June 2019

Deschutes Water Quality and the Pelton Round Butte Project

Frequently Asked Questions

2019 Water Quality Study: **Design and Process**

1. Why was this study conducted?

Since our salmon and steelhead reintroduction efforts in the Deschutes Basin began, PGE and the Confederated Tribes of Warm Springs have worked together to make well-informed, science-based decisions for the benefit of fish and water quality above and below the Pelton Round Butte Hydroelectric Project. Several years ago, it became clear we needed a better understanding of water quality conditions in the upstream tributaries, reservoirs and Lower Deschutes River to continue making these informed decisions.

- This report supplements our ongoing fisheries research and water quality monitoring program. It is one collection of information within a larger dataset, helping us and the Pelton Round Butte Fish Committee make thoughtful decisions backed by an ever-growing body of scientific evidence.
- While the study was designed primarily to give decision-makers in the basin the data needed to make informed management decisions, we know many other people care about the river as well, including anglers, tribal members and environmental advocacy groups. This study will help give everyone a deeper understanding of what's going well on the Deschutes and what we might be able to do together to make basin-wide improvements.

2. Who conducted the study?

This water quality study was conducted and authored by Joe Eilers and Kellie Vache of MaxDepth Aquatics. They are respected experts on water quality and modeling, with extensive water quality research experience in the Deschutes Basin and throughout the region.

3. What's in the study?

The study has two main parts: water quality monitoring and scenario modeling.

- The monitoring section aims to describe the status of water quality in the river and reservoirs and assess historical changes.
- The modeling section forecasts possible outcomes that could result from changes in operation of the project, as well as changes driven by climate change. These results help us understand the current impact of the Pelton Round Butte Project and assess the feasibility of various operational scenarios.
- For a breakdown of topics in the study, see our Reading Guide at www.portlandgeneral.com/waterquality.

4. How were the study sites and parameters chosen?

We chose sites distributed along the Lower Deschutes in order to represent the entire length of the river below our project. Fewer sites were sampled in the reservoirs and tributaries since the focus of the study was the Lower Deschutes.

- We also determined sites based on their accessibility over multiple seasons and years so that the data could track variability over time.
- Where we could access them, we selected a subset of sites from a similar study that was conducted in 1997, allowing for historical comparison.
- To evaluate water quality, we studied parameters that measure water chemistry (pH, dissolved oxygen, temperature and conductivity), nutrients (nitrogen and phosphorus), and biological factors (periphyton, phytoplankton and zooplankton).
- These parameters allowed us to evaluate the productivity and overall condition of the water.

5. Why doesn't the water quality study discuss fish, macroinvertebrates or other wildlife?

We conduct ongoing fisheries research in the Deschutes Basin and completed a macroinvertebrate study in 2016. These studies have already given us extensive information about fish and insect life in the basin, and will be considered along with the results of the water quality study when making decisions about how the project is managed. Adding more biological components to our large water quality dataset would have made an already complex study unwieldy without yielding any more definitive answers to our management questions.

6. How and why does the water quality study use models to generate and analyze data?

A model is a mathematical tool that provides a simplified description of what's happening in the river and reservoirs. The models in this study are used to organize and interpret large datasets to help us understand how water quality might change with different operational scenarios. Although all models are simplifications of natural systems, they can be extremely helpful for isolating key factors in lake and river behavior, thereby demonstrating how a waterbody might respond to changes. We can use this information to decide whether changes would be effective, whether we need to conduct more evaluation or try a different approach.

7. Are these models accurate?

Robust models like the ones used in this study require extensive data inputs, rigorous calibration and testing. To ensure their utility and quality, the models used in the study went through this process. These models are widely-accepted among water quality scientists and researchers and have been thoroughly tested.

- However, the models do have their limits. Certain parameters, such as temperature, can be modeled with a high degree of accuracy, whereas complex biological factors, such as algae growth, are more difficult to model precisely.
- The scenarios are not intended to provide hard-and-fast direction for management change, but provide insight into what types of changes might be worth exploring and the potential results if changes are adopted. Before implementing any long-term policies or projects based on the scenarios, we will likely need to perform pilot tests or collect and assess additional information.
- The models are a starting point and will be a useful tool moving forward in this process. They will also be useful in helping us rule out actions that would be ineffective for achieving desired results.

