RADLER WHITE PARKS & ALEXANDER LLP
ATTORNEYS AT LAW
111 SW COLUMBIA STREET SUITE 700 PORTLAND, OREGON 97201 P 971 634 0200 F 971 634 0222

Renee France
rfrance@radlerwhite.com
971-634-0217

June 25, 2026

VIA: EMAIL

1600 SE 190th Avenue
Portland OR 97233-5910
lup-hearings@multco.us

RE: Applicant's Pre-Hearing Statement
T2-2025-0067

Hearings Officer Turner:

These comments are submitted on behalf of the applicant, the Portland Water Bureau, in response to the four grounds identified in the notice of appeal challenging the County's approval of the Significant Water Resources (SEC-wr) permit for a steam restoration project along Johnson Creek.

As the record and County's decision demonstrate, the approved restoration project (the "Project") will provide significant and longstanding watershed and riparian benefits. Located on a 8.14-acre property near the headwaters of Johnson Creek (the "Project Site"), the Project is specifically designed to improve water quality and restore fish passage. It accomplishes these objectives by removing an existing dam and associated pond that has been identified in the record as a significant contributor to elevated stream temperatures, and by using accumulated sediments to reestablish a natural, meandering stream channel with enhanced riparian function. The Project is further supported by extensive riparian and upland plantings that will provide shade and habitat benefits.

Despite the clear resource and watershed benefits, the appeal is primarily directed at the Bull Run Filtration Facility (the "Filtration Facility"), located approximately 700 feet to the northeast, rather than the Project or the applicable approval criteria. The Filtration Facility, however, is not the project under review in this application. The Filtration Facility impacts were fully evaluated under the distinct approval criteria applicable to that facility in a separate land use proceeding that is now final. In February 2026, LUBA upheld the County's decision on remand approving the Filtration Facility land use permits. While the Filtration Facility approval includes a condition requiring restoration of a natural stream channel and riparian plantings at the Project Site, that condition does not alter the governing criteria for this SEC-wr application or expand the scope of this proceeding. We fundamentally agree with the position that staff articulated in its June 16, 2026 memorandum that this Project must be reviewed separately and on its own merits as an independent use. As a result, and as explained under each specific ground for appeal below, the claims related to a different, finally approved project provide no basis for reversal of the County's decision here.

GROUND 1

Failure to Assess Cumulative Impacts (MCC 39.5590(C)(3) and MCC 39.5590(D)(2)(b)(iv)) The County erred by reviewing this application entirely in isolation from the previously approved Portland Water Bureau Bull Run Filtration Facility (T3-2022-16220). The restoration of Cottrell Pond was a condition of that prior approval. The environmental impacts of the two projects on Johnson Creek - including changes to stormwater discharge, streamflow, and riparian corridor function - are inseparable and must be evaluated together. The decision failed to assess cumulative adverse effects on the riparian area as expressly required under MCC 39.5590(D)(2)(b)(iv).

Appellants' initial ground for appeal rests on a fundamental misreading of MCC 39.5590 and an improper attempt to import the Bull Run Filtration Facility into this proceeding. Nothing in the text or context of the cited provisions required the County to evaluate the Filtration Facility under the SEC-wr approval criteria applicable to this Project.

Appellants cite MCC 39.5590(D)(2)(b)(iv) to argue that the County's approval failed to assess cumulative adverse effects of the Filtration Facility, but that criterion is both limited in scope and discretionary in application. Subsection (D)(2) governs the mitigation sequence of avoiding, minimizing, or compensating for adverse impacts to natural resource areas. Pursuant to (2)(a) that sequence must be followed "unless the applicant demonstrates that an overriding public benefit would warrant an exception to the preferred sequence." In other words, an applicant need only demonstrate a public benefit if they are seeking to deviate from the preferred sequence. Subsection (D)(2)(b), in turn, provides a list of factors that the County "may consider" in determining "whether there is an overriding public benefit for the public project" in those cases where a public benefit is needed. One of those discretionary factors, subsection (iv), allows consideration of "[t]he cumulative adverse effects of <u>past activities on the Riparian Area</u> either directly or indirectly." (emphasis added).

In this case, the project is consistent with the mitigation sequence, and thus an exception is not needed. Temporary soil disturbance and grading are unavoidable because they are necessary and fundamental requirements of a restoration project that removes a substantial creek impairment. As explained in the attached memo, unavoidable disturbance is minimized, and the final Project enhances riparian and stream function beyond pre-project conditions. Overall, the project is self-mitigating. Because the Project does not rely on an exception to the mitigation sequence, the County was not required to evaluate the discretionary factors in subsection (D)(2)(b), including factor (iv).

Even if the factors were applicable, factor (iv) is one of just five factors the County could consider and all four of the other factors tip in favor of the public benefit because of the substantial benefits to Johnson Creek watershed. Finally, even if factor (iv) were a mandatory approval criterion as appellants seem to suggest, the referenced Riparian Area is specific to the Project Site and the relevant past activities include the damming and ponding of the creek for irrigation purposes that resulted in adverse effects that include the barrier of fish passage, significant increases in stream temperature, and degradation of water quality. The Project directly reverses those conditions and eliminates those cumulative adverse effects rather than contributing to them.

For these reasons, neither the text nor context of MCC 39.5590(D)(2)(b)(iv) requires the Filtration Facility impacts to be considered in this SEC-wr permit as suggested under the first ground for appeal.

GROUND 2

Inadequate Stormwater Analysis (MCC 39.5590(C)(4)(g) and MCC 39.6235) The decision summarily dismissed stormwater concerns on the basis that no new impervious surfaces are proposed by this project. However, the decision failed entirely to analyze how increased stormwater discharge from the adjacent PWB filtration facility draining into the same Johnson Creek corridor will interact with the restored channel. This concern was raised in public comments (Exhibits D.l and D.4) and was not substantively addressed. The decision's stormwater findings are therefore not supported by substantial evidence in the record as required under MCC 39.5590(C)(4)(g) and MCC 39.6235.

Appellants' second ground for appeal similarly relies on inapplicable code provisions and an improper attempt to introduce issues associated with the Bull Run Filtration Facility into this proceeding. Neither MCC 39.5590(C)(4)(g) nor MCC 39.6235 required the County to conduct the analysis Appellants advocate.

MCC 39.6235 does not apply to this Project. That provision governs stormwater drainage control facilities required for development that creates or replaces more than 500 square feet of impervious surface. Here, the Project introduces no new or replacement impervious surfaces. As a result, no stormwater drainage control facility is required, and MCC 39.6235 is not applicable.

For related reasons MCC 39.5590(C)(4) is also inapplicable. Subsection (C)(4) identifies development standards applicable to "development within the Riparian Area, and subsection (g) specifically and exclusively provides development standards for "stormwater drainage control facilities." As the decision correctly concludes, because the Project does not require a stormwater drainage control facility, the development standards applicable to such a facility are not applicable to this SEC-wr review.

Stormwater facilities located on the Filtration Facility site were extensively evaluated through the Filtration Facility land use proceeding and are not part of this Project. There is nothing in the land use criteria applicable to this SEC-wr permit that requires or permits consideration of off-site stormwater drainage control facilities approved through a separate and final land use review. Finally, we note that concerns related to stormwater that were raised in public comments are directly and substantively addressed in Exhibit A.10.

GROUND 3

Conclusory Alternatives Analysis (MCC 39.5590(C)(3)(a)-(e)) The decision accepted the applicant's alternatives analysis without adequate independent analysis or substantial evidence that the proposed 1.22-acre disturbance footprint [TB1.1]represents the minimum area necessary to achieve project objectives. Staff findings on this criterion are conclusory and do not constitute the substantial evidence required to support approval under MCC 39.5590(C)(3)(a) through (e).

MCC 39.5590(C)(3) includes the alternatives analysis requirements for SEC-wr approval. Pursuant to subsection (C)(3)(a) an applicant must demonstrate that "[n]o practicable[1] alternatives to the requested development location exists on the property further than 100 feet from the protected water feature." The requested development in this case is a restoration project to remove an artificial dam and resulting inline pond on the Project Site. As explained in the application, meaningful stream restoration is achievable only through in-channel work. The project purpose in this case includes alteration of the protected water feature, Johnson Creek. Therefore, as the decision correctly concludes, there is no location on the Subject Site further than 100 feet from the stream channel available

Given that a primary Project objective is restoration of the dammed streambed at Cottrell Pond, the Subject Site is the only location that the dam removal and stream restoration can happen. There are no alternative sites that can achieve the project objectives. Removal of the dam and the pond on this site have been identified by multiple organizations and government entities as a priority objective, including the following:

1. The Johnson Creek Watershed Council (JCWC) identified the removal of Cottrell Pond as a top priority to improve water quality in Johnson Creek. The JCWC confirmed the priority in a written a letter of support for this project. Exhibit A.7.
2. The Clackamas Partnership identified this as a priority project in their Strategic Restoration Action Plan [SAP] to guide voluntary restoration actions designed to improve stream habitat, water quality, and native fish populations. See Attachment 1.
3. The City of Gresham and the Oregon Department of Environmental Quality, conducted studies concluding this pond increased stream temperature more than any other remaining Johnson Creek pond studied and was second highest in increase of stream temperature for any creek in the area. See Attachments 2 and 3.

Appellants primarily focus on the subsection (b) analysis to demonstrate development has been "limited to the minimum amount necessary to allow for the proposed use." Appellants specifically claim that there is not substantial evidence to support the conclusion that the proposed 1.22 acre disturbance footprint represents the minimum area necessary to achieve project objectives. The claim, however, is inconsistent with the evidence in the record.

As explained in the application, there are no buildings or structures proposed, so development is limited to the area necessary to achieve the restoration objectives, equivalent to the proposed use. The application describes the proposed use as a restoration project to: 1) convert a "Degraded Riparian Corridor" to a "Good Riparian Corridor" condition; 2) restore fish passage through the removal of the impounding dam; 3) improve water quality in Johnson Creek through the decrease in water surface area and residence time (which will significantly decrease downstream water temperatures); and 4) retain

[1] MCC 39.5520 defines "practicable" as "available and capable of being done after taking into consideration cost, existing, technology, and logistics <u>in light of the overall project purpose</u>."

ecological functions such as breeding opportunities for native amphibians and floodplain retention of flood waters.

The restoration design was developed by several experts, and reviewed by permitting agencies, to achieve the project objectives while limiting the project footprint to the minimum area necessary to achieve project objectives. As a result, the development area necessary to restore fish passage through the removal of the dam and recreation of a natural stream channel with the identified ecological functions and floodplain benefits is roughly equivalent to the existing combined footprint of the dam and the pond. The existing footprint of the dam and the pond is approximately 51,200 sq. ft. or 1.18 acres. The design included in the original application identified a restoration grading area totaling 53,400 square feet, or the 1.22 acres referenced in the decision and appeal statement. However, additional design improvements following submittal of the initial land use application, including changes suggested by ODFW, in a restoration grading area just under 51,200 sq (approximately 1.18 acres). As a result, the existing footprint of the dam and pond is effectively equal in size to the riparian restoration grading area. As detailed in the memo provided as Attachment 4, reducing the riparian restoration grading area further would be inconsistent with the restoration objectives, and thus the restoration area is the minimum area necessary for the proposed use.

The record also details how tree removal has been minimized to the extent practicable. Exhibit A.3, page 10 explains how impacts to trees have been minimized and Exhibit A.2, Sheet 4 depicts the disturbance area modifications to exclude and protect areas with established trees. As explained in Exhibit A.5, a total of 20 trees (12 native trees and 8 non-native trees) must be removed for the grading work necessary to remove the dam, which is approximately 8% of the trees on the site (well below the allowance of 50% removal for dense tree groves). While removing those trees is necessary to allow the proposed use, trees of 6-inch DBH or greater that are removed will be replaced with a total of 966 native trees, a 48:1 ratio that vastly exceeds the 1:1 replacement standard. Replacement trees will be placed within the riparian corridor or the adjacent upland area to provide shade, water retention, and wildlife habitat.

GROUND 4

Failure to Adequately Address Public Comments (MCC 39.1105) Substantive concerns raised by the Cottrell CPO and adjacent property owners (Exhibits D.l, D.3, and D.4) regarding the relationship between this project and T3-2022-16220 were dismissed with identical boilerplate responses stating the application "solely concerns the review of restoration of Cottrell Pond." This does not constitute meaningful engagement with the merits of the concerns raised and fails the standard of reasoned decision-making required under a Type II review process per MCC 39.1105.

