State of the Watershed

Water Quality Report for the Clackamas River Basin

Clackamas River Basin Council

The Clackamas River provides over 300,000 people with drinking water, generates hydroelectric power, supplies farms and nurseries with irrigation water, and is home to critical habitat for fish, wildlife, plants and people too. Thousands also flock to its shores to swim, boat, hike, hunt, and camp each year. It's clear that in order to continue to enjoy the wealth of abundant resources that the Clackamas River bestows, good stewardship to ensure clean and cool water is needed more than ever.

One of the best ways to determine watershed health is through the sampling of water quality. The Clackamas River Basin Council (CRBC), with funding from the Oregon Department of Environmental Quality (DEQ), spent the fall of 2014 doing just that. CRBC staff collected water quality data along with macroinvertebrate (i.e. water bugs) and habitat characteristics in the lower Clackamas watershed at five locations including Rock Creek, the Clackamas River Mainstem, Clear Creek, Deep Creek, and Tickle Creek — all chosen based on their proximity to current restoration projects. By engaging in water quality monitoring, CRBC can gauge the relative health of the streams we are working on, fill geographic gaps in data, and encourage the adoption of stream friendly practices. This report summarizes methods and results of CRBC's water quality monitoring.

Macroinvertebrate findings and the models used to analyze them are displayed in Figure 1. Using a Thermo Orion Star multi-meter and HACH turbidimeter, water quality parameters including temperature, pH, dissolved oxygen, conductivity, and turbidity were measured as seen in Figure 2 (definitions for terms are listed below).

Temperature (Temp C°) has a wide range of effects on stream function and can be affected by a variety of factors including human impacts to surrounding areas (e.g. reduced riparian canopy cover, irrigation withdrawals, runoff from impervious surfaces, discharge from industrial wastewater facilities, etc). Cool water temperatures are critical for both fish and wildlife.

pH (pH SU) is a measure of acidity or alkalinity in a water sample and it impacts the growth and survival of aquatic life. Good pH readings can indicate low nutrient inputs from human operations such as agriculture activities which often affect algae growth. Algal photosynthesis can cause pH levels to increase and create fluctuations during day and night.

Dissolved Oxygen (DO mg/L and DO % sat) is the measurable amount of oxygen in water and is essential to all life dependent on aquatic respiration. It is determined by many factors (e.g. barometric pressure, decomposition of organic materials, photosynthesis, etc.) but has an inverse relationship to water temperature. The lower the water temperature, the higher the amounts of oxygen that can be dissolved into water, which means happy salmon.

Conductivity (Cond µs/cm) is the ability to conduct electricity based on the amount of dissolved salts present in a stream's water and is needed to support diverse aquatic life. It can be absorbed through natural means or human activities. High conductivity can indicate inputs of fertilizers, pesticides, and other pollutants that contain charged particles.

Turbidity (Turb NTU) is an optical measurement that can indicate the amount of suspended solids (e.g. soil) present in a body of water. The higher the turbidity reading, the higher the amount of solids in the water column which translates to unhealthy streams. Excess sediments (i.e. from bank erosion) are detrimental to juvenile salmon and other aquatic life, can adversely affect gill function and visibility, and can smother fish and amphibian eggs. More turbidity leads to warmer water temps and less oxygen.

Relative Bed Stability (RBS), also known as sediment load is the relationship between sediment supply and transport in a stream. It is useful in measuring excess sediment (or erodibility) caused by human activities.

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DEQ

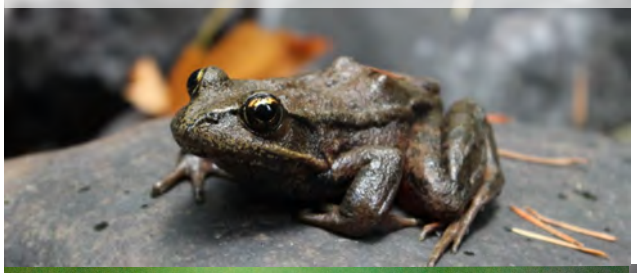
State of Oregon
Department of
Environmental
Quality

Lower Clear Creek at Metro Property

Large wood structure (middle right and left) at Lower Clear Creek.