8. How and why did this study go through an independent technical review?

Scientifically-sound studies are typically reviewed by independent scientists prior to publication. Technical reviewers provide suggestions for improvement, allowing the authors to strengthen their analysis and reporting before finalizing the study.

- Tetra Tech, an engineering, construction and environmental consulting firm, provided two rounds of review, reading drafts of the study and offering their suggestions. Tetra Tech has the modeling, biological and water quality expertise to critically review the report.

9. Why did this study take so long to complete?

Comprehensive, large-scale studies like this one, with widely-dispersed sites sampled over the course of several years, take time. Our sample collection produced a high volume of data that had to be reviewed, analyzed and interpreted.

- The complex models used in the study take months to build, calibrate and test.
- Once a draft of the study was completed, it was also important to allow time for independent technical review.
- While the measured pace of science can be frustrating, multi-year studies are worth the extra time, capturing variation in the environment and producing results that are more likely to reflect nature's complexities. For example, Central Oregon experienced drought in 2015 and record snowfall in 2017. A one-year study would not have captured this variation and could have led to misleading conclusions.

10. How is this study different from other reports that have been generated on Deschutes water quality?

We – and the independent consultant we commissioned to conduct this study – follow rigorous protocols for data collection, analysis, review and publication. Our goal with this report was to provide comprehensive, independently reviewed analysis of the complexity of water quality in the Lower Deschutes.

- The scope and scale of the study is much broader than others that have been conducted on the river, examining multiple water quality factors (including temperature, algae, nutrient composition, dissolved oxygen and pH) in multiple areas (the tributaries, reservoirs and lower river) at multiple time scales (variation throughout the day, from season-to-season, from year-to-year and historical changes over several decades).
- Additionally, this is the first report on the Deschutes Basin to develop and utilize models to understand interactions and forecast changes that affect the Lower Deschutes River.

Background Information:
Water Quality Management at Pelton Round Butte

11. What does the Selective Water Withdrawal (SWW) do? Is it working as intended?

The Selective Water Withdrawal, completed in 2010, is the centerpiece of the Pelton Round Butte Project's Fish Passage Plan. The facility has effectively reconnected the Deschutes Basin, which was artificially divided for half a century. The SWW is working as intended; fish are now migrating both downstream and upstream of the project and benefiting from a more natural seasonal temperature pattern.

- The SWW was designed with direction given by stakeholders involved in the relicensing process in the late '90s and early 2000s.
- It works by creating attractant currents in the surface of Lake Billy Chinook, pulling in juvenile fish and enabling their transport downstream. Prior to the SWW's installation, juvenile fish were unable to find the outlet to the lower river and couldn't continue their ocean-going migration. Since construction, over 1.2 million juvenile fish have been passed through the system on their way downstream to the ocean.
- By mixing water from both the surface and depths of the reservoir, the SWW also reduces the project's effect on water temperature in the Lower Deschutes. The water blend released downstream targets what temperatures would be like without the dams' presence, restoring natural seasonal temperature patterns. This restored temperature regime helps juvenile salmon emerge from their spawning gravel earlier. For fall Chinook, this allows the juveniles to grow larger before leaving the river, so they have higher survival rates when they enter the ocean – as reflected in the high return rates of adult fall Chinook the Deschutes has enjoyed since the system became operational.
- The large-scale, long-term Deschutes reintroduction effort is widely-supported by many individuals and partnering organizations. While most of the SWW's outcomes were anticipated by the licensees and our partners, they were not necessarily expected or welcomed by some members of the public. To some, the warmer water temperatures, though more natural, feel abnormal because they're different from the unusually cold spring and early summer temperatures of the previous six decades. This discrepancy and the slow pace of adult fish returns have contributed to a perception that the SWW is damaging the river and the reintroduction effort is failing, when in fact, they're both working as intended and improving each year, albeit slowly and subject to many factors outside our control.

12. What is the process for deciding when to release surface water, bottom water, or a blend?

We release 100% surface water from late fall through early spring to optimize fish collection. As temperatures at the ReRegulating Dam rise in the late spring, we begin increasing the percentage of bottom water added to the blend.