Appellants' fourth ground for appeal misstates the requirements of MCC 39.1105. The record demonstrates that the County complied with the Type II process and provided adequate, reasoned responses to the comments submitted. MCC 39.1105 requires the County to consider and respond to relevant public comments in a Type II proceeding. It does not require the County to provide extensive findings addressing arguments that fall outside the applicable approval criteria or seek to expand the scope of review. Here, many of the comments identified by Appellants focused on the Filtration Facility and its alleged impacts.

The Applicant nevertheless provided detailed written responses to all submitted comments (Exhibit A.10), and the County considered those materials in issuing its decision. To the extent the County's responses consistently explained that this application "solely concerns" the restoration Project, that conclusion correctly reflects the limited scope of the proceeding and the limits of the applicable approval criteria. Consistency in those responses does not render them inadequate. Instead, it reflects the recurring nature of comments that sought to introduce issues beyond the scope of this SEC-wr review. Nothing in MCC 39.1105 requires the County to include extensive or individualized findings addressing arguments that are not relevant to the applicable approval criteria.

CONCLUSION

The Applicant requests that the Hearings Officer uphold the County's approval of the SEC-wr permit for this stream restoration project. The Project and the Project's significant benefits to the resource and water quality of Johnson Creek meet and exceed the applicable SEC-wr approval criteria. Project opponents focus their objections primarily on the Filtration Facility, amounting to an impermissible collateral attack on a permitted facility, and otherwise offer no legitimate grounds for denial based on the approval criteria applicable in this case.

Best regards,

Renee France
RADLER WHITE PARKS & ALEXANDER

ATTACHMENT 1

Clackamas Partnership

Project Name or Description

About the Clackamas Partnership

In 2018, the Clackamas Focused Investment Partnership (FIP) developed a Strategic Action Plan to restore ESA-listed Clackamas fish populations in the Clackamas River Basin, Abernethy, Kellogg, Johnson Creek watersheds, and other lower Willamette tributaries as well as east bank/floodplain of the lower Willamette River from Willamette Falls to Johnson Creek. Based on the Strategic Plan's comprehensive restoration strategy, OWEB awarded a $8,477,795 grant to support fish habitat restoration from 2019 to 2025. As the Partnership concludes the OWEB-funded projects, we are revising our Strategic Plan and reaching out to partners to assess interest in guiding the Partnership's future restoration activities and grant applications.

The Clackamas Partnership is a collaboration of more than fifteen organizations committed to restoring native fish populations:

Clackamas River Basin Council

Greater Oregon City Watershed Council
Lampreys

Johnson Creek Watershed Council

NORTH CLACKAMAS WATERSHEDS COUNCIL

OREGON STATE PARKS
Nature
HISTORY
Discovery

CLACKAMAS SWCD

Clackamas River Water Providers

CONFEDERATED TRIBES OF WARM SPRINGS
1855

State of Oregon Department of Environmental Quality
DEQ

CLACKAMAS WATER ENVIRONMENT SERVICES

ProjectFirma is a service provided by Environmental Science Associates (ESA), which builds on the Tahoe Regional Planning Agency's EIP Project Tracker. This program is free software; you can redistribute it and/or modify it under the terms of the GNU Affero General Public License as published by the Free Software Foundation. Source code is available on GitHub.

Copyright (C) 2026 Tahoe Regional Planning Agency and ESA | Code last updated (compiled) at 2026-03-25 17:34:11.

Clackamas Partnership

Project Name or Description

Clackamas Partnership Project Tracker

Partners in Restoring Clackamas Populations of Salmon and Steelhead

Welcome to The Clackamas Partnership!

The Clackamas Partnership is a collaboration of Portland metropolitan area watershed councils, government agencies, tribes, and other organizations committed to improving watershed health. The Partnership recently developed a **Strategic Restoration Action Plan** to guide voluntary restoration actions designed to improve stream habitat, water quality, and native fish populations. The Strategic Plan covers the Clackamas River Basin, a stretch of the Willamette River, and other tributaries flowing into the east side of the Willamette River, including Abernethy, Kellogg, and Johnson Creeks. Historically, the Clackamas River and these tributaries supported thriving salmon, steelhead, and other native fish populations.

The **Strategic Plan** focuses on salmon and steelhead populations that are listed under the Federal Endangered Species Act (ESA). The Plan also addresses anadromous Pacific lamprey and resident Clackamas River Basin bull trout populations identified in federal and state native fish recovery and conservation plans.

Restoration actions are guided by the habitat and population objectives and conservation approaches set forth in the following plans:

- Oregon Department of Fish and Wildlife's (ODFW) Lower Columbia River Conservation & Recovery Plan for Oregon Populations of Salmon & Steelhead
  Focus species: Spring and fall Chinook salmon, chum salmon, coho salmon, winter steelhead
  Co-benefit species: Redband trout; cutthroat trout

- U.S. Fish and Wildlife Service's (USFWS) Conservation Agreement for Pacific Lamprey and 2020 Regional Pacific Lamprey Implementation Plan for the Lower Columbia/Willamette Regional Management Unit Willamette Sub-Unit

- USFWS' Final Recovery Plan for the Coterminous United States Population of Bull Trout
  Focus species: Bull trout
  Co-benefit species: Redband trout; cutthroat trout

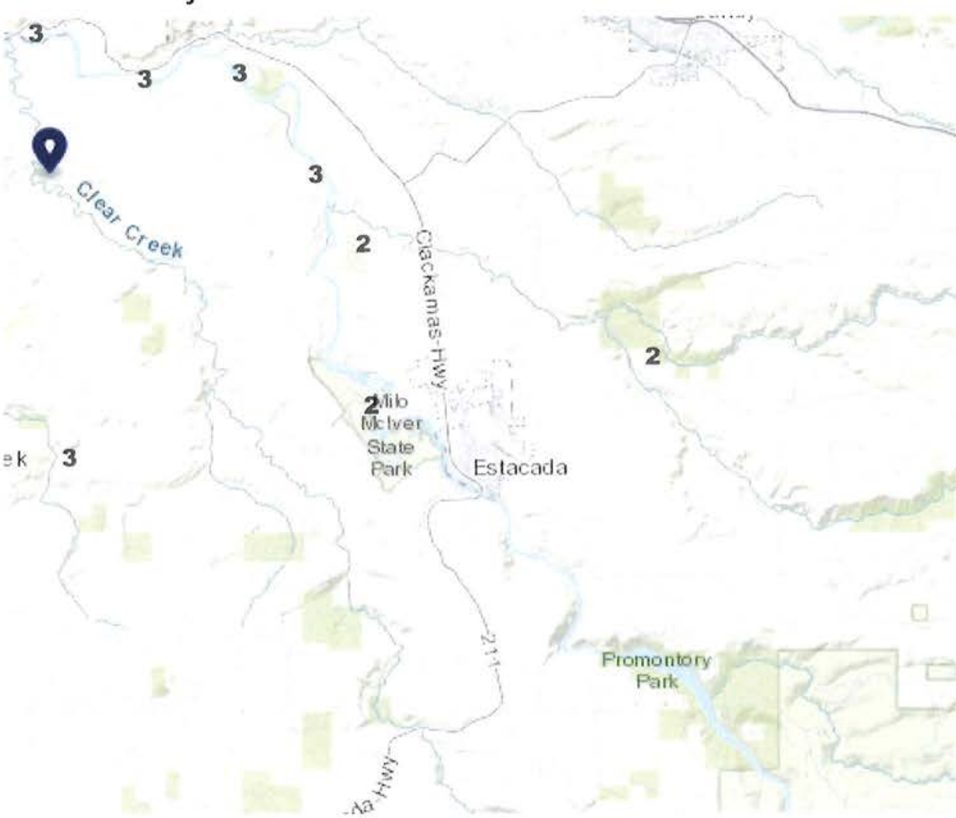
The Clackamas Partnership was awarded a grant through the Oregon Watershed Enhancement Board's (OWEB) Focused Investment Partnership (FIP) program. The $8,744,080 grant will support fish habitat restoration, outreach, monitoring, and other activities over a 6-year investment period, 2019 - 2025. The Partnership estimates leveraging an equal amount of additional funding from Partnership organizations and other sources to support the restoration program.

Project Map

Full Project Map (Link)

This map shows approximate Project Locations. For more detail, view the comprehensive map page.

☑ Cluster Project Locations



Project Stage

Clackamas Partnership

Project Name or Description

Cottrell Pond Fish Passage

View Fact Sheet

Back to all Proposals

Proposal | Planning/Design | Implementation | Post-Implementation | Completed

Basics

Ecological Concern
Impaired Upstream Passage

Limiting Factor
Small Dams and Diversions

Project
Cottrell Pond Fish Passage

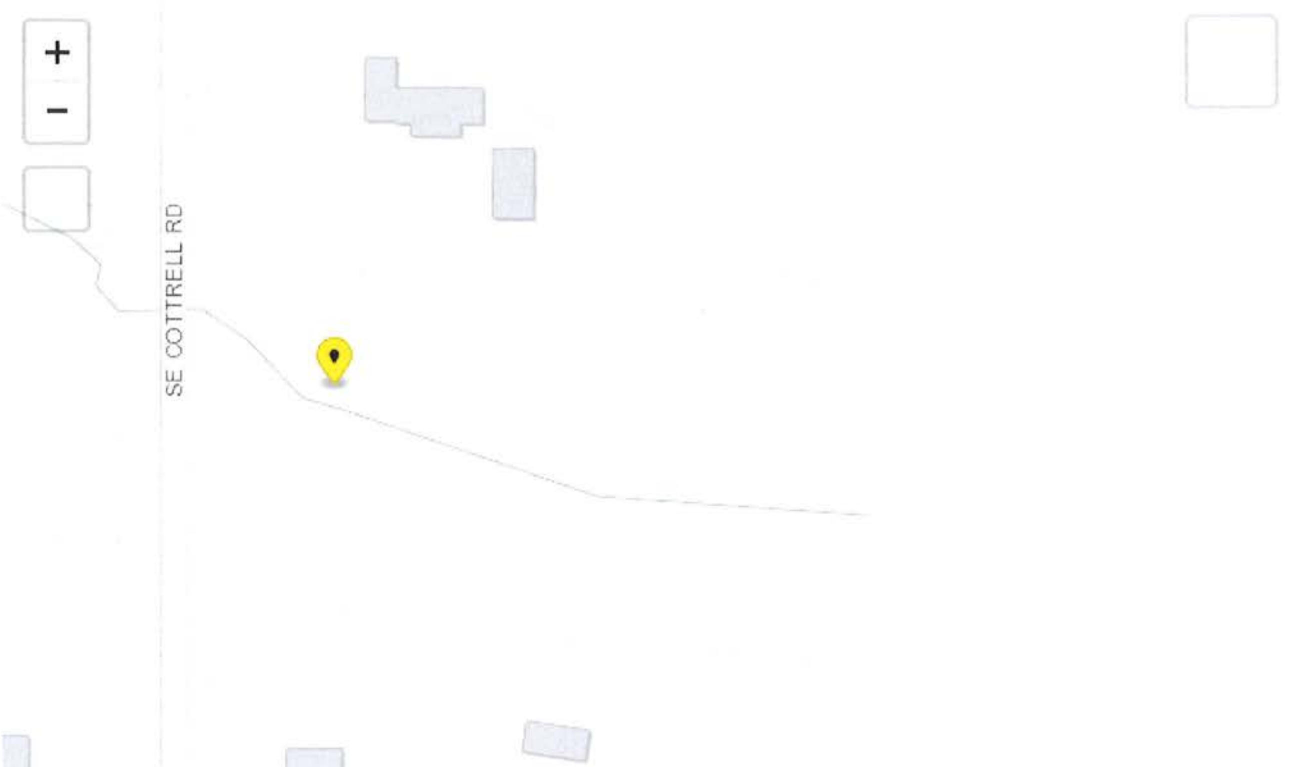
Project Stage Proposal

Project Description

An inline pond created on a private taxlot near the headwaters of Johnson Creek in the community of Cottrell was created several decades ago. This 0.73 acre pond not only blocks fish passage, but also heats up Johnson Creek. In 2018, JCWC temperature monitoring showed as much as 8.3C (15F) change in temperature through the pond (17.8C to 26.1 C).
The earthen dam, including up to six feet of fill, will be removed, to restore a free-flowing creek through this area. The property owner uses this pond for stock/horse watering. We will work with OWRD for a solution through groundwater to provide small watering tanks for the horse(s).

