, particularly during periods of heavy precipitation or snowmelt. This difficulty is further exacerbated by the location of some CAFO facilities near limited acceptable land application areas. CAFO facilities may not have the capability to store manure through extended wet weather periods and the lack of capacity can result in the land application of manure when conditions are not agronomically favorable (saturated soils and/or potential for surface runoff). The permit does allow application when it is a desired alternative to allowing waste storage or wastewater control facilities to overflow (e.g., land application to saturated soils to pond wastewater onsite provides for greater protection of surface waters than a direct overflow of a waste storage tank to surface waters). The land application in these circumstances will be considered an upset condition according to their permti. The general permit stipulates that, during such a discharge, effluent cannot cause or contribute to a violation of state water quality criteria.

5.2.2 Residential septic systems

The population of Baker County, which represents most of the population within the Powder River Basin, as of 2020 was 16,668 (US Census Bureau 2021).

The Powder and Burnt subbasins along with the Brownlee Reservoir Subbasin in Baker County and Union County are predominately rural. Even though urban areas make up a small percentage of the land use area in the subbasins, approximately 68% of the county's population lived within these areas (US Census Bureau 2021). These urban centers are served by permited wastewater treatment systems and with state-issued wastewater permits to limit *E. coli* bacteria discharge to surface waters to protect public health and beneficial uses of water.

A septic system is the predominate method of sewage treatment for homes and businesses that are not connected to a centralized wastewater treatment system. Rural residences and businesses that utilize onsite or subsurface wastewater management (septic systems) are not evenly distributed throughout the subbasin.

Septic systems consist of a tank and a subsurface distribution system, or drainfield. Wastewater flows into the tank where solid material settles to the bottom and the remaining effluent flows out of the tank into a drainfield where it leaches into the ground. The initial treatment occurs in a septic tank, where most of the settleable and floatable materials are removed and partial digestion of organic matter occurs under anaerobic conditions. Microbes in the soil and other biological processes further breakdown the remaining contaminants to yield treated effluent that is often delivered to groundwater, and in some cases, surface waters (USEPA, 2002). For properly functioning on-site systems, bacteria dies off during the treatment process and discharge impacts to groundwater are negligible. However, there are factors described below that affect whether a system is functioning properly.

Oregon Administrative Rule 340-071-0100 governs the rules and permit conditions for onsite wastewater treatment systems. OAR 340-071-0100(65) defines a "Failing System" as any system that discharges untreated or incompletely treated sewage or septic tank effluent directly or indirectly onto the ground surface or into public waters or that creates a public health hazard. Many of Oregon's older onsite systems may fall under this definition. These systems have a higher potential to adversely impacting water quality relative to systems installed after the establishment of OAR 340-071-0100.

The regulatory programs in place at DEQ and county agents are intended ensure onsite systems are properly sited, installed and maintained in order to prevent causing or contributing to water quality violations, and onsite systems are designed to produce no bacteria loads to surface waters. However, failing and/or poorly situated onsite sewage systems can produce significant bacterial loads.

A resource to address these potential sources are the DEQ Onsite Wastewater Management Program is partner in the Oregon Septic Smart Initiative (https://www.oregon.gov/deq/Residential/Pages/Septic-Smart.aspx) that provides access to information about their septic systems including a voluntary approach to existing system evaluation during property transactions or when failing systems are identified. Ongoing education and outreach as well as regulatory programs are in place to help ensure onsite disposal systems do not cause or contribute to water quality violations.

5.2.3 Permitted wastewater and stormwater discharges

Table 55 lists all National Pollutant Discharge Elimination System permits for discharge of wastewater and stormwater within the Powder River Basin.

5.2.3.1 Wastewater discharges

As shown in Table 55, there are three active industrial wastewater discharge permits within the Powder River Basin. DEQ determined that the processes involved in these sugar and power facilities do not have a reasonable potential for *E. coli* in discharges.

Table 55 also lists four permitted municipal wastewater facilities that regulated *E. coli* discharges. As detailed in the table and its notes, the active sewage treatment plants discharging in the Powder River Basin are at Baker City (≤2 MGD to the Powder River; Figure 28), North Powder (≤1 MGD to the North Powder River; Figure 28) and Huntington (≤1 MGD to the Burnt River; Figure 31). *E. coli* concentrations in effluents from these facilities are not permitted to be above the criteria in OAR 340-041-0009(6)(b)(A) and (B). Based on available data on wastewater treatment infrastructure, DEQ concluded that point source discharge of treated sewage wastewater contributes less *E. coli* to surface waters than nonpoint sources in the basin.