- We determine the timing of the start of bottom water mixing by comparing discharge temperatures to a model of how the river would warm without the dams (without-project temperatures). The timing varies from year to year depending on weather and conditions in the tributaries.
- Throughout the summer, we continue to add bottom water to the mix, still comparing the discharge temperatures to the model. Typically, by late summer we are releasing the maximum amount of bottom water (60%) to the blend. By early November we go back to full surface-water release to conserve cold water for the following summer.
- We always consult with our two water quality regulators (the Oregon Department of Environmental Quality and Tribal Water Control Board) once we've called for a blending change.
- All decisions regarding blending are directed by state standards and the guidelines written in our Water Quality Management and Monitoring Plan.

13. Why is surface water released into the lower river throughout most of the year? Why is warm water released when the weather gets warmer?

We are trying to reduce our own impact on the river. One of the ways we do this is by releasing water downstream that matches "without-project" temperatures – temperatures that would occur naturally if the dams weren't there.

- This target temperature is calculated using measurements from the incoming tributaries. Water is warmer in the summer than it is in the spring – that's what's natural, so that's what we release downstream.
- Cold water from the depths of Lake Billy Chinook is a finite resource that can be depleted if we release too much bottom water early in the year. If we do that – as we did before the SWW was constructed – we will cause the river to be unnaturally warm in the late summer and early fall. To create natural and more optimal conditions for fish, we add the available cold water to our blend strategically, to closely match "without-project" temperatures for as much of the year as possible.
- Juvenile fish also tend to move in the top layers of Lake Billy Chinook. To effectively capture and transport these fish, we need to pull water from the surface of the reservoir.

14. How do managers of the Deschutes Basin balance water quality objectives with fish passage goals?

Both aspects of SWW operation – water quality and fish passage – have standards that we are required to meet as part of our regulation under Oregon Department of Environmental Quality and the Tribes' Water Control Board. PGE and the Tribes, with consultation from the Fish Committee, make management decisions to optimize both outcomes.

- We've made changes over time to improve both fish collection and water quality, bringing us closer to our long-term goals. These changes include nighttime generation to increase our fish collection numbers and modifying our blending schedule to more closely predict project outflow temperatures.
- These changes are a result of our adaptive management philosophy; we identify an issue, gather more information and make operational changes to improve the outcome. The same methodical process is used to improve progress toward water quality objectives and fish passage goals.
- This water quality study is a prime example of our methodical, science-based approach. The Fish Committee will review information from this study in conjunction with numerous other reports, working to identify potential solutions that maximize results throughout the entire basin.

15. Is the Deschutes River healthy?

There is no single measurement that can provide a complete answer as to whether any river is healthy or not. There are many ways in which the Deschutes is thriving – record Fall Chinook migration, robust fish and bird populations and successful restoration projects throughout the basin. Other aspects of river health, such as nutrient and algae levels, are more concerning.

- Throughout the entire Deschutes River Basin, conditions are highly variable from section to section. For example, the Metolius River boasts clear and cold waters that are largely unaffected by human activity. However, the reaches of the Deschutes below Wickiup Reservoir and the city of Bend are warmer with higher nutrient levels, likely caused by the effects of agricultural and urban runoff.
- Some measurements of water quality assessed in the report, like high nutrient levels, contribute to undesirable water quality conditions such as toxic cyanobacteria blooms. We will target these parameters when considering management changes.
- Other parameters, such as higher temperatures in the early spring, are less troubling because they were intended outcomes of the SWW, designed to aid fish development.
- The Deschutes continues to provide abundant habitat for a variety of fish and wildlife species and remains a world-class destination for people who want to enjoy the basin's recreational opportunities.

16. How does water quality in the Deschutes compare to other rivers in the region?

All rivers have unique characteristics that make them difficult to compare. The source of water (i.e. spring fed vs. snowmelt), underlying geology and degree of human influence can all have a significant effect on water quality and vary widely from river to river, even within the state of Oregon.