Planning / Design Start Year	2025
Implementation Start Year	2026
Completion Year	2027
Last Updated	7/26/2024

Location



To zoom, hold down Shift and drag a rectangle.

Location Information

Latitude: 45.4623
Longitude: -122.3054

Watersheds

- Upper Johnson Creek

Organizations

Project Association	Organization
Funders	East Multnomah SWCD Oregon Watershed Enhancement Board
Lead Implementer	Johnson Creek Watershed Council
Other Partners	Oregon Water Resources Dept.

Contacts

ATTACHMENT 2

Effects of Inline Ponds on Stream Temperatures in the Johnson Creek Watershed

Author: Katie Holzer, City of Gresham
Publication Date: June 25, 2020
Other Data Contributors: Johnson Creek Watershed Council, United States Geological Survey, City of Portland

1. Summary

Streams that have been altered by urban and agricultural activities are often too warm for some native aquatic species. Johnson Creek and its tributaries in the Portland, Oregon metropolitan area often exceed the summer instream temperature standard for salmonid rearing and migration. There are dozens of inline ponds in the watershed and their effects on stream temperature have been largely unknown. This study examined hourly data collected from upstream and downstream of 25 inline ponds from 2008-2019 to examine the effects of the ponds on stream temperatures. The ponds were comprised of a variety of sizes, locations, and outlet structures. Most ponds were found to substantially raise the stream temperature by several degrees Celsius in the summer months and to increase the amount of time that a stream segment exceeded the temperature standard by several weeks each year. The few ponds which decreased summer stream temperatures were all formed either by beaver dams or by an outlet structure which pulled water from below the pond surface. The effect that each pond had on stream temperature varied greatly and was associated with several factors. Stream temperature increases were greater where upstream temperatures were cooler, where pond surface areas were larger, and where ponds were formed with flow-over dams with outlet structures which released water from the surface of the ponds. These finding demonstrate that inline ponds add substantial heat to stream sections throughout the Johnson Creek watershed and that removal, off-lining, or retrofitting of inline ponds could substantially cool those sections. These actions would likely have larger effects when prioritizing large ponds with surface outlets in areas where the upstream flow is still cool.

2. Background

Human activity can increase stream temperatures through a variety of mechanisms. These include removal of trees shading the streams, construction of field tile drains and impervious surfaces such as buildings and pavement which prevent groundwater recharge, and impounding water in inline ponds which increase the residence time that water is exposed to solar radiation. Johnson Creek in the Portland metropolitan area has been altered by human activity in all of these ways, and the current summer temperatures are often warmer than the optima for many native species, including federally listed salmon. The creek has a Total Maximum Daily Load (TMDL) for temperature administered by the Oregon Department of Environmental Quality (DEQ). Local jurisdictions are working to understand the major sources of heat in the creek and to implement projects which reduce temperatures.

The Johnson Creek Inter-Jurisdictional Committee (IJC) is a group of scientists and land managers formed in 1995 who work together to coordinate monitoring and restoration projects in the watershed. The group has been conducting temperature monitoring in the creek since 1998 with widespread continuous monitoring beginning in 2008. Early efforts showed that the mainstem of the creek generally exceeded DEQ's instream temperature standard for salmon migration and rearing for much of the summer throughout its entire length, and that only a few highly forested tributaries stayed cool enough to meet the standard all summer.

The temperature TMDL strategy in the watershed focuses primarily on riparian tree plantings to increase shade. Cities and counties in the watershed have been implementing widespread planting efforts as part of their TMDL Implementation Plans, and the watershed council and soil and water conservation districts have been successfully conducting riparian restoration on the properties of willing landowners. There are still public and private riparian properties in need of tree planting, but stream temperature reduction through shading will also require time as the vegetation grows.

In 2015 the Johnson Creek Watershed Council (JCWC) conducted a pond inventory of the watershed using aerial images and discovered around 70 likely inline ponds. These ponds were hypothesized to increase stream temperatures, but the exact effects were unknown. From 2008-2019 members of the IJC collected continuous summer stream temperature data upstream and downstream of accessible inline ponds throughout the watershed. The results of these efforts are summarized in this study.

3. Methods

3.1 Site Selection

Temperature monitoring locations were discussed and chosen by the IJC (Fig. 1). Sites focused on known inline ponds with access to upstream and downstream locations for placing temperature loggers. Logger locations were generally selected as close as reasonable to ponds to avoid other influences to stream temperature. Loggers were generally placed a few inches above the streambed in a location where they were likely to remain submerged throughout the summer. Instantaneous investigations in several sections demonstrated that temperatures were generally consistent across a stream cross-section with the exception of pools being cooler at the bottom. Some inaccuracies may exist due to the microclimate of the logger location, but there are no biases expected which would be unique to upstream or downstream locations.

A total of 22 ponds in the Johnson Creek watershed were monitored. Most of these ponds were monitored for a single summer (16) while the remaining six were monitored for two or three summers. Three nearby ponds outside of the watershed are also included in this analysis. These ponds are in Gresham and were included because they represent gaps in the Johnson Creek data in terms of pond size and because they provide multiple years of data (3-6 summers each). These ponds were on Beaver, Kelly, and Fairview Creeks. The first is similar in size and summer flow to the Johnson Creek mainstem while the others are similar to major Johnson Creek tributaries.

Most of the ponds were formed by dams constructed by humans (16) while the remaining nine were formed by beaver dams. Most of the human dams had flow-over outlet structures that discharged water off the surface of the pond (15) while one had a subsurface outlet structure which released water from below the pond surface. Beaver dams were porous and released water from throughout the pond water column. Most of the ponds were located on tributaries (17) while the remaining eight were on the mainstem.

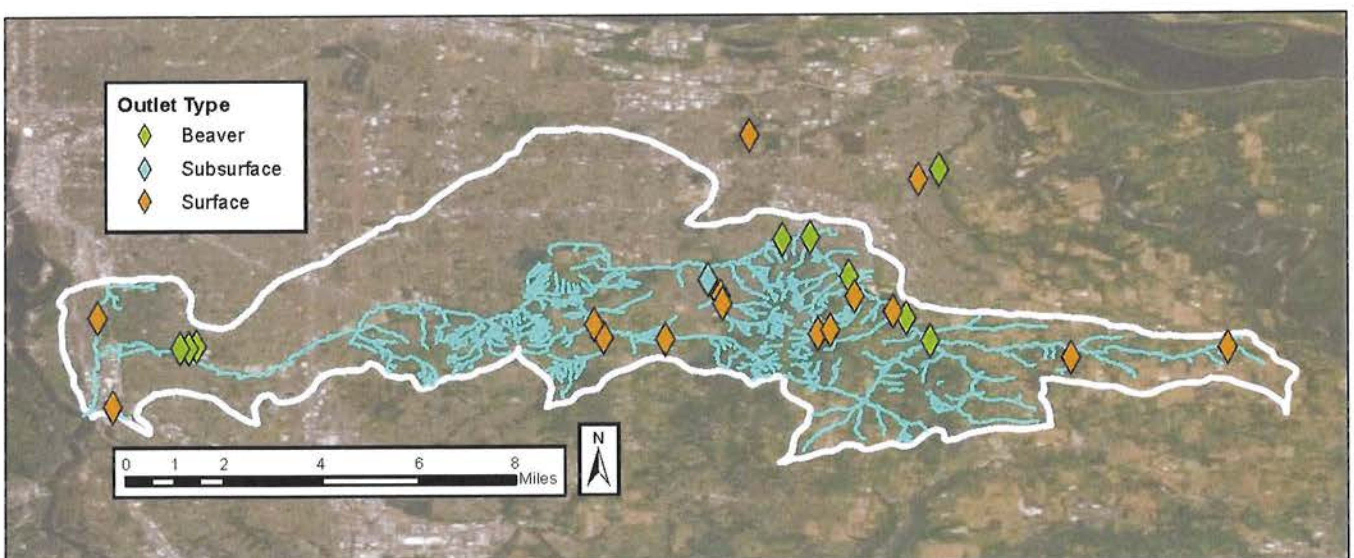


Figure 1 Map of 25 ponds examined in current study. All but three ponds were located in the Johnson Creek watershed which is shown in the white outline.

3.2 Data Collection

Continuous temperature data were collected with Hobo Tidbit temperature loggers (Onset Corp.) set to collect data at least hourly. Temperature loggers were generally deployed from May through October of a given year. Several sites were already exceeding the instream temperature standard when the loggers were deployed in the spring, so some additional exceedances were likely missed in the early season for those sites. Additionally, a few loggers were out of the water for small portions of the summer, so some mid-summer exceedances are also missing for those sites. Surface areas of ponds were estimated using aerial imagery.

3.3 Analysis

We calculated the 7-day moving average of the daily maximum (7DADM) for each site. From this we calculated the maximum 7DADM for the entire summer and the number of days that the 7DADM exceeded the instream temperature standard of 18 °C. To examine the effect of each pond on stream temperature we calculated the change in the maximum 7DADM for the entire summer, the maximum change in the 7DADM for a given day, and the change in the number of exceedances from the upstream site to the downstream site. For ponds with multiple years of data we summarized the average of these changes across years.

We examined several local factors which may affect the influence of the ponds: temperature at the upstream site, surface area, and outlet structure type. To explore the relationship between these factors and the influence of the pond on stream temperature we conducted simple linear regressions for continuous variables (upstream temperature and surface area) and a Mann-Whitney U test for the categorical variable (outlet structure type). Surface areas were log-transformed prior to analysis to fit the assumptions of normality. We also created a generalized linear model to determine which of these factors were most useful in predicting the effect of the ponds on stream temperature. For model selection we used minimization of the Akaike Information Criterion with a 2nd order correction for use with small sample sizes (AICc).

3.4 Modelled Additional Exceedances

To obtain an estimate of additional exceedances that were missed by the temperature loggers we employed a simple linear regression model constructed from the sites with complete data. This model was built by relating the maximum 7DADM temperature to the number of exceedances for each site with complete data (R^2=0.80). The resulting regression equation was applied to sites with missing data. Both the raw and modelled exceedances are reported.

Twelve of the upstream locations and 17 of the downstream locations likely had additional exceedances of the temperature standard that were not captured by the temperature loggers. The estimates for six of the upstream sites and four of the downstream sites were the same or lower than the observed number of exceedances. Each of these sites had datasets that started with 7DADM values very close to the temperature standard, so there were likely to be few, if any, additional exceedances. For those sites, summary statistics are reported with the observed number of exceedances.

4. Results

4.1 Summary

Most inline ponds (20 out of 25) increased summer stream temperatures (Fig. 2). The average increase in maximum 7DADM temperature was 2.1 °C (range: -2.3 – 8.7 °C). The average increase in 7DADM for a given day was 3.0 °C (range: -1.1 – 9.7 °C). The average increase in the number of days of exceedances of the temperature standard was 26 days (range: -23 – 112 days) for sites with complete data and 35 days when including modelled estimates for sites with incomplete data (range: -27 – 134 days). These measures were all highly correlated (Fig. 3; all $p < 0.001$, all $R^2 \geq 0.77$). The increase in the maximum 7DADM was the most informative of these three measures for factor analyses and did not require any estimations, so it was therefore used as the dependent variable for factor analyses.

Upstream maximum 7DADM temperatures averaged 20.9 °C (range: 16.7 – 25.3 °C) and downstream maximum 7DADM temperatures averaged 23.0 °C (range: 17.9 – 28.3 °C). Exceedances at upstream sites averaged 51 days for sites with complete data (range: 0 – 116 days) and 58 days when including modelled estimates for sites with incomplete data (range: 0 – 116 days). Exceedances at downstream sites averaged 79 days for sites with complete data (range: 0 – 132) and 93 days when including modelled estimates for sites with incomplete data (range: 0 – 162 days). Four of the upstream sites stayed below the temperature standard for the entire summer while all but one downstream site had exceedances. The sites without exceedances were all on small headwater streams: Hogan Creek, Spring Creek, Errol Springs Creek, and the headwaters of the Johnson Creek mainstem. Summary data for each pond are shown in Table 1.