Table 55: Powder River Basin wastewater and stormwater discharge permits

Discharge type	DEQ file number	EPA number	Permittee	Facility type	NPDES Permit type	Receiving water	River Mile
Municipal wastewater	5324	OR0020699	City of Baker City*	sewage treatment	DOM-C1b	Powder River	116.3
	36156	OR0023329	City of Halfway**	sewage treatment	DOM-Db	Pine Creek	19.5
	40981	OR0020052	City of Huntington	sewage treatment	DOM-Db	Burnt River	2
	61600	OR0022403	City of North Powder	sewage treatment	DOM-Db	Powder River	82.4
Industrial wastewater	2142	OR0002526	Amalgamated Sugar Co, Inc	food preparation	IW-B04	Snake River	252
	41297	OR0027278	Idaho Power Co - Hells Canyon Plant	electric power	IW-O	Snake River	247
	41299	OR0027286	Idaho Power Co - Oxbow Plant	electric power	IW-O	Snake River	273
Stormwater	125054	ORR303528	Rare Earth Resources, LLC - Bonnanza Mine	gold ore	GEN12Z	Pine Creek	26.43
	126933	ORR303529	Bayhorse Silver (USA) Inc.	silver ore	GEN12Z	Snake River	317
	102507	ORR211070	Ash Grove Cement Co	limestone	GEN12Z	Burnt River	27
	108030	ORR211613	Ash Grove Cement Co - Lime Plant	concrete products	GEN12Z	Burnt River	8.5
	101822	ORS110870	Oregon Department of Transportation	highway	MS4 - Phase I	various	NA

Notes:
* Baker City ceased discharge to the Powder River in summer 2022. Water Pollution Control Facility (no discharge) permit application in process. However, discharge resumed in summer of 2023 under the NPDES permit.
**Halfway ceased discharge to Pine Creek in 2018. NPDES permit terminated and WPCF permit issued in 2019.
NA = Not applicable because outfalls are located along the road system throughout the basin

5.2.3.2 Stormwater discharges

Stormwater running off from lands contaminated by fecal material potentially contributes nonpoint sources of *E. coli* to waterways in the basin. Stormwater originates from a variety of land uses within the basin and may be conveyed to waters as overland flows, along roadways, or other conveyances and can be addressed using nonpoint source management strategies.

DEQ determined that the handful of ore operations in the basin registered under the NPDES 1200Z Industrial Stormwater general permit do not have reasonable potential to contribute *E. coli* in discharges. The only permitted point source of *E. coli* in stormwater discharge in the basin is through the Oregon Department of Transportation management of stormwater from highways statewide under a Phase I Municipal Separate Storm Sewer System (or MS4) permit. Although ODOT's MS4 permit does not specify an effluent limit for *E. coli*, *E. coli* may be present at times in highway stormwater conveyances within the Powder River Basin. Therefore, DEQ opted to assign a WLA of at least 1% of the loading capacity for ODOT's MS4 permit.

EPA's draft TMDLs to Stormwater Permits Handbook (USEPA, 2016) offers several methods for calculating WLAs for NPDES stormwater permits, including MS4 permits. DEQ chose the ratio of jurisdictional boundary method, which calculates the ratio of ODOT jurisdictional area to the total watershed area to determine a percentage of the *E. coli* loading capacity to be given as the WLA for ODOT's MS4 permit discharges within the watershed.

DEQ calculated right-of-way area using road centerlines from 2019 Oregon Transportation Network spatial data (Oregon Explorer 2022). Roads designated as owned by ODOT were clipped to the HUC6 boundary of the Powder Basin. A 30-ft planar buffer around the ODOT roads was used to calculate the area of the right-of-way using the Buffer tool in ArcGIS Pro 3.0. This resulted in a MS4 jurisdictional area of 3,350 acres assigned to ODOT. Based on the Powder Basin area (2,630,554 acres), the proportion of the basin that fell within the jurisdictional boundary of the ODOT MS4 was 0.1%.

There is uncertainty in the estimation of jurisdictional area and resultant potential *E. coli* loads due to the following factors:

- Roads tend to be near the valley bottoms and adjacent to streams.
- The episodic nature of pollutant loads from roads makes it difficult to capture only using jurisdictional boundary area to watershed area ratio.
- The mixture of impervious and pervious contributing areas results in variations in loads from different locations within the estimated jurisdictional boundaries, even for the same events.