The Clear Creek Canyon Natural Area is a gem along the lower reaches of Clear Creek near Oregon City. Owned by Metro and purchased with funds from a voter-approved 1995 and 2006 bond measures to protect natural areas, CRBC has partnered with Metro and other partners to complete a suite of habitat improvements on lower Clear Creek since 2012. In 4 years, over 90,000 native trees and shrubs have been planted along 1.7 continuous miles — a 35.5 acre area! Students from nearby Springwater Environmental Sciences School even helped seed native grasses. This site was also one of the first Shade Our Streams projects, serving as a pilot site for CRBC's program which has now grown to over 100 projects across the Clackamas watershed. In addition, an OWEB grant made construction at this site possible as multiple log jams were placed in 3 different areas along Clear Creek and in a backwater channel using 191 logs and 345 boulders. This added roughness to a stretch of Clear Creek that was previously limited, which helps slow high water flows and provides important refuge for young fish during flood events. Water quality data collected at this site was obtained after both in-stream construction and a majority of the revegetation activities, though more planting has taken place since fall of 2014. Overall, Lower Clear Creek had good readings for pH, conductivity, and turbidity which were all within the standard benchmarks. Dissolved oxygen and RBS were not too far off the mark either. However, this site's sparse canopy cover, wide floodplain, and low summer flows likely contributed to warm water temperatures that did not meet requirements for spawning salmon during September sampling. The last several dry summers in Oregon have also been more extreme and extended in recent years. Timing may also be contributing to a disturbed macroinvertebrate community as sampling occurred during a transition from one season to the other and may have caught populations in-between changing lifecycle stages. Furthermore, Clear Creek is surrounded predominately by agricultural lands, most of which are Christmas tree and rural farms. These land uses can contribute to increased nutrient levels. In general, Clear Creek water quality is typically in better condition than in other lower basin watersheds and as such is a priority for maintaining coho, Chinook, and steelhead populations. In addition to CRBC's work on lower Clear Creek, Metro has been improving upland forest and savanna habitat at Clear Creek Canyon Natural Area to provide healthy habitat for wildlife and to improve water quality conditions. Project partners at Clear Creek include Metro, Oregon Watershed Enhancement Board, Oregon Wildlife Foundation, US Forest Service, Portland General Electric, Oregon Department of Fish & Wildlife, The Nature Conservancy, and CRBC's Shade Our Streams program.

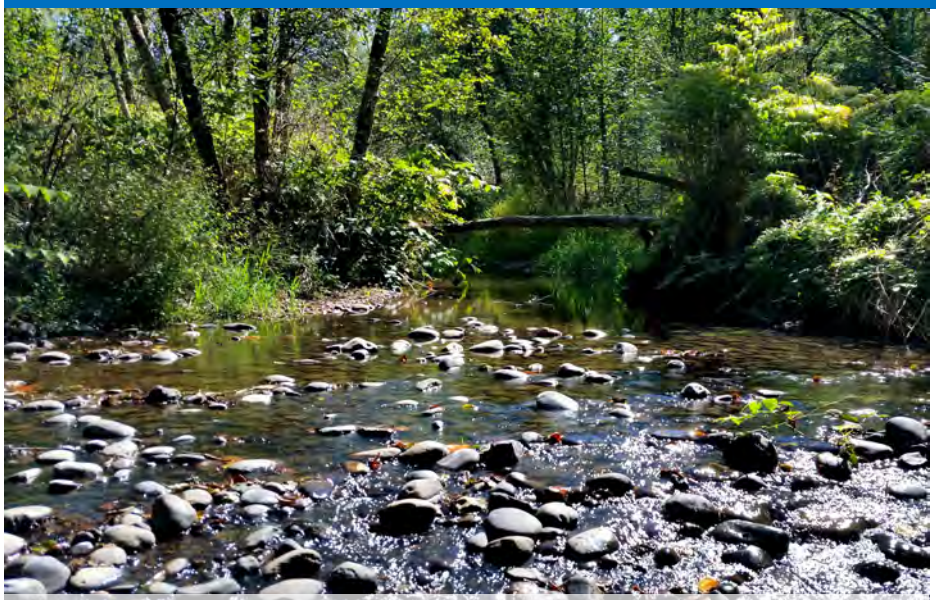
A frog rests on a rock along Deep Creek.



A snail climbs a spider web at Clear Creek.

A rough-skinned newt crawls around Clear Creek.

Deep Creek along Judd Road



Deep Creek stretch with Japanese knotweed and reed canary grass along banks.