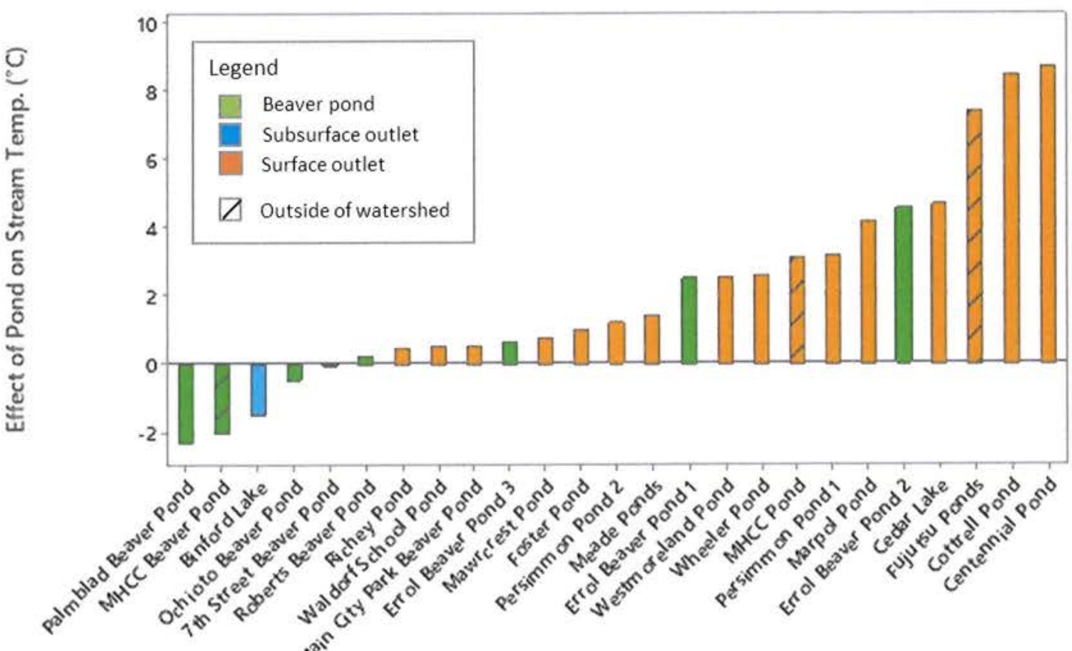


Figure 2 Effect of each pond on stream temperature. The y-axis is the difference in the maximum value of the 7-day average of the daily maximum temperature (7DADM) between the upstream and downstream sampling locations for each pond over the entire summer (values averaged across years for sites with multiple years of data). Ponds are ordered from left to right in by amount of temperature increase they caused. Bars below 0 represent ponds which decreased stream temperature while those above 0 represent ponds which increased stream temperature.

Table 1 List of ponds and major attributes. All temperatures are the maximum 7-day average of the daily maximum (7DADM). Exceedances (ex.) are the number of days that the 7DADM exceeded the instream temperature standard of 18 °C for salmonid rearing and migration. The far-right columns show the increase (Incr.) from the pond in the stream temperature in the number of days of measured or modelled (mod.) exceedances. Numbers which changed with modelling are italicized. Ponds are ordered from highest to lowest in how much they increased stream temperature.

Pond name	**Creek**	**Outlet structure**	**Surf. area (acres)**	**Up-stream temp. (°C)**	**Down-stream temp. (°C)**	**Up-stream ex. (# days)**	**Down-stream ex. (# days)**	**Incr. in temp. (°C)**	**Incr. in daily temp. (°C)**	**Incr. in ex. (# days)**	**Incr. in mod. ex. (# days)**
Centennial Pond	Mitchell Creek	Surface	0.58	19.6	28.3	36	116	8.7	7.3	80	*126*
Cottrell Pond	Johnson Creek	Surface	0.73	17.8	26.2	0	95	8.4	8.5	95	*134*
Fujutsu Ponds	Fairview Creek	Surface	17.82	18.4	25.7	20	132	7.4	9.7	112	112
Cedar Lake	Hogan Creek	Surface	1.74	19.8	24.4	25	95	4.7	2.6	70	*72*
Errol Beaver Pond 2	Errol Springs Creek	Porous	1.25	20.0	24.5	45	116	4.6	5.2	71	71
Marpol Pond	Butler Creek	Surface	1.18	20.5	24.6	55	96	4.1	6.9	41	*61*
Persimmon Pond 1	Hogan Creek	Surface	0.97	16.7	19.8	0	53	3.1	5.0	53	53
Mt. Hood CC Pond	Kelly Creek	Surface	2.02	21.4	24.5	72	102	3.1	4.0	31	*41*
Wheeler Pond	Wheeler Creek	Surface	0.13	17.5	20.1	0	18	2.6	2.7	18	*30*
Westmoreland Pond	Crystal Springs Creek	Surface	2.57	20.2	22.7	50	81	2.5	0.6	28	*35*
Errol Beaver Pond 1	Errol Springs Creek	Porous	1.50	17.5	20.0	0	45	2.5	3.3	45	45
Meade Ponds	Brigman Creek	Surface	0.17	22.9	24.3	83	96	1.4	2.9	13	*29*
Persimmon Pond 2	Hogan Creek	Surface	0.35	19.8	21.0	53	49	1.2	1.3	-4	*9*
Foster Pond	Kelley Creek	Surface	0.10	21.5	22.5	63	67	1.0	2.0	4	4
Mawrcrest Pond	Butler Creek	Surface	0.07	19.9	20.7	35	60	0.8	2.0	25	25
Errol Beaver Pond 3	Errol Springs Creek	Porous	0.15	24.5	25.2	116	124	0.7	1.0	8	8
Main City Park Beaver Pond	Johnson Creek	Porous	0.47	24.4	24.9	34	48	0.5	1.2	14	*8*
Waldorf School Pond	Spring Creek	Surface	0.10	17.4	17.9	0	0	0.5	2.6	0	0
Richey Pond	Kelley Creek	Surface	0.23	22.0	22.5	67	91	0.5	3.0	24	24
Roberts Beaver Pond	Johnson Creek	Porous	0.22	21.4	21.6	80	83	0.2	0.8	3	3
7th Street Beaver Pond	Johnson Creek	Porous	0.39	23.8	23.8	38	39	-0.0	0.4	1	*0*
Ochioto Beaver Pond	Johnson Creek	Porous	0.43	23.1	22.7	89	84	-0.5	0.1	-5	*-6*
Binford Lake	Butler Creek	Sub-surface	1.38	23.0	21.6	97	90	-1.5	2.8	-7	-7
MHCC Beaver Pond	Beaver Creek	Porous	0.08	25.3	23.3	50	40	-2.0	0.1	-10	*-27*
Palmblad Beaver Pond	Johnson Creek	Porous	0.24	25.0	22.7	112	89	-2.3	-1.1	-23	-23
Summary		**Min.**	0.07	16.7	18.0	0	0	-2.3	-1.1	-23	-27
		Mean	1.39	20.9	23.0	49	76	2.1	3.0	27	33
		Max.	17.82	25.3	28.3	116.0	132	8.7	9.7	112	134

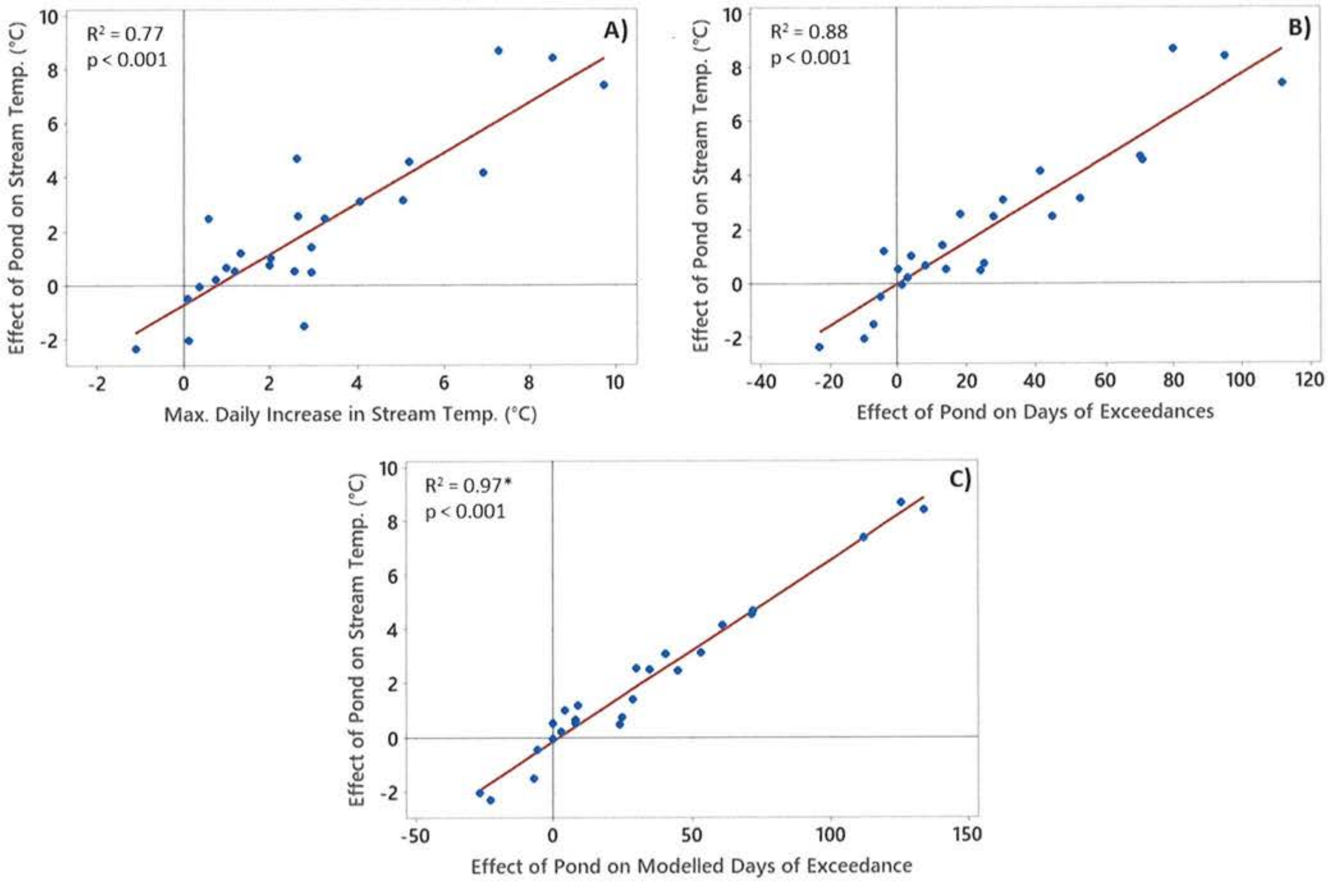


Figure 3 Correlations among measures of increases in stream temperature from the 25 ponds studied. Each point represents one pond (with data averaged for those with multiple years). Most ponds increased stream temperature for all three measures, and the measures were highly correlated. The y-axis for each graph is the increase in the maximum of the 7-day average of the daily maximum temperature (7DADM) over the entire summer. The x-axes are as follow: A) the maximum increase in the 7DADM on a given day, B) the raw data for the increase in the number of days of exceedances of the instream water quality standard of 18 °C for salmonid migration and rearing, and C) is the modelled increase in the number of days of exceedances of that standard for sites with missing data. *The R^2 value in C) is artificially inflated because the modelled data use the y values to predict the x values.

4.2 Factors Affecting Pond Influence on Stream Temperature

Simple regressions showed significant relationships between increase in maximum 7DADM temperature and several local factors (Fig. 4). Generalized linear models indicated that the top model included all three factors examined: upstream temperature, surface area, and outlet structure type (AICc weight of full model = 0.47, $p < 0.001$, $R^2 = 0.60$). This indicates that each of these factors explain a significant proportion of the variation in the increase in temperature from a given pond.

Ponds on stream segments with lower upstream temperatures tended to cause more warming (Fig. 3A, $T = -4.04$, $p = 0.001$, $R^2 = 0.41$). Ponds with maximum 7DADM upstream temperatures <21 °C generally increased stream temperatures by 2 – 8 °C whereas those with upstream temperatures >21 °C generally increased stream temperatures by <2 °C.

Ponds with larger surface areas tended to cause more warming (Fig. 3B, $T = 3.26$, $p = 0.003$, $R^2 = 0.32$). Ponds with surface areas of >0.5 acres generally increased stream temperatures by 2 – 8 °C whereas those <0.5 acres generally increased stream temperatures by <2 °C.

Ponds created by human dams with surface release outlet structures tended to cause more warming than those created by porous beaver dams or by the human dam with a subsurface outlet structure that drew from below the pond surface (Fig. 3C, W = 76.0, p = 0.003). On average, ponds with surface release structures warmed stream segments by 3.3 °C (range: 0.5 – 8.7 °C) while those with porous or subsurface release warmed stream segments by 0.1 °C (range: -2.5 – 4.6 °C).