5.2.3.3 Water Pollution Control Facility (WPCF) Permits

DEQ administers Water Pollution Control Facility (WPCF) Individual Domestic Permits that do not allow discharge of treated wastewater to surface waters. The WPCF permit is a state requirement for the discharge of wastewater to the ground; discharge to surface water is not allowed. WPCF permits are issued for land irrigation of wastewater, wastewater lagoons, onsite sewage disposal systems, and underground injection control systems (i.e., dry wells, sumps, etc.). The primary purpose of a WPCF permit is to prevent discharges to surface waters and to protect groundwater from contamination. This permit is also used to prevent nuisance conditions such as odors and mosquitoes.

Permit applications and operational requirements are based on the type of proposed facility, type of wastewater involved (industrial, domestic sewage or both) and design capacity, along with a number of siting requirements. The applicable rules are found in OAR Chapter 340, Division 071.

WPCF Individual Domestic Permits apply to larger wastewater volumes than single residential onsite (septic) systems and may employ advanced onsite wastewater treatment systems.

DEQ identified the WPCF permits for Baker County in Table 56 in the source assessment for this TMDL because a WPCF system could contribute pollutants to surface water if it fails or is not properly maintained. DEQ is responsible for all phases of regulatory oversight for WPCF permits and does not delegate this program to County agents.

Table 56: Water Pollution Control Facility (WPCF) permits issued in the Powder River Basin

DEQ File Number/ Facility ID	Legal Name	City	County	Permit Type
114814	BAKER COUNTY PARKS AND RECREATION DEPARTMENT	RICHLAND	BAKER	WPCFOS-Bii
105305	CHRISTANSEN, JOHN	PINE	BAKER	WPCFOS-BiiiSF>
112743	CORNUCOPIA WILDERNESS LODGE, LLC	HALFWAY	BAKER	WPCFOS-Bii
36005	HAINES, CITY OF	HAINES	BAKER	WPCF-DOM-E
36156	HALFWAY, CITY OF	HALFWAY	BAKER	WPCF-DOM-E
111911	IDAHO POWER COMPANY	OXBOW	BAKER	WPCFOS-Bii
111553	OREGON PARKS & RECREATION DEPARTMENT	HUNTINGTON	BAKER	WPCFOS-Bii
109353	Oregon Travel Information Council	BAKER CITY	BAKER	WPCFOS-Bii
75135	RICHLAND, CITY OF	RICHLAND	BAKER	WPCF-DOM-E
5450	SUMPTER VALLEY RAILROAD RESTORATION, INC.	SUMPTER	BAKER	WPCF-DOM-E
103793	SUMPTER, CITY OF	SUMPTER	BAKER	WPCF-DOM-E
91445	UNITY, CITY OF	UNITY	BAKER	WPCF-DOM-E
106196	USDOI; BUREAU OF LAND MANAGEMENT	BAKER CITY	BAKER	WPCF-DOM-E
127643	Oasis on the Snake	HUNTINGTON	MALHEUR	WPCF-IW-B13
103287	Baker City WWTP	BAKER CITY	BAKER	WPCF-DOM-E
103297	City of North Powder	NORTH POWDER	UNION	WPCF-DOM-E

5.2.4 Wildlife

Wildlife may contribute *E. coli* loading to surface waters in the Powder River Basin. In 2019 and 2020, the Powder Basin Watershed Council conducted a *E. coli* and total phosphorus water quality study at two elk feeding areas managed by the Oregon Department of Fish and Wildlife (Powder Basin Watershed Council 2021). The feeding sites are located on the east side of the Elkhorn Mountains along Anthony Creek and the North Powder River. Results showed that *E. coli* were detected in surface waters downstream of the feeding sites, particularly during the summer months after animals had dispersed. This suggests that although elk may not contribute to excess *E. coli* loads during the time of year when feeding sites are active, they may contribute to excess loads during the spring and summer months due to transport of fecal material during runoff and irrigation. However, these areas may also be used by livestock at different time of the year as well (ODFW 2017).

In high densities, waterfowl can contribute to elevated *E. coli* in waterbodies (Meerburg et al. 2011; Weyant 2021). Thus, resident and migratory waterfowl, common throughout the Powder River Basin (Holthuijzen, 2003), may contribute to observed *E. coli* loads. Similarly, other wildlife present in the basin, including mule deer, bighorn sheep, mountain goats, and beavers, may contribute to observed *E. coli* loads. Additional monitoring during TMDL implementation, possibly including the use of Bacteria Source Tracking (BST), is needed to assess wildlife contributions to *E. coli* loads in specific areas of the basin.