Along the Deep Creek stretch parallel to Judd Road in the Eagle Creek area, is a 2 mile corridor of private properties with landownership beginning at Hwy 211 — all enrolled in CRBC's Shade Our Streams program. This water quality sampling site is located on the downstream end of this stretch and data was collected prior to restoration activities. The property was recently planted with 4,000 native trees and shrubs in the winter of 2016 along approximately 1,500 feet of streambank as part of the Shade Our Streams program.

Unfortunately, the Deep Creek subbasin is heavily invaded by Japanese knotweed, a tenacious weed that loves to spread aggressively downstream by way of water. This site is no exception with nearly 2 acres that needed to be treated for invasive species including knotweed. By tackling 11 acres of contiguous streamside properties, CRBC is much more effective in knocking back infestations by treating long stretches and involving entire neighborhoods in the process. Both coho salmon and steelhead use over 30 miles of stream in the Deep Creek subbasin for rearing and spawning, which is why it's so important to remove these monocultures of weeds and replace them with shade producing natives such as Douglas fir, cottonwood, and Western red cedar, keeping the water cool for these temperature sensitive species.

Water quality findings for Deep Creek were consistent with what is known about the basin. The parameters within range included pH, turbidity, RBS, and dissolved oxygen saturation. However, temperature and conductivity were the highest of all of the sites. While this reach is fairly forested and shaded compared to the other sites, the mixed agricultural and urban land uses within the upper Deep Creek subbasin contribute to high pollutant concentrations that contain charged particles which would affect conductivity and temperature. Low stream flow at the end of summer can also influence these readings as the creek is relying on groundwater this time of year which could be concentrated with nutrients and bacteria. Also of note, water quality sampling was located just downstream of a large powerline field where no tree canopy is present.

Overall, Deep Creek had the best macroinvertebrate assessment with the most mayfly and stonefly richness (i.e. count) and was classified as moderately disturbed instead of most disturbed or severely impaired like the other sites. As seen in the photo above, there is plenty of riffle and cobble habitat. Warm water temperatures at this time of year and pollutant inputs are most likely influencing macroinvertebrate populations.

Following EPA Environmental Monitoring and Assessment Protocols (EMAP), CRBC compiled habitat characteristics which consisted of collecting bank measurements, pebble counts, channel cross sections, substrates, fish cover, riparian vegetation, human disturbances, thalweg profile, large woody debris, slope and bearing, and percent shade at each location. Macroinvertebrates were analyzed according to the models listed below.

Macroinvertebrate Assessment

Sampling Site	Model Analysis	Condition Class
Rock Creek Confluence	Predator MWCF Model	Most Disturbed
Fishers Bend Alcove	EPT Index/OWEB Level 2	Severe Impairment
Lower Clear Creek	Predator WCCP Model	Most Disturbed
Deep Creek at Judd Rd.	Predator WCCP Model	Moderately Disturbed
Sandy Bluff Park	EPT Index/OWEB Level 2	Severe Impairment

Figure 1. Macroinvertebrate Condition Class: Riffle habitat at Rock Creek, Lower Clear Creek, and Deep Creek are based on O/E (P > 0.5) (i.e. observed community vs. what is expected) analyzed by Cole Ecological, Inc. Pool and glide habitat at Fishers Bend and Sandy Bluff Park were assessed using the OWEB Water Quality Monitoring Guidebook.

CRBC staff measures water depth at Rock Creek Confluence.

Rock Creek Confluence

Located between the junction of Hwy 212/224 and the Clackamas River, Rock Creek Confluence is a beautiful natural area owned by Clackamas County and private landowners that is surrounded by encroaching urban development. In the summer of 2014, CRBC and partners completed a large scale in-stream habitat construction project along over a quarter mile stretch. At the time of water quality sampling, 25 log structures with 140 logs and numerous boulders were recently installed to increase stream complexity — including the creation of 18 complex pools for salmon habitat. The project also reconnected the stream to its floodplain and was designed to reduce bank erosion. In addition, over 22,000 native trees and shrubs were planted (some of which by SOLVE Green Team students), 12 acres of invasive weeds were treated (such as Japanese knotweed, butterfly bush, and Himalayan blackberry), and 200 Christmas trees have been placed in the creek to date.