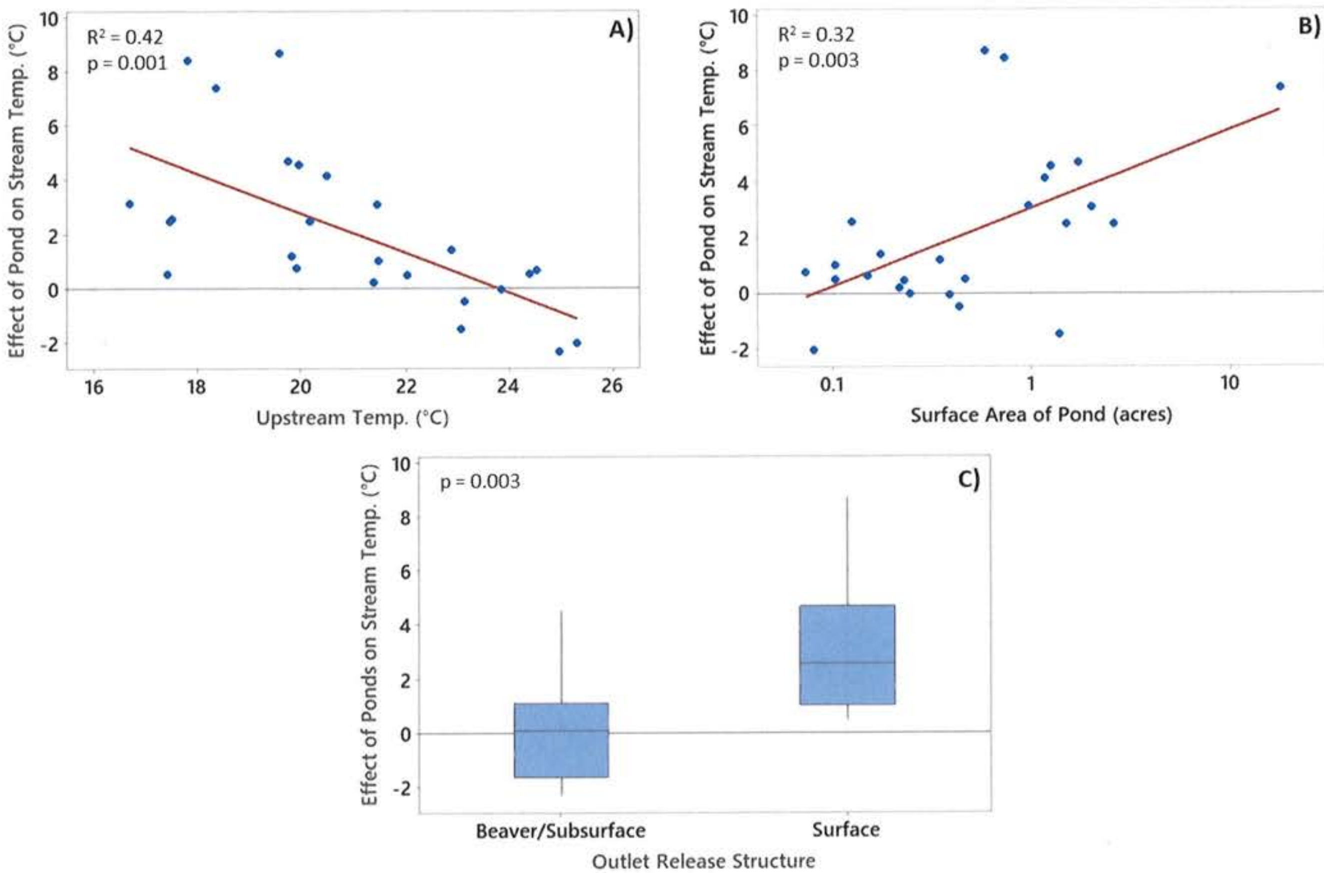


Figure 4 Correlation of pond features with increases in stream temperatures. Three local pond features were correlated with amount of stream warming. A) Ponds located on cold stream segments tended to warm the stream more than those on segments where the stream was already warm. B) Ponds with larger surface areas tended to warm stream sections more than smaller ponds. C) Ponds with flow-over outlet structures tended to warm stream sections more than ponds created by porous beaver dams or by a dam with a subsurface release structure. The y-axis for each graph is the increase in the maximum of the 7-day average of the daily maximum temperature (7DADM) over the entire summer (values averaged across years for sites with multiple years of data). The x-axis in A) is the maximum 7DADM at the upstream location.

5. Discussion

Inline ponds generally increased stream temperatures in the Johnson Creek watershed. The effects of individual ponds varied depending on several factors, but the majority of ponds increased summer stream temperatures by several degrees Celsius. These ponds generally caused stream segments to exceed the instream temperature standard for salmon rearing and migration by several additional weeks each summer. Most stream segments were already exceeding the temperature standard for a portion of the summer before they encountered inline ponds, and these ponds increased this issue.

Several factors were shown to be correlated with a pond's effect on stream temperature: upstream temperature, surface area, and outlet structure type. Cooler streams tended to experience more warming than streams that were already relatively warm. This indicates that efforts targeting ponds on cool streams, such as tributaries and headwater areas, may have the greatest impact on cooling stream temperatures. Ponds with larger surface areas tended to warm streams more than those with smaller surface areas. Therefore, larger ponds may be prioritized for retrofit or removal. We did not examine depth, streamflow, or shade in this study which likely have substantial effects of the amount of warming though stratification and attenuation of solar radiation.

Outlet structures appear to have a strong effect on the amount of warming. Flow-over structures which skimmed the hottest water from the surface of ponds tended to increase stream temperatures much more than those which drew cooler water from below the pond surface. Observations of the beaver dams indicated that generally no water spilled over the tops of the dams during the summer months and that water was percolating through the entire structure, presumably drawing from the entire water column. Instantaneous observations taken in several ponds (human and beaver) during the hottest part of the summer in 2017 and 2019 showed that most ponds >2' deep possessed some thermal stratification. Therefore, targeting dams with surface outlet structures is more likely to reduce stream temperatures addressing than those with other structures. Additionally, retrofitting ponds to be porous or have subsurface release structures may be a cost-efficient and worthwhile option for reducing stream temperatures where pond removal is not desired and where fish passage is not a concern.

The factors identified work together to explain the increases in stream temperature from a given pond. One clear example of this is with the beaver ponds. Most beaver ponds in this study had little effect on downstream temperatures, and these tended to be deep, narrow, shaded ponds on the mainstem of the creek which was already warm. Conversely, two beaver ponds increased stream temperature substantially, with one being among the top ponds in the watershed for increase, and these were large, shallow, sunny ponds on a small, cool, spring-fed stream. Although beaver ponds tended to increase stream temperatures less than human ponds of similar sizes and upstream temperatures, they had a wide variety of impacts dependent on the specifics of the pond.

The factors identified in this study can contribute to prioritization for pond removal or retrofit. There are additional factors that could also be considered such as overall thermal loading, potential rearing habitat provided by the pond, the willingness of the landowner for change, and the feasibility and cost of a project. The Johnson Creek Watershed Council has already been using this information to target ponds for removal and retrofit. By the writing of this report the pond showing the largest increase in stream temperature (Centennial Pond) had already been retrofit through a project led by the council and projects for several other ponds were actively in process.

This study examined summary data for measures of temperature maxima and exceedances over the entire summer. There are other aspects of this data which may be biologically relevant, such as daily minima or timing of warming. Fig. 5 shows example raw data from six ponds which show very different patterns. Additionally, this study examined stream temperatures immediately upstream and downstream of ponds, but it did not look at the legacy effects of these ponds on the stream. Changes in stream temperature may be sustained far downstream or may attenuate in a short distance dependent on factors such as flow rate, shade, and microclimate. This is a substantial gap in the knowledge of the effects of inline ponds on stream temperatures in Johnson Creek and warrants more study.

This study indicates that many inline ponds increase stream temperatures throughout Johnson Creek and its tributaries. Therefore, removing or retrofitting ponds would likely reduce thermal loading and be an important part of working towards meeting the instream water quality temperature standard. Individual ponds showed large differences in how much they increased stream temperature. Efforts to reduce temperature impacts could prioritize ponds on cool stream sections, those with large surface areas, and those which draw water off the surface of the pond. The results of this study may also be useful in other watersheds with inline ponds where temperature reduction is desired.

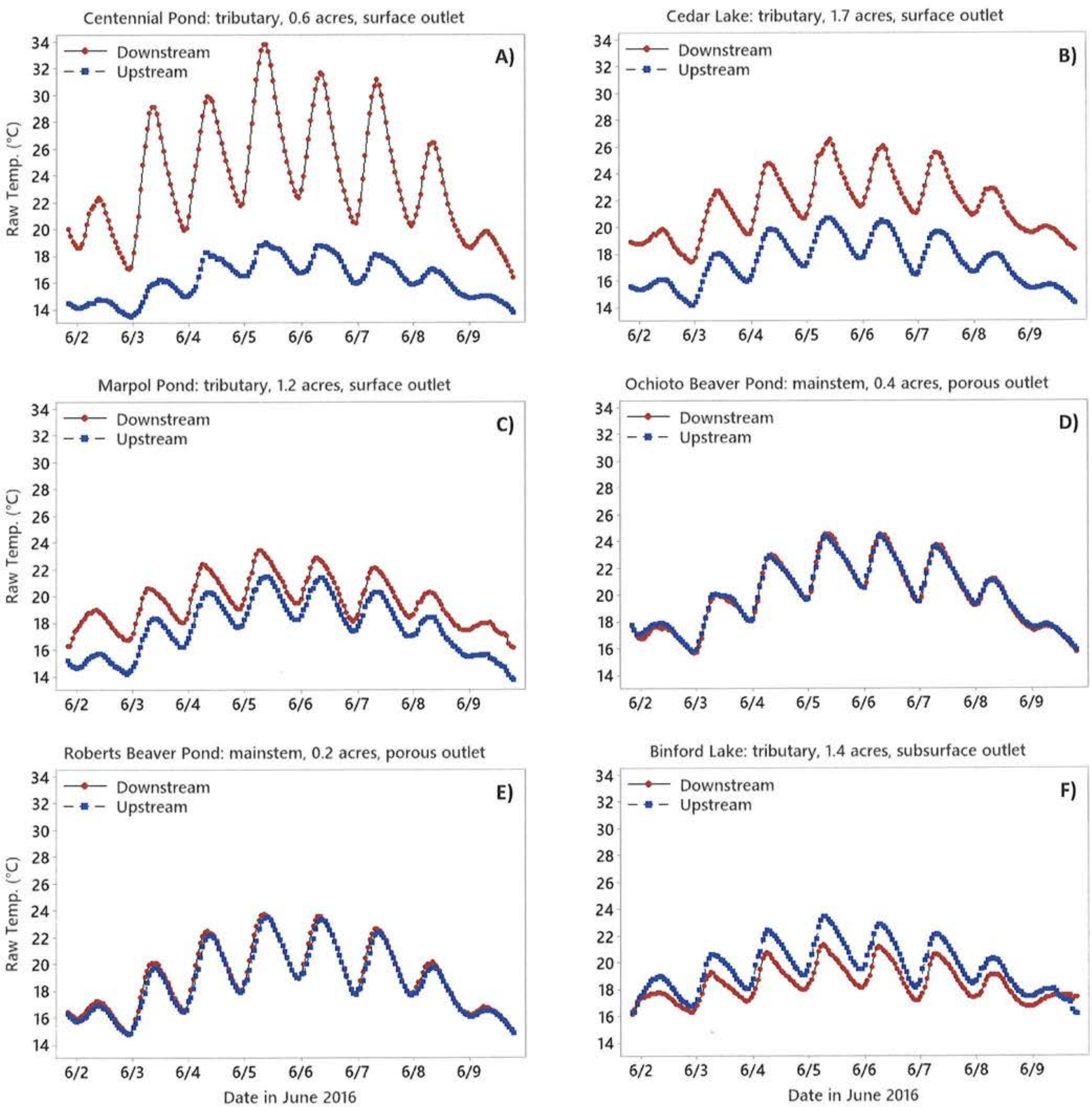
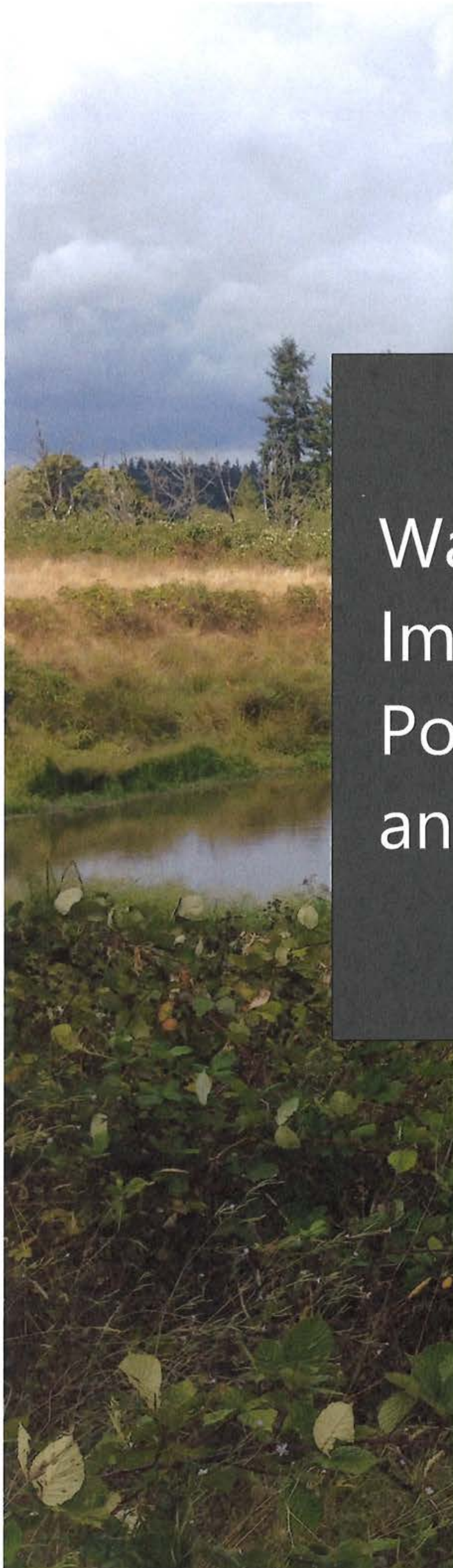