- The Deschutes is unique in one major way: it has an extremely stable flow. This can influence periphyton (attached algae) production because the river rarely experiences scouring events in which large flows flush these algae downstream. This type of event is far more common in other river systems.
- Phosphorus in the Deschutes is also naturally elevated due to geologic sources.
- The water quality study did find that the Deschutes has higher levels of chlorophyll and nitrate compared to most other Oregon rivers, although the Rogue is higher in nitrate. pH levels on all the rivers compared in this study are high but are highest in the John Day and the Lower Deschutes. The Deschutes has typical levels of dissolved oxygen.

17. What is water quality like in the three main tributaries to the Deschutes (the Metolius, Crooked and Upper Deschutes Rivers)? How have these rivers changed over time?

The Metolius, Crooked and Upper Deschutes Rivers have distinct characteristics with respect to hydrology, temperature and chemistry.

- The Metolius River, which provides nearly 40% of the inflow to Lake Billy Chinook, is the coldest of the three tributaries. It is primarily fed by groundwater discharge from the Cascade Mountains and is not impeded by reservoirs.
- Flows in the Crooked and Deschutes are highly regulated by reservoirs and irrigation withdrawals. The Crooked River is the warmest on average, but the Upper Deschutes has the highest peak temperatures in the summer.
- Compared to the other tributaries, the Crooked River is the largest source of nitrate and ammonia, contributing 86% of the dissolved nitrate to Lake Billy Chinook. It is also the most turbid.
- All three tributaries have increased in temperature since 2007, with the largest increase taking place in the Upper Deschutes.
- pH has increased in all three tributaries since 1960, with most of the increase occurring prior to 1990.
- All three tributaries have high concentrations of phosphorus, primarily a result of the underlying geology of the region.

18. How much influence do these tributaries have on the condition of the Lower Deschutes River?

The condition of the Lower Deschutes River is, in many ways, a direct reflection of water quality in the tributaries, especially with regard to flows, temperature and nutrients.

- Our license requires that we operate our project as “run of the river,” which means that flows entering Lake Billy Chinook are roughly the same as our output at the ReRegulating Dam. The SWW allows us to do the same for water temperature, creating a blend of surface and bottom water that more closely matches what downstream temperatures would be like without the project’s presence.
- Higher temperatures in the tributaries are directly translated into higher temperatures downstream. Nutrient laden waters from the tributaries are discharged downstream as well, which means that improving water quality in the Deschutes will require basin-wide strategies.

19. What changes has the SWW caused in the reservoirs and in the Lower Deschutes River?

The SWW has changed flow patterns in Lake Billy Chinook, creating attractant currents in the surface of the reservoir to pull in juvenile fish. Before the SWW was constructed, only cold water from deeper in the lake was passed through the project – until that cold water was depleted in midsummer, after which the entire outflow was unnaturally warm. Now, in the spring and early summer, a larger proportion of the discharge from Round Butte Dam is comprised of water from the Crooked River, which is warmer, less dense and floats toward the surface of the reservoir. Because the Crooked River has higher nitrate levels, more nutrients are transported to the Lower Deschutes River than before, potentially causing elevated rates of algae growth downstream. Additionally, algae production has increased in the reservoir itself – a result of Crooked River water being pulled further down the reservoir, closer to the project.

- The composition of algae and cyanobacteria has also likely changed in Lake Billy Chinook, and there is more mixing (less stratification) in the reservoir.
- Concentrations of nitrate have increased in the Lower Deschutes River since 2010. It is possible that additional nitrate has allowed for an increase in periphyton, but we currently lack the data to confirm this hypothesis.
- The SWW has allowed for the passage of fish downstream, so there are more juvenile fish in the Lower Deschutes River now than prior to 2010. More importantly, fish are now able to migrate freely throughout the entire Deschutes Basin, more closely reflecting the natural processes that occurred in the ecosystem prior to dam construction.

20. Has there been an increase in algae on the Lower Deschutes?

Unfortunately, algae data collected in the Lower Deschutes River during a 1997 study were not properly processed by the taxonomist. Consequently, our two datasets cannot be compared. Although we cannot use this data to confirm whether algae composition or quantity has changed in the Lower Deschutes, summer increases in nitrate concentrations, pH and dissolved oxygen suggest that algae has likely become more abundant.

21. What causes algae? Are they a problem?

Algae are a natural part of any ecosystem and are present in all rivers and reservoirs. They can be found attached to substrate on the river floor (periphyton) as well as suspended in the water (seston). Algae growth can be exaggerated by excess nutrients, especially phosphorus and nitrogen, and are typically more abundant in slower flowing, warmer waters.