6. Allocation approach

As indicated by the assessment of *E. coli* sources, permitted point source contributions are limited in location and contribution. Due to the overlap of wildlife, residential, and agricultural land uses, nonpoint and background sources are not distinguishable. These land use types make up most of the basin area. Thus, the mixed category of nonpoint and background sources comprise the largest contribution to *E. coli* loads in rivers and streams of the Powder River Basin. Permitted point sources make up a smaller fraction of the allocation. The allocation distribution among sources reflects proportional contributions, as well as allowing for uncertainty and any subsequent change to permitted discharges. Proportionality and conservative MOS support reasonable assurance of implementation.

6.1 Wasteload allocation methods

As noted in Table 57, four facilities within the basin are permitted to discharge industrial stormwater and three facilities are permitted to discharge industrial wastewater. DEQ determined that stormwater exposed to the activities at these ore and concrete processing facilities and wastewater associated with sugar and power operations do not have reasonable potential to increase *E. coli* in streams. This is because *E. coli* is unlikely to be associated with these activities and not monitored under the permits. Therefore, no *E. coli* reductions are needed and the WLAs for the NPDES 1200Z Industrial Stormwater general permit and the three industrial wastewater permits are set at current, unquantified loads, with the narrative requirement of implementing the permits.

DEQ developed WLAs for the wastewater treatment plants serving the cities of Baker City, North Powder, and Huntington. Based on the permit limits for these facilities, DEQ used a maximum discharge of 2 MDG at Baker City and 1 MGD at North Powder and Huntington with the maximum *E. coli* concentration allowed by the geometric mean criterion, 126 organisms/100 mL, to ensure the recreation-based criteria were attained. For the Huntington facility, the calculated WLA is 4.77E+09 organisms/day. This amounts to 0.2 to 8.7% of the loading capacity for 11494-ORDEQ: Burnt River at Snake River Road (Huntington) based on the geometric mean criterion across the gradient of high to low flow categories. For the Baker City and North Powder facilities combined 3 MGD, the calculated WLA is 1.43E+10 organisms/day. This amounts to 0.3 to 46.1% of the loading capacity for 11857-ORDEQ: Powder River at Snake River Road (Richland) based on the geometric mean criterion across the gradient of high to low flow categories. Discharges typically operate well within their permit limits and discharge smaller loads than those presented above, especially in consideration of chlorination treatment. When operating properly, they will not cause or contribute to water quality violations. Because the facilities have existing permits, no additional reductions are required.

Although the calculated ratio of jurisdiction area assigned to ODOT to the area of the Powder Basin was 0.1%, DEQ assigned 1% of the loading capacity as the ODOT MS4 (Phase I permit) WLA following recommendations by the EPA's draft TMDLs to Stormwater Permits Handbook (EPA 2008). Implementation of the ODOT MS4 permit conditions and control measures is anticipated to keep *E. coli* loads in highway stormwater discharges within the watershed below the WLA of 1% of the loading capacity. These conditions and measures include:

- Public education and outreach – including information specifically on *E. coli.*
- Public involvement and participation – including facilitation of a public website with *E. coli* information and illicit discharge reporting.
- Illicit discharge detection and elimination – including procedures for addressing potential illicit dumping of wastes.
- Construction site runoff control – requiring use and maintenance of controls for erosion, sediment and waste materials management at all ground disturbing projects, from initial clearing through final stabilization, to reduce all potential pollutants in stormwater.
- Post-construction site runoff control – including inventorying and maintaining all water quality facilities, which reduce loads of *E. coli* and other pollutants.
- Pollution prevention and good housekeeping – including inspection and cleanout of catch basins and litter control, both of which contribute to reducing loads of *E. coli* and other pollutants.

6.2 Nonpoint source and background load allocation methods

DEQ used a two-step process for determining LAs for each reach and identifying reaches where reductions in fecal indicator bacteria loading were needed. First, DEQ calculated the loading capacity, MOS, WLAs, and LAs for each flow category. Basing these calculations on the 90-day geometric mean criterion of 126 organisms/100 mL, ensured that both geometric mean and single sample criteria are met throughout the year. Second, for each flow category and season, DEQ compared observed data based on seasonal period (November-April vs. May-October) against both geometric mean and single sample criteria. This allowed identification of the maximum percent reduction in loads needed to meet the applicable criteria. DEQ calculated percent reductions according to methods described in Section 4.5.1. As an additional layer for MOS, DEQ applied the maximum percent reduction identified to all criteria, flow categories, and seasons. This ensures that both geometric mean and single sample criteria will be met annually under all flow scenarios.

Based on the source assessment presented in Section 5.2, nonpoint and background sources constitute the dominant contribution of *E. coli* to the Powder Basin. DEQ assigned nonpoint/background source LAs to all areas of the basin on an annual basis. Thus, LAs calculated from the percent reduction and MOS calculations for each reach apply to all contributing land areas (Tables 10-52). The reductions apply only to nonpoint sources in the contributing area of the reach. If another designated reach for reductions occurs upstream, only the loads from the contributing area downstream of the upstream station apply. LAs apply year-round.