Figure 5 Raw data from six representative ponds during a warm week in 2016. The raw hourly data from these six example ponds demonstrate how various factors contribute to stream warming and how patterns of temperature effects differ among ponds. Ponds A-C warmed the stream, ponds D-E had no significant effect, and pond F cooled the stream. Pond names and major measured factors are described at the top of each graph.

ATTACHMENT 3



Water Temperature Impacts From In-Channel Ponds in Portland Metro and Northwest Region

DEQ

This document was prepared by
Oregon Department of Environmental Quality
Watershed Management Section
700 NE Multnomah Street, Portland Oregon, 97232

February 2023

Contact: David J. Fairbairn, PhD
david.fairbairn@deq.oregon.gov
Phone: 503-229-5777
www.oregon.gov/deq

Cover image: Johnson Creek Watershed
Photo by: Katie Holzer, City of Gresham

State of Oregon
DEQ Department of Environmental Quality

Translation or other formats

Español | 한국어 | **繁體中文** | **Русский** | **Tiếng Việt** | العربية

800-452-4011 | TTY: 711 | deqinfo@deq.oregon.gov

Non-discrimination statement

DEQ does not discriminate on the basis of race, color, national origin, disability, age or sex in administration of its programs or activities. Visit DEQ's Civil Rights and Environmental Justice page.

Table of contents

Abstract

This project represents Phase 1 of a potential two-phase study of in-channel ponds (ICPs) in Oregon. In Phase 1, DEQ staff compiled, analyzed, and summarized data acquired to date from local monitoring organizations to address, for internal DEQ purposes, the critical question: "Are in-channel ponds linked to in-stream water temperature increases in Oregon?" Several sub-questions exist regarding the magnitudes, patterns, consistency, and regulatory aspects of any temperature increases. Phase 1 results and remaining gaps are presented in this context.

Data from 26 ICPs were analyzed, representing 19 anthropogenic – human constructed – ponds and seven beaver ponds (Fig. 1, Tbl. 1). All ICPs were in the Portland metro area (DEQ's Northwest Region), with 22 in the Johnson Creek (including six beaver ponds), three in the Sandy River (including one beaver pond), and one in the Columbia Slough watersheds. Over 400,000 pairs of upstream-downstream temperature data provided by local entities were aggregated into hourly and seven-day average daily maximum (7DADM) summary data for analysis. Interpretation focused on 7DADM values (n=6838) given their time integration and relevance to water quality standards.

Across the 19 studied ICPs, the median and mean hourly-based upstream-downstream temperature increases ("T_{Gain}") were 1.55°C and 1.86°C, respectively. Corresponding median and mean 7DADM T_{Gain} were 1.74°C and 2.43°C, respectively (Tbl. 4). The range of median 7DADM T_{Gain} for individual ICPs was 0.09-6.0°C (Fig. 2, Tbl. 3). Among 15 ICPs with surface outlets, 14 had statistically significant 7DADM T_{Gain} (Tbl. 3, i.e., $p<0.05$ by Generalized Estimating Equation method) and the median 7DADM T_{Gain} among individual ICPs was 1.55. Thirteen of these surface-outlet ICPs had median 7DADM T_{Gain} ≥0.5°C (Tbl. 3).

Three ICPs had significantly negative 7DADM T_{Gains} (median range: $^{(-)}$0.85- $^{(-)}$0.40°C). The two ICPs with subsurface outlets did not show significant 7DADM T_{Gain}, suggesting that outlet modification may reduce ICP discharge temperature vs. surface outlets; such modification may however increase in-pond temperature (not studied). On a monthly basis, ICPs had median 7DADM T_{Gain} ≥2.0°C from May-August, with the greatest 7DADM downstream temperatures occurring in July-August (median >20°C) (Fig. 4).

Among beaver ponds, two had significant median 7DADM T_{Gains} (0.31, 0.5), three had insignificant changes, and two had significant decreases (-1.1, -0.15); thus, among beaver ponds with significant 7DADM temperature changes, the median and mean 7DADM T_{Gain} was 0.08 and 0.04, respectively (°C, Tbl. 3).

Conclusions: Generally and as previously reported by local entities,[1,2] human-built ICPs showed strong trends of raising downstream temperatures in the study area. Fourteen of 17 ICPs (82%) with surface or porous outlets showed significant T_{Gain}. Remaining questions or study limitations pertain to:

A. In-channel pond impacts on water temperature beyond the studied basins (i.e., statewide) and time periods.
B. Which factors most influence ICP temperature impacts, e.g., pond, watershed, climatic, hydrologic parameters.
C. If other environmental factors influence water temperature more strongly than ICPs, e.g., watershed land use, shading.
D. This report did not focus on beaver dams or beaver dam analogues. Focused literature review or additional monitoring may be required to draw related conclusions.

Recommendations: Alongside the existing evidence of ICP water temperature impacts and identified gaps, DEQ's interest in and potential uses of ICP impact information should drive decision-making on if and how to conduct additional study (Phase 2); this suggests management discussion beyond the scope of this report. Based on this report, however, DEQ might consider (a) recommending denial of ICP water right permits through the Oregon Water Resources Department unless applicants provide evidence that water temperature impacts are unlikely, or (b) supporting removal of ICPs as a generally effective practice to reduce water temperature impacts. If DEQ requires more specific or deep-rooted evidence (e.g., to (c) compel landowners to remove ICPs or defend decisions in court), then additional, more refined analysis across important geographic, watershed, and design conditions, and/or critical time periods is warranted.

Introduction

In-channel ponds include constructed impoundments built between a stream channel's banks for a range of human uses (e.g., irrigation, livestock, aesthetics, recreation, nurseries); ICPs also form behind beaver dams. Although ICP designs vary, they commonly include dams that retain water until overflow. Recent Johnson Creek Watershed-based studies reported that ICPs with surface overflow (i.e., "surface outlet") dams increase downstream water temperatures when water is released, and suggested causative mechanisms (e.g., that warmer water overflows first; slow-moving pond water absorbs more sunlight).[1,2] However, a comprehensive aggregation and analysis of these data has not been completed.

Despite a general understanding that ICPs often act as a downstream heat source in Oregon[1,2] and other (potentially less relevant) conditions,[3–7] their installation and permitting continues in Oregon. This is partly due to complicating regulatory factors. For one, rules enacted in the 2000s were intended for retroactive approval of smaller existing ponds (dam ht.<10', area <9.2 ac-ft) for water rights (WR) permits, but not as a solution for subsequently installed ponds. Yet, ICPs are routinely built without prior regulatory permits, reviews, inspections, approvals, or other documentation unless a post-installation complaint or other situation triggers such and/or requires a water right permit application. When reviewing water right applications, it is difficult for DEQ staff to recommend conditions to reduce water temperature impacts of an already-constructed ICP.

Except for two recent Portland-area reports that showed significant water temperature impacts of surface-outlet ICPs,[1,2] the few published studies of in-stream water temperature effects of small dams and impoundments do not generally reflect watershed characteristics relevant to much of Oregon.[3,4,7–10] Several such studies, however, reported that small dams increased downstream water temperatures in their study areas (e.g., MA, MI, PA, and France)[3–5,9], and that dam removal[4] or modification[11] can mitigate these impacts. Conversely, reports of beaver dam and beaver-dam analogue temperature impacts vary;[12,13] some recent studies in Oregon and adjacent states indicate a general lack of negative impacts[14–16] and/or positive water temperature benefits for cold-water species.[17,18] Yet, a recent study of eight beaver dams in the Umpqua River Basin reported significant downstream monthly mean daily maximum water temperature gains (1.9°C) that attenuated with downstream distance; this study suggested caution or further study when considering beaver dam analogues for water quality management.[12]

This project phase was targeted to address the primary question: "Are ICPs linked to in-stream water temperature increases in Oregon?" A few tangential questions were also considered. Although much of the studied dataset was previously reported and analyzed,[1,2] DEQ opted to analyze a somewhat broader dataset to understand the data, confirm initial results, expand the (group-wise) statistical analysis, and determine if and what further steps (e.g., new monitoring data collection, existing information mining) may be warranted to aid potential DEQ decision-making.

Methods

Scope

In Phase 1, DEQ staff compiled, processed, verified, analyzed, and summarized ICP water temperature data provided by the Interjurisdictional Committee for Johnson Creek member organizations, several of whom were responding to DEQ requests for data. We reviewed existing reports by the members and conducted an academic literature search and review. Phase 1 would conclude when the analysis indicated answers (e.g., "yes", "no", "insufficient information") to the following questions:

1. Are ICPs linked to in-stream water temperature increases in Oregon?
    a. If yes, how are these effects characterized? For example, in terms of size, consistency, time periods, downstream and geographical extent.
    b. If yes, what are the causative factors and which are most important? For example, various mechanisms, situational conditions, and design parameters.

2. Can DEQ make regulatory recommendations for ICPs now? If "yes", what and what applicability?

The Phase 1 goal was to (a) determine if we can answer the above questions and (b) answer them as feasible. If gaps prevent this (and if DEQ wants the questions answered), this report would recommend a Phase 2 process to address this, which could include additional data collection or analysis. The Phase 1 deliverable is this summary report that (i) compiles, analyzes, and summarizes available Oregon ICP water temperature data, (ii) addresses the two primary questions, (iii) identifies new or remaining knowledge gaps, and (iv) outlines an optional strategy to address them.

Study sites and data

To facilitate data aggregation and comparisons, DEQ only analyzed ICPs with water temperature data reported at ≤2-hr intervals for ≥3 months each year. Monitoring typically occurred from May to October. The earliest date was March and the latest date was December. Fourteen ICPs had one year and 12 had ≥2 years of data. Continuous water temperature sensors were deployed a few inches above the streambed. A previous report[1] details the typical sensor placement and QA/QC.

The analyzed dataset represents twenty-six individual ICPs with previously collected upstream (T_{US}) and downstream (T_{DS}) water temperature data (Fig. 1, Tbl. 1). All analyzed ICP data were provided by the City of Gresham and the Johnson Creek Watershed Council.[1,2] Twenty-two of approximately 70 total ICPs identified in the Johnson Creek Watershed were monitored[1] along with three ICPs in the Sandy River Basin and one in the Columbia Slough Watershed. Nineteen ICPs were classified "anthropogenic", meaning that their dam structure or "footprint" (ponding area) were a product of human development. Note that DEQ categorized two of the three Errol Springs Creek ICPs as human-and beaver-influenced, while a previous analysis categorized them as beaver ponds.[1] DEQ made this distinction because while Errol 1 & 2 are currently flooded by beaver dams, they were originally developed as trout-rearing ponds and their physical footprints reflect human-caused disturbance (e.g., they are relatively large with little to no shading). Thus, for analysis and interpretation, Errol 1 & 2 are categorized as "anthropogenic", while Errol 3 Beaver is categorized as "beaver".