- There are multiple types of algae in the Deschutes, some of which form the base of the aquatic food web, others of which are considered "nuisance" algae. These algae can be inconvenient for river users and are typically less nutritious to aquatic organisms.
- Algae can become a problem when rapid blooms lead to mass decomposition, using up oxygen and creating "dead zones" in the water. Some toxic algae can be harmful to human health.
- Managing algae can be challenging because project operations intended to improve water quality can create conditions that favor the growth of one form of algae over another.
- There is no evidence to suggest that Deschutes algae are hurting fish.

22. What influences pH levels on the Deschutes? Are pH levels concerning?

Higher pH values in Lake Billy Chinook can be attributed to an increase in algae production, while pH in the Lower Deschutes River varies throughout the day in response to periphyton activity. pH has increased over the full period of record (1960-2017) and has not shown a more pronounced increase since the SWW went into operation. pH levels recorded on the Deschutes are comparable to other Oregon rivers, and we have no indication that current levels are harmful to fish.

23. How have agriculture, urbanization and development in Central Oregon affected the condition of the Deschutes Basin?

There is a long history of development in Central Oregon, which has certainly had consequences for the Deschutes River ecosystem.

- Hydropower projects constructed in the basin, including Pelton Round Butte, have caused major changes over the last century. In addition to blocking or limiting fish passage, dams have altered temperatures, changed the composition of nutrients and disrupted the flow of gravel and woody debris downstream. While many of these problems are now being corrected, there will be some long-lasting effects on the ecology of the basin.
- Irrigation withdrawals for urban and agricultural purposes have affected the timing and magnitude of river flows. Additionally, runoff from agricultural and urban areas has likely contributed to poor nutrient chemistry, especially in the Crooked and Upper Deschutes Rivers. Development in the Crooked Basin began as early as the late 1800s – there are hundreds of years of damage to undo.
- Deschutes County is the fastest-growing county in Oregon. As urbanization increases throughout the basin, we may see impacts on water quality.
- On the other hand, conservation practices and habitat restoration projects in recent years have helped improve or restore conditions for fish and wildlife in the Deschutes.

24. What role does climate change play in the condition of the Deschutes River Basin?

Deschutes River Basin weather is often reflective of climate conditions throughout the Columbia Basin, and there are predictable effects of climate change we can anticipate.

- Wildfires in the upper basin can increase nutrient input and sediment loading and elevate water temperatures by destroying streamside vegetation. As the size and frequency of wildfires increase, these effects may become more pronounced.
- Snowpack and precipitation directly affect the amount of water available throughout the Deschutes, both above and below the project. Drier, warmer winters will result in less available cold water, making it increasingly difficult for project managers to conserve and strategically release bottom water from Lake Billy Chinook.

25. How do variable weather conditions from year to year (including snowpack and air temperature) affect the Deschutes?

Years with less precipitation and a smaller snowpack result in lower flows on the Deschutes. Low flows can facilitate periphyton growth, especially during warm weather. High precipitation events typically result in high flows, flushing periphyton from the river and improving fish passage.

26. Does water quality in the Deschutes have a negative effect on fish returns?

Water quality conditions in the Deschutes aren't typically a significant barrier to thriving fisheries or fish passage. Ocean conditions are far more important and usually outweigh any impact that the river might have. An exception to this would be in drought years, like 2015, when water temperatures at the mouth of the Deschutes can rise dramatically.

- Low flows concurrent with summertime heating of the Deschutes canyon can result in temperatures beyond the optimal range for migrating adults. In 2015, sockeye salmon, already stressed by conditions in the Columbia River, took refuge in the Deschutes at night to escape the blistering temperatures of the main Columbia. But when the sun rose, the Lower Deschutes quickly became warmer than the Columbia, causing fish to die. Abnormally high temperatures in 2015 resulted in dismal sockeye returns throughout the Columbia River Basin.
- It is important to note that weather, sunlight and flows are the driving factors behind these harmful conditions, not operation of the SWW or outflow from the Pelton Round Butte Project.