6.3 Allocations to assessment units

Allocations for individual assessment units (DEQ 2022b) may be calculated using the following equations:

(3) Geometric mean allocation (organisms/day) = 126 organisms/100 mL x Flow x CF x 0.9
(4) Single sample allocation (organisms/day) = 406 organisms/100 mL x Flow x CF x 0.9

Where CF is the appropriate conversion factor for units of volume and time needed to convert units of flow for calculations of allocations in terms of organisms/day and the multiplier of 0.9 reflects the 10% explicit MOS and 0% reserve capacity. The scheme for distributing the calculated allocation among loads and wasteloads is presented in Table 57.

Future *E. coli* water quality impairments detected in assessment units identified in Table 3 will receive allocations consistent with the calculations determined from equations 3 and 4 and the scheme in Table 57.

Table 57: Distribution of *E. coli* allocations among loads and wasteloads for individual assessment units

State highway MS4 Phase I Permit present	NPDES permit for sewage treatment discharge present	Percent of allocation		
		Nonpoint source and background load	ODOT MS4 wasteload	Wastewater treatment wasteload
No	No	100.0	0.0	0.0
Yes	No	98.9	1.1	0.0
No	Yes	Difference between 100.0% and the percent of permitted wasteload that contributes to allocation[1]	0.0	Percent of permitted wasteload that contributes to the alloctation[1]
Yes	Yes	Difference between 98.9% and the percent of permitted wasteload that contributes to allocation[2]	1.1	Percent of permitted wasteload that contributes to the allocation[2]

Notes: Assessment units are described in Methodology for Oregon's 2022 Water Quality Report and List of Water Quality Limited Waters (DEQ 2022b) and include watersheds, rivers and streams, and lakes and reservoirs.
Percents may be used to determine individual load and wasteload allocations from the calculated allocations in Equations 3 and 4
Presence of a state highway MS4 Phase I or sewage treatment discharge NPDES permit includes those intersecting and upstream of the assessment unit.
[1]Percent of permitted wasteload that contributes to allocation must be ≤ 100.0%
[2]Percent of permitted wasteload that contributes to allocation must be ≤ 98.9%

6.4 Reserve capacity

As indicated in OAR 340-042-0040(k), RC is an element of the TMDL which is an allocation for increases in specific pollutant loads from future growth and new or expanded sources. Alternatively, a TMDL may allocate no RC. For this TMDL, DEQ assumed minimal growth and development in the Powder River Basin and reserved zero percent of the load capacity. New sources or increased discharges from existing sources will be allowed however they will be required to meet *E. coli* standards prior to discharge. This ensures these additions of load will not cause violations of water quality standards. Allocation of any available capacity may be considered on a case-by-case basis by DEQ for NPDES permitted point sources, should the need arise in the future.

6.5 Margin of safety

As indicated in OAR 340-042-0040(4)(i), MOS can be calculated either explicitly or implicitly. Implicit margins of safety incorporate conservative assumptions in water quality targets, sources or restoration effectiveness and uncertainty ranges (Minnesota Pollution Control Agency 2017). In comparison, explicit margins of safety set conservative water quality targets, add a specific safety factor to pollutant load estimates or reserve a portion of the load capacity. For this TMDL, DEQ adopted an explicit MOS that specifically reserves a 10 percent portion of the loading capacity.

In addition, the following conservative analytical assumptions were included to incorporate an additional, implicit MOS. DEQ used reasonable maximum scenarios for each part of the analysis to ensure that calculated loads would be the highest potential loads. Naturally reproducing populations of *E. coli* originating from fecal material may also contribute to observed concentrations at some locations (IDEQ, 2020). However, DEQ assumed that all measured *E. coli* concentrations originate from point or nonpoint sources because optimal growth conditions for *E. coli* exist in animal intestines; thus, elevated *E. coli* concentrations in surface water suggest relatively recent surface water fecal contamination (IDEQ, 2020). By assuming that all *E. coli* originate from land base sources, the highest potential loads and load reductions are calculated. In calculating WLAs for wastewater treatment facilities, DEQ used permitted discharge limits for *E. coli* without considering the *E. coli* reduction from chlorination applied to remove all pathogens from effluent prior to discharge. DEQ also chose to apply reductions needed as the maximum from among those calculated based on geometric mean or single sample criteria across all flow categories and both seasons. This approach ensures additional reductions are applied to sources contributing during flows other than those associated with the maximum observed concentration.

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