The studied ICPs reflects different flow outlet structure types (i.e., surface, subsurface, and porous (beaver)) and a range of dimensions and *in situ* conditions such as location, surface area (177-10,400 m^2), elevation (80-632 feet above mean sea level) and shading (qualitatively/visually assessed) (Tbl. 1). A Certificate of Water Right was found for eight of the anthropogenic ICPs at the OWRD online search page.

Data processing and analysis

For each ICP, all temporally paired water temperature data (i.e., simultaneous T_{US} and T_{DS} data) were extracted; this yielded ~400,000 data pairs. The variable "T_{Gain}" was then calculated for each pair as: $T_{Gain} = T_{DS} - T_{US}$. T_{US}, T_{DS}; and T_{Gain} data were summarized as rolling seven-day average daily maximums (7DADMs) (n=6838) and included as response variables of interest in statistical models (Generalized Estimating Equations). Predictor variables included ICP ID, type (beaver or anthropogenic), outlet type, T_{US}, and water temperature date. Because multivariate statistical modeling should be completed with single versus multiple models and due to insufficient data, additional descriptors (e.g., ICP dimensions, flows, shading) were not included in the final model or analyzed separately. Statistical analysis was conducted on numerical and ranked outcome data, and results of multiple methods (i.e., Generalized Linear Mixed Models, Repeated Measures ANOVA) were assessed to support GEE analysis. Discussion focuses on T_{Gain} as this most directly addresses the critical question of this report.

Results and discussion

Statistical analysis (GEE) of the ICP water temperature data confirmed that (a) for the ICP group, $T_{DS}>T_{US}$ (i.e., T_{Gain} was significant, $p<0.01$, Tbl. 2). The respective median and mean upstream-downstream 7DADM T_{Gains} were 1.74 and 2.43°C (Tbl. 4). The following discussion focuses on median values as they are more resistant than means to outlier effects and skewed distributions, and thus represent a more conservative estimate of central tendency.

Statistical analysis also confirmed that most (14 of 17, 82%) ICPs with surface or porous outlets had significant positive median T_{Gains} (Tbl. 3). T_{Gain} was insignificant for one of these (Waldorf) and significantly negative for two (Persimmon 2 and Kelley Cr 1). The remaining ICPs (Kelly Cr. and Binford Lk., with subsurface outlets) showed respectively insignificant and significantly negative (-0.40°C) median T_{Gain}, suggesting that outlet modification may prevent downstream T_{Gain}; yet, further assessment may be required to determine if such modifications increase in-pond water temperatures to an important extent. The range of median T_{Gains} (°C) for individual surface-outlet ICPs was $^{(-)}$0.85-$^{(+)}$6.0 (median: 1.55; Tbl. 3); The corresponding 25th and 75th percentiles were 0.45 and 3.0, respectively. Together, this shows that ≥75% of the calculated 7DADM T_{Gains} at each of ≥75% of anthropogenic surface-outlet ICPs were ≥0.45°C.

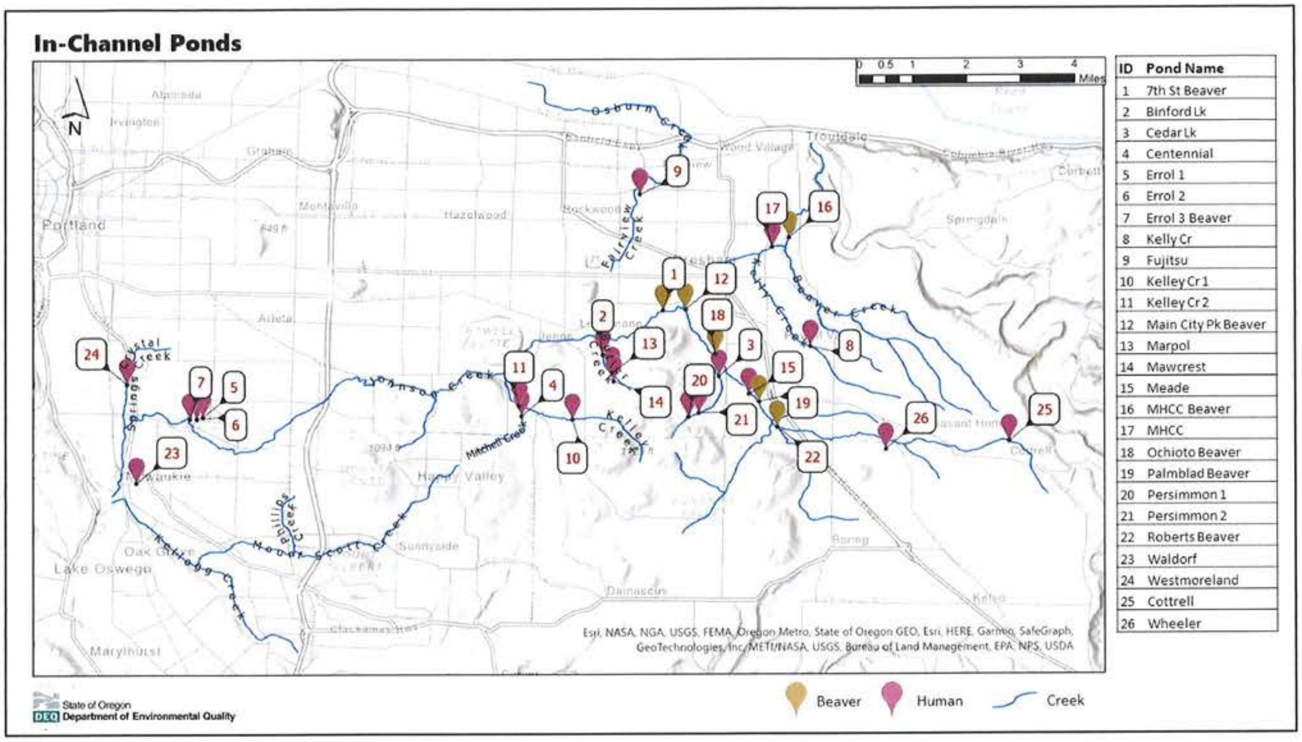


Figure 1: Map of monitored ICPs.

The implications for water temperature standard exceedance associated with these T_{Gains} are potentially major. Figures 2 and 3 show the complete distributions and summary data (i.e., medians, 25th & 75th percentiles, maxima, minima) of 7DADM T_{Gain}, T_{US}, and T_{DS} for each ICP; 13 of the 19 ICPs had median T_{DS}'s above the 18°C summer standard for salmonid rearing and migration, and two more had median T_{DS}'s (i.e., ≥17.4°C) approaching it. Anthropogenic ICPs with subsurface outlets (n=2) and beaver ICPs (n=7) show comparatively small to insignificant or negative T_{Gains} from upstream to downstream monitoring locations (e.g., median T_{Gain} (°C) was ≥0.5 for only one beaver ICP, and for two others was 0.31 and 0.36; Fig. 2, Tbls. 1, 3, 4). These results should be interpreted with caution, however, given divergent results reported in other beaver dam and beaver dam analogue studies.[12–21]

Table 1. Analyzed ICP information

ICP ID	Water Right Cert # (if present)	Lat.[1]	Long.[1]	Elev.[1] (ft)	Shaded[2] (None, L, M, H)	Stream	Watershed	Type	Outlet Structure[3]	Pond S.A. (m^2)[3]	Data Year(s)[3]
7th St Beaver	N/A	45.4954	-122.4382	269	L/M	Johnson Cr.	Johnson Cr.	Beaver	Porous	1563	2018
Binford Lk	28265	45.4831	-122.4606	297	L	Butler Cr.	Johnson Cr.	Human	Subsurface	5605	2013, '16, '17
Cedar Lk	84789	45.4781	-122.4166	344	L	Hogan Cr.	Johnson Cr.	Human	Surface	7046	2008, '16
Centennial	None found	45.4662	-122.4913	326	N	Mitchell Cr.	Johnson Cr.	Human	Surface	2365	2014-16
Centennial No Dam	N/A	45.4662	-122.4913	326	N	Mitchell Cr.	Johnson Cr.	Human	None	N/A	2019-21
Errol 1	N/A/None	45.4639	-122.6127	96	L	Errol Springs Cr.	Johnson Cr.	Human/Beaver	Porous	6070	2018
Errol 2	N/A/None	45.4634	-122.6150	89	N	Errol Springs Cr.	Johnson Cr.	Human/Beaver	Porous	5059	2018
Errol 3 Beaver	N/A/None	45.4634	-122.6176	80	M	Errol Springs Cr.	Johnson Cr.	Beaver	Porous	607	2018
Fujitsu Ponds	None found; 4 Lg ICPs	45.5264	-122.4478	192	N	Fairview Cr.	Columbia Slough	Human	Surface	72123	2011, '13, '14, '16, '17, '19
Kelley Cr. 1	86731	45.4656	-122.4717	342	L/M	Kelley Cr.	Johnson Cr.	Human	Surface	436	2018
Kelley Cr. 2	None found	45.4689	-122.4923	300	M	Kelley Cr.	Johnson Cr.	Human	Surface	177	2018, '20
Kelley Cr. 2 No Dam	N/A	45.4689	-122.4923	300	M	Kelley Cr.	Johnson Cr.	Human	None	N/A	2021
Main City Pk Beaver	N/A	45.4958	-122.4298	276	L/M	Johnson Cr.	Johnson Cr.	Beaver	Porous	1884	2018
Marpol	28128	45.4784	-122.4568	354	N	Butler Cr.	Johnson Cr.	Human	Surface	4779	2016-18
Mawcrest	None found	45.4761	-122.4562	373	M	Butler Cr.	Johnson Cr.	Human	Surface	296	2016-17
Meade	None found	45.4734	-122.4051	344	H	Brigman Cr.	Johnson Cr.	Human	Surface	701	2015-16
MHCC Beaver	N/A	45.5157	-122.3910	259	H	Beaver Cr.	Sandy R.	Beaver	Porous	322	2018
MHCC	89068	45.5130	-122.3974	271	L/M	Kelly Cr.	Sandy R.	Human	Surface	8161	2011, '13, '15, '16, '17, '19
Ochioto Beaver	N/A	45.4840	-122.4181	304	M	Johnson Cr.	Johnson Cr.	Beaver	Porous	1754	2016
Palmblad Beaver	N/A	45.4715	-122.4012	354	M	Johnson Cr.	Johnson Cr.	Beaver	Porous	988	2016, '17
Persimmon 1	87865	45.4669	-122.4278	556	M	Hogan Cr.	Johnson Cr.	Human	Surface	3923	2018
Persimmon 2	87865	45.4681	-122.4239	527	L	Hogan Cr.	Johnson Cr.	Human	Surface	1409	2018
Roberts Beaver	N/A	45.4647	-122.3940	384	M	Johnson Cr.	Johnson Cr.	Beaver	Porous	880	2016
Waldorf	12103	45.4458	-122.6374	56	H	Spring Cr.	Johnson Cr.	Human	Surface	418	2012
Westmoreland	None found	45.4723	-122.6420	36	N	Crystal Springs Cr.	Johnson Cr.	Human	Surface	10400	2012
Cottrell	None found	45.4623	-122.3050	632	L	Johnson Cr.	Johnson Cr.	Human	Surface	2965	2018
Wheeler	None found	45.4594	-122.3521	494	H	Wheeler Cr.	Johnson Cr.	Human	Surface	506	2018
Kelly Cr.	N/A	45.4866	-122.3820	385	H	Kelly Cr.	Sandy R.	Human	Subsurface	471	2011, '13

[1] Source: Google Earth

[2] Qualitative (visual) assessment of Google Earth imagery

[3] Source: see bibliography[1,2]

Table 2. Statistical results and significance

Model Information	Summary Data					Tests of Model Effects[1]				
	N	Mean	Std. Dev.	Min	Max	df	Rank-based	Sig.	Value-based	p
(Intercept)						1	660.5	**<0.01**	*N/A*	*0.32*
Response: T_{Gain} (°C), 7DADM	6502	2.11	2.85	-3.27	12.45	1	1072	**<0.01**	369.0	**<0.001**
Covariate: T_{US} (°C), 7DADM	6502	17.10	2.68	9.82	32.36	1	8.744	**0.003**	4.216	**0.040**
Correlated Data Summary										
Pond ID (Subject Effect), # of Levels	26	# of Meas./Subject, Min			75	Probability Dist.			Normal	
Date (W/in-Subject Effect): # of Levels	1660	# of Meas./Subject, Max			871	Link Function			Identity	
Subjects, #	26	Correl. Matrix Dimension			1660	Working Correl. Matrix Structure			Independent	

[1] Method: Generalized Estimating Equation modeling, repeated on numeric & ranked values for QA/QC. Wald Chi-Square scores presented (Type III).