Since 2010, students have used the Rock Creek Confluence as an outdoor classroom, testing water quality and learning about nature in the process. The macroinvertebrate data CRBC gathered at this site will supplement long-term data collected by Clackamas High School and Portland State University students over the past 5 years — a unique capture of pre and post data at a restoration site. Though using different models of analysis for interpreting macroinvertebrate data, both indicated a disturbed biological community in the fall of 2014 following construction activities within the stream. Gauge flow monitoring by USGS has also been completed at this location. Out of the 5 total sites sampled by CRBC, the Rock Creek Confluence was the only one that fell within the good temperature criteria which benefits rearing and migration for salmon and trout.

Turbidity, pH, and RBS were also within range. Dissolved oxygen was only slightly below the DEQ standard and conductivity was the only parameter that resulted in a poor reading. This could be due to a low summer flow and more groundwater input, which can concentrate constituents (e.g. nutrients) and increase conductivity. Since the Happy Valley area is rapidly developing, Rock Creek is influenced by fertilizers, pesticides, and other pollutants dissolving in groundwater and surface water runoff. While current canopy cover from trees and shrubs at this site is not optimal, the additional natives recently planted will further increase shade and their roots will help filter excess nutrients before they reach Rock Creek.

Project partners and funding for restoration at the Rock Creek Confluence is supported by Clackamas County Water Environment Services, Metro's 2006 Natural Areas bond measure, Oregon Watershed Enhancement Board, The Nature Conservancy's PGE Habitat Fund and CRBC's Shade Our Streams program.

Water Quality Data in t

Parameters			T
Oregon Department of Environmental Quality (ODEQ) Water Quality Standard Benchmarks	**Oregon's Biologically Based Temperature Criteria:** From the mouth at Oregon City to River Mile 8.15, the confluence of Clear Creek, the Clackamas River is designated for Salmon and Trout Rearing and Migration (18°C). Spawning season requirements in this reach extend from Oct 15-May 15 (13°C). The rest of the Clackamas subbasin is designated Core Cold Water Habitat (16°C) except during spawning season (13°C) which begins as early at Sept 1 and extends as late as June 15.	**Good** Within water quality standards	<13°C fo in Core a <18°C fo Reari outside b
		Poor Outside water quality standards	
Sampling Site/Location	**Beneficial Use Temperature Criteria**	**Date/Weather**	
Rock Creek Confluence (Happy Valley)	Salmon & Trout Rearing & Migration	9/26/14 Cloudy 60-69°F	
Fishers Bend along Clack. River (Damascus)	Salmon and Steelhead Spawning in Core Cold Water Habitat	9/11/14 Sunny/Windy 64-75°F	
Lower Clear Creek at Metro Prop. (OR City)	Salmon and Steelhead Spawning in Core Cold Water Habitat	9/26/14 Partly Cloudy 60-69°F	
Deep Creek along Judd Rd. (Eagle Creek)	Salmon and Steelhead Spawning in Core Cold Water Habitat	9/19/14 Sunny 69-77°F	
Tickle Creek at Sandy Bluff Park (Sandy)	Salmon and Steelhead Spawning in Core Cold Water Habitat	9/19/14 Sunny 65-77°F	

Figure 2. Benchmarks of Tested Parameters: Interpretations determined using Oregon's water qua (Mulvey, Leferink, and Borisenko). DEQ's 2006 Willamette Basin TMDL: Clackamas Subbasin chapte

Fishers Bend Alcove

Pond in Fishers Bend Alcove.

About 2 miles west of Barton just off Hwy 224 in Damascus, Fishers Bend presents an alcove backwater area of nearly 1,000 feet that has been disconnected from the mainstem of the Clackamas River until recently. The entire bench of Fishers Bend is owned by Clackamas County and private landowners at Chrysalis Farms. In 2015, as part of Phase I of the project, an alcove inlet was reconnected to the Clackamas mainstem and 7 large wood structures and 65 boulders were added. By re-establishing this connection to the floodplain, the river now has an outlet for fast flowing flood-stage waters to slow, which reduces streambank erosion, and provides rearing and resting waters for juvenile salmon. In addition, over 32 acres of invasive weeds were treated adjacent to the alcove, 200 Christmas trees were added for stream complexity by Trout Unlimited volunteers, and 34,600 natives trees and shrubs were installed in the winter of 2016.