27. What do the modeled scenarios suggest about the effect of potential management changes on Lower Deschutes water quality?

The scenarios show that climate conditions, nutrient inputs and project operations influence water temperature and quality. In general, releasing more cold water in the spring will likely reduce growth rates of periphyton in the Lower Deschutes River and reduce the transport of phytoplankton downstream. However, there are limitations to this type of management change.

- Operational changes that reduce surface water withdrawal are limited by regulatory requirements and the finite amount of cold water in Lake Billy Chinook. The challenge in maintaining this volume of cool water will likely be exacerbated by rising regional temperatures and climate change. A reduction in surface withdrawal could also significantly hinder fish passage.
- The scenarios suggest that nitrogen and phosphorus reduction, particularly in the Crooked River Basin, could benefit water quality downstream. While phosphorus is more naturally occurring in the basin and therefore difficult to control, nitrogen-reduction strategies, such as streambank protection and wetland construction, will likely reduce phosphorus to some degree.
- The scenario modeling the installation of an algae curtain requires further study.
- It is important to note that operational changes intended to benefit the lower river will likely affect water quality in the reservoirs, often to their detriment.
- The scenarios by themselves do not provide enough information to move forward with an immediate management change. The Fish Committee and project managers will need to consider many factors not addressed in the water quality study, including fish passage, license requirements and state water quality standards, before moving forward with any new action.

28. What were the limitations of this study?

While this study is comprehensive and highly detailed, it cannot and does not address every facet of water quality in the Deschutes. Here are some the study's limitations:

- The study does not explore fish, their potential effect on water quality or water quality's effect on fish populations.
- Macroinvertebrates were previously studied in 2014-2016 so are not addressed in this report.
- River morphometry (variation in shape and depth of the river) is not considered when analyzing periphyton.
- Spatial variation of water quality in the reservoirs is not addressed. Only two sites were sampled in each of the reservoirs because the focus of this study is on the Lower Deschutes.
- Other limitations in the monitoring include: lack of sampling for algal toxins or pesticides and limiting most sampling to daytime hours.
- River discharge was relatively stable during the span of the study, as it has been for the last decade. This is the second longest period in recorded history without a large, flushing flow event on the Deschutes. Water quality conditions would likely be very different after a flushing flow.
  - *Note that in 2019, the Deschutes did achieve a flow exceeding 10,000 cubic feet per second (CFS) for the first time since 1996. We will observe and analyze any water quality changes that followed this moderately high flow.*
- The models, and therefore the scenarios, are limited to measures of water quality. The feasibility of each scenario will need to be considered in conjunction with other factors, like fish passage, license obligations, public safety and recreation access.

Ongoing Decisions and Next Steps

29. Now that PGE and the Tribes have more information about water quality on the Deschutes, what happens next?

We have shared the study with the Fish Committee, Oregon Department of Environmental Quality and the Warm Springs Water Control Board. These groups will provide guidance on potential next steps. The water quality study is an important new component in our dataset and will help us to continue making science-based decisions that benefit the entire river.

- The models developed for the study will continue to be used to evaluate the impact of potential management changes. As we narrow our options, we may run additional, refined scenarios through the models.
- In collaboration with the Fish Committee, we will consider management changes by assessing their combined long-term effect on water quality and fish passage. We will also need to consider feasibility with respect to public safety and recreation access and our ability to meet license obligations. Decisions that impact water quality cannot be made in a vacuum.
- Based on the results of the study, possibilities for next steps include programs that reduce or mitigate nutrient loading, changes to SWW operations, installation of an algae screen and others. The project co-owners cannot make unilateral decisions for the project – our direction will be determined through collaboration with our stakeholders and consultation with our regulators.

30. Where can I access additional information about the study?

- www.portlandgeneral.com/waterquality

  – *Download the study and its data, reading guides, fact sheets and additional resources.*

- www.portlandgeneral.com/healthydeschutes

  – *The story of our journey toward fish reintroduction on the Deschutes. Additional information about our history, collaborative partners, ongoing studies and more.*

- Join us at an upcoming event to learn more about the study results and ask us your questions in person. Dates, locations and other logistics can be found on our Updates and Events page.
- Feel free to contact us with your questions at Deschutes.Passage@pgn.com.