Figure 2. Boxplots of 7DADM T_{Gain} (°C) data by ICP.

Beaver ponds (n=7) are on the right. The horizontal lines represent no change (black), 0.5°C gain (purple), and 1°C gain (red), respectively.

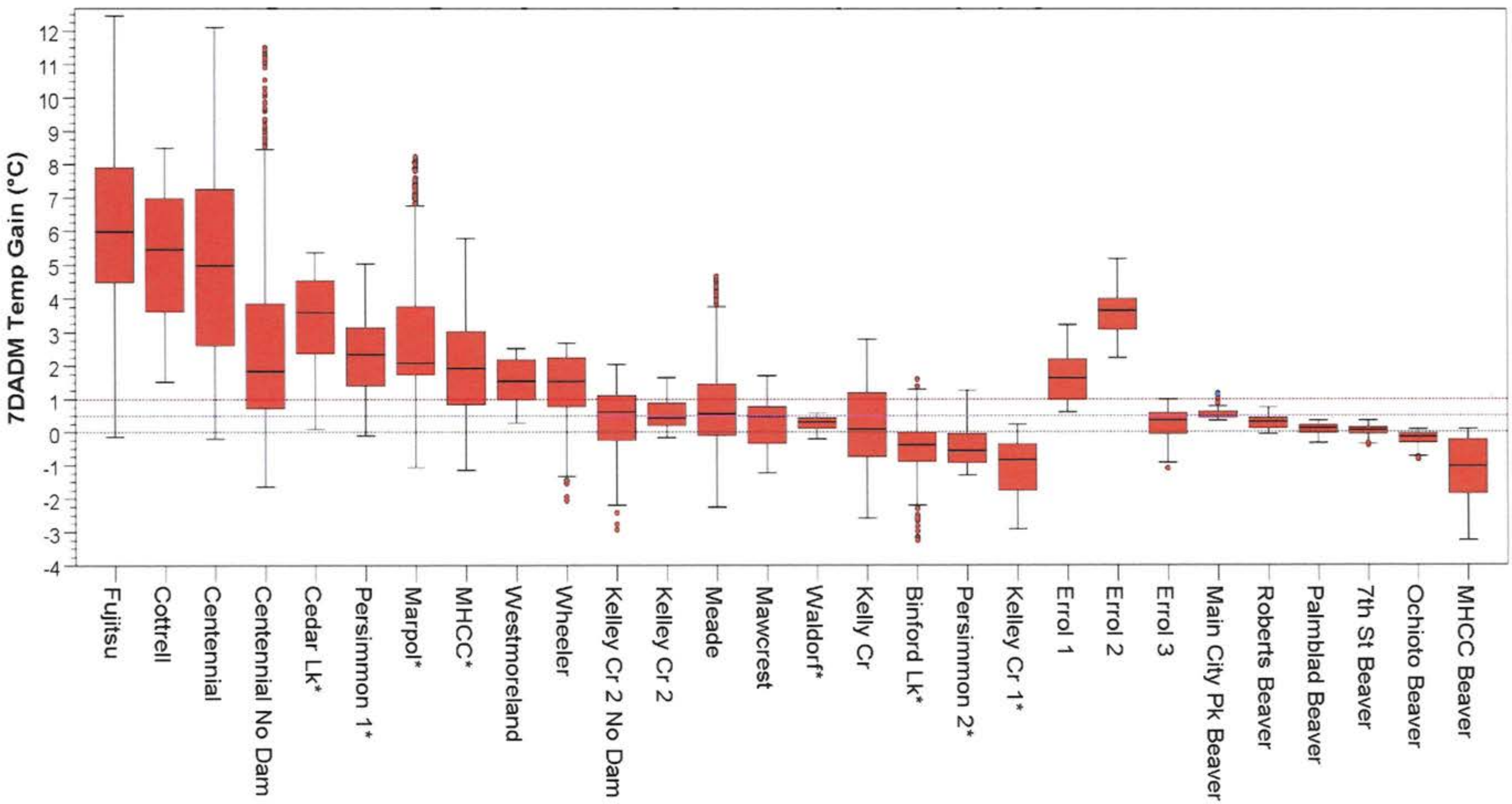


Figure 3. Boxplots of 7DADM TUS, TDS, and TGain data (°C) by ICP.

Beaver ponds (n=7) are on the right. The horizontal lines represent no change (black) and 1°C gain (red), respectively.

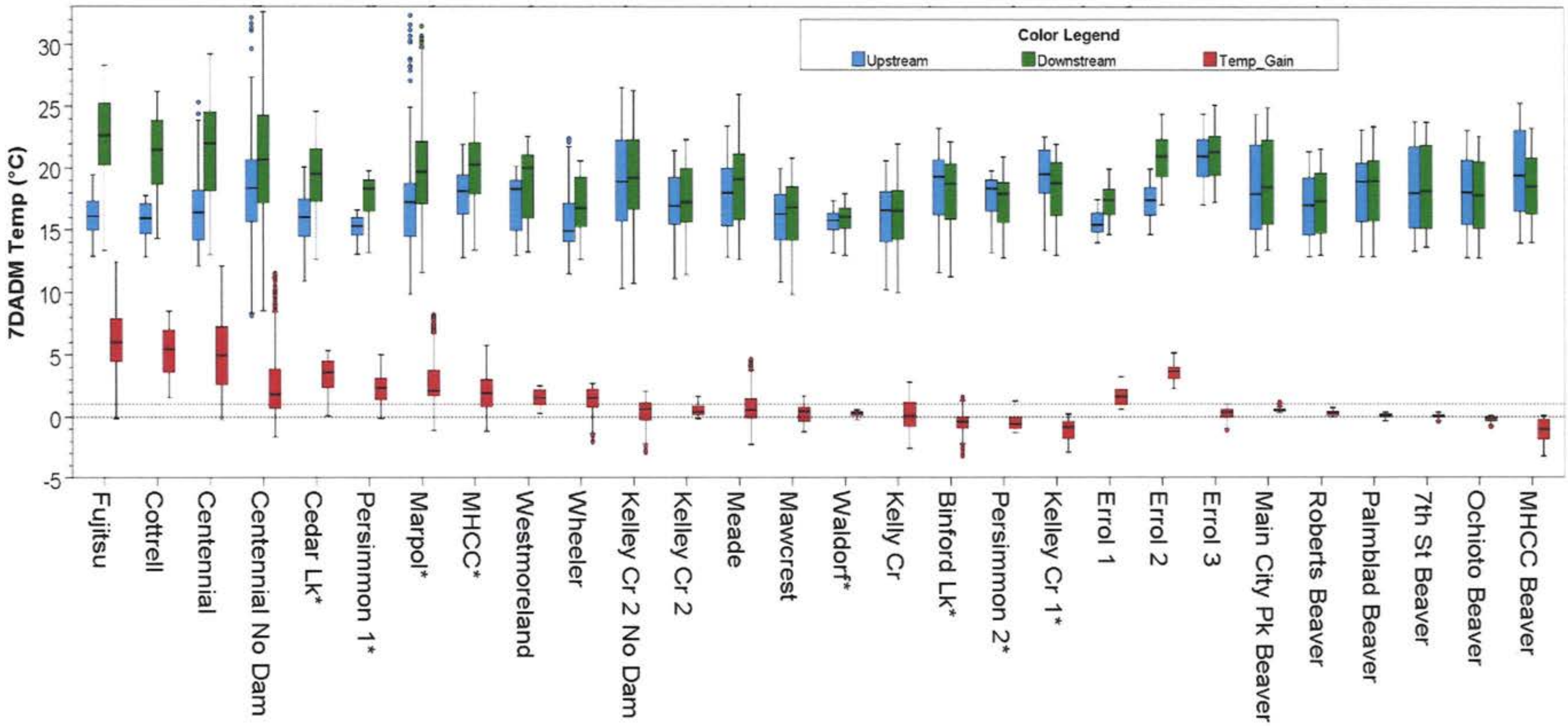


Table 3. Summary Data: Change in 7DADM WT (°C) for individual ICPs.

Median TGain with p<0.05 were considered significantly different than 0 (°C), which is roughly equivalent to <5% probability of a false positive (or false negative) difference.

ICP	Mean T_{Gain} (°C)	Median T_{Gain} (°C)	LCL95	UCL95	n	p
Fujitsu	6.24	**5.98**	5.83	6.14	925	**<0.001**
Cottrell	5.29	**5.46**	4.93	6.46	127	**<0.001**
Centennial	4.97	**4.97**	4.54	5.36	522	**<0.001**
Cedar Lk*	3.30	**3.60**	3.33	3.75	277	**<0.001**
Persimmon 1*	2.34	**2.34**	2.03	2.62	105	**<0.001**
Marpol*	2.95	**2.09**	1.97	2.19	455	**<0.001**
MHCC*	2.07	**1.92**	1.79	2.14	823	**<0.001**
Westmoreland	1.53	**1.55**	1.34	1.88	88	**<0.001**
Wheeler	1.24	**1.54**	1.16	1.74	127	**<0.001**
Meade	0.79	**0.56**	0.46	0.75	334	**<0.001**
Mawcrest	0.26	**0.47**	0.33	0.57	326	**<0.001**
Kelley Cr 2	0.52	**0.42**	0.34	0.51	178	**<0.001**
Waldorf*	0.26	0.30	0.28	0.32	149	0.076

ICP	Mean T_{Gain} (°C)	Median T_{Gain} (°C)	LCL95	UCL95	n	p
Kelly Cr	0.21	0.09	-0.13	0.27	362	0.080
Binford Lk*	-0.52	**-0.40**	-0.45	-0.35	476	**<0.001**
Persimmon 2*	-0.42	**-0.57**	-0.63	-0.45	105	**0.003**
Kelley Cr 1*	-1.06	**-0.85**	-0.98	-0.71	126	**<0.001**
Errol 2	3.59	**3.65**	3.48	3.77	140	**<0.001**
Errol 1	1.67	**1.63**	1.40	1.78	146	**0.032**
Errol 3	0.23	0.35	0.29	0.44	140	0.106
Main City Pk Beaver	0.57	**0.50**	0.47	0.57	81	**0.041**
Roberts Beaver	0.29	**0.31**	0.27	0.35	176	**0.038**
Palmblad Beaver	0.09	0.11	0.08	0.15	312	0.062
7th St Beaver	0.03	0.05	0.00	0.10	81	0.091
Ochioto Beaver	-0.22	**-0.15**	-0.20	-0.13	176	**0.011**
MHCC Beaver	-1.18	**-1.05**	-1.30	-0.80	81	**<0.001**

* ICP was linked to a WR permit. **Bold values** = statistically significant means (family-wise error rate <0.05). Red font = negative values.

CI = confidence interval (around the mean); SEM = standard error of the mean.

Light gray fill = anthropogenic ICPs, dark gray fill = beaver ICPs, medium gray fill = anthropogenically & beaver-affected ICPs.

Table 4. Mean 7DADM TGain (°C) of ICPs by type and dam outlet type.

Pond Type	Mean	Median	Median, LCL95	Median, UCL95	n
Anthropogenic	2.43	1.74	1.62	1.81	5931
Beaver	0.00	0.07	0.05	0.10	907
Dam Outlet Type					
Surface	2.97	2.26	2.17	2.38	4667
Subsurface	-0.20	-0.28	-0.36	-0.23	838
Porous	0.58	0.21	0.19	0.23	1333

Table 5. Summary 7DADM WT (°C), two ICPs with pre-/post-ICP dam removal data.

Location	Years	n	$T_{US,}$ DADM	$T_{DS,}$ 7DADM	$T_{Gain,}$ 7DADM
Centennial Pre	2014-16	504	16.42	22.07	4.97
Centennial Post	2019-21	544	18.26	19.99	1.21
Kelley 2 Pre	2018, 2020 (May-June)	296	17.24	17.60	0.47
Kelley 2 Post	2020, 2021 (Aug-Nov)	266	17.53	18.77	0.85

Literature comparisons