Water quality data collected at this site was gathered prior to restoration activities in order to have baseline data and observe changes over time. As seen in Figure 2, a number of water quality parameters were found to have poor or fair readings including temperature, dissolved oxygen, conductivity, and relative bed stability. None of these were surprising, given that prior to construction and restoration activities at this site, Fishers Bend was a pond — with stagnant water. This means less flowing water and increased surface area for sunlight to warm water temperatures and decrease dissolved oxygen. These conditions are detrimental to healthy macroinvertebrate populations and are also ripe for algae growth. With a silty substrate, absence of cobble, a lack of roughness (i.e. large woody debris) and vegetation in the floodplain, it also creates opportunity for erosion of sediment indicated by the RBS and turbidity values. This site is also influenced by its close proximity to the highway. While water quality parameters and macroinvertebrates were collected in pond habitat, the channel characteristics were measured in the dry stream channel. With the creation of a functioning alcove that reconnects the pond to the Clackamas River, these water quality parameters and habitat measurements should improve over time. Furthermore, anticipated future restoration during Phase II of the project is expected to reconnect the downstream alcove to another 2,350 feet of historic side channel and restore 4.5 acres of habitat. With these enhancements, Fishers Bend will provide key off-channel fish habitat and makes it an ideal site to promote restoration and conservation through educational opportunities. The Fishers Bend project was made possible with funding from the Oregon Wildlife Foundation, Oregon Watershed Enhancement Board, and the US Forest Service. Partner support includes Chrysalis Farms, Clackamas County Parks, Clackamas Soil & Water Conservation District, Oregon Department of Fish and Wildlife, and CRBC's Shade Our Streams program.

he Clackamas River Basin

Temp °C	pH SU	DO mg/L	DO % sat	Cond µS/cm	Turb NTU	RBS	Canopy Cover
or spawning salmon Cold Water Habitat above Carver or Salmon and Trout ng and Migration e spawning season below Carver	6.5-8.5	>11.0	>95%	<93	<6	>-0.9	- -
	<6.5 or >8.5			>137	>22	<-3.4	- -

Results

13.9	7.73	9.6	94	171	2	.0178	35%
16.5	7.03	5.6	58	118	9	-1.9308	39%
15.4	7.53	10.1	102	77	2	-0.9406	19%
16.7	7.80	10.0	103	176	2	-.0787	53%
16.2	6.09	5.3	56	84	9	-3.3320	30%

ality standards provided in ODEQ's 2009 Willamette Basin Rivers and Streams Assessment r. Fair readings were interpreted as not Good or Poor according to benchmarks above.

Tickle Creek at Sandy Bluff Park

Tickle Creek below pond at Sandy Bluff Park.

Uniquely situated on the boundary between the Clackamas and Sandy River watersheds, Sandy Bluff Park is a community open space owned by the City of Sandy which is highly visible to the public and adjacent to residential neighborhoods and Sandy High School. Tickle Creek flows through the park and empties into a pond before flowing out and eventually emptying into Deep Creek. The creek has been heavily influenced by beavers and the existing pond provides a high level of bird and other wildlife habitat. It's also home to a Shade Our Streams restoration project along Tickle Creek. Beginning in 2013, 3.8 acres of invasive species including Himalayan blackberry, Scotch broom, and reed canary grass were treated. Nearly a half mile of stream bank was planted with 8,200 native plants to create shade needed to cool water temperatures, stabilize soils, improve both fish and wildlife habitat, and enhance the natural beauty of the park for visitors. Through the City of Sandy's SOLVE IT event, dozens of volunteers including Sandy High School students have come out each spring to add a layer of mulch and clean up trash dumped over the years.

Water quality at this site had the poorest readings of all sites sampled, with temperature, pH, and dissolved oxygen outside the optimal range. Tickle Creek also had the highest turbidity and RBS. Of note however, this portion of Tickle Creek is near the headwaters which originate beneath a shopping center located on the hillside. The creek is created from surface runoff and groundwater from this hill as well as the adjacent high school sports fields and agricultural lands. Tickle Creek flows into a pond and during periods of low water, the outlet is a dry channel bed before groundwater once again establishes flow downstream. This dry channel influenced some of the water quality and habitat readings. Additionally, the presence of beavers creates disturbance and can increase suspended solids, slow water flow, and thereby warm water temperatures and reduce available oxygen. The lack of tree canopy needed to provide shade at the site also contributes to these conditions and will continue to do so until the recent plantings can establish themselves in years to come. Of all 5 sites, Sandy Bluff Park had the worst macroinvertebrate results (as seen by species richness) with severe impairment due to its glide habitat (i.e. smooth water) and absence of cobbles and riffles.

Conserve Water
Use only what you need

Stash the Trash
Pack out what you pack in

Pickup Poo
Clean up after your pets

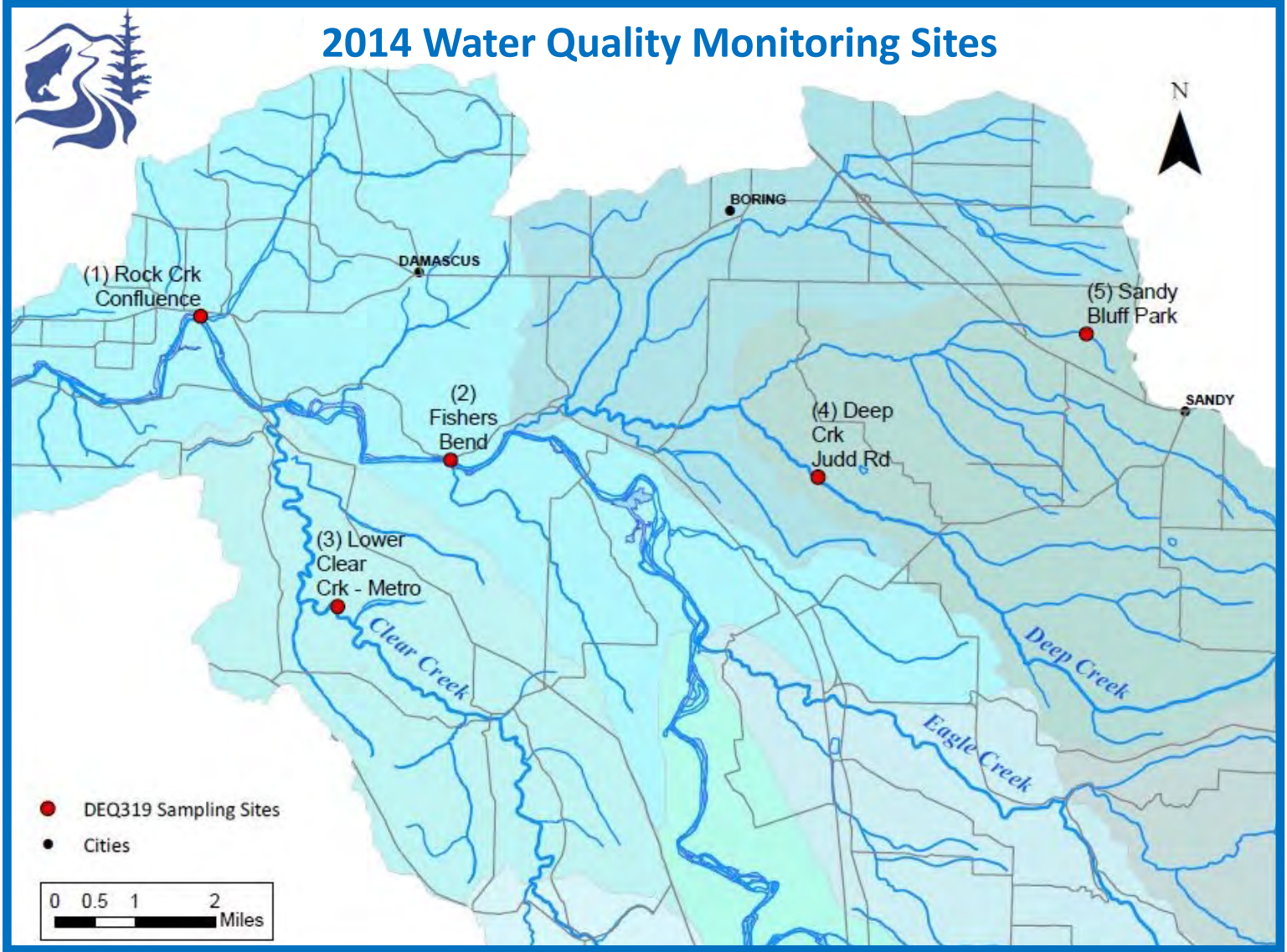
Minimize Erosion
Plant native trees to hold soil

Reduce Chemical Use
Choose non-toxic alternatives

Maintain Vehicles
Fix oil leaks and check exhaust

Map

2014 Water Quality Monitoring Sites



"Any river is really the summation of the whole valley. To think of it as nothing but water is to ignore the greater part."
— Hal Borland, *This Hill, This Valley*

Coho salmon returning to spawn in Deep Creek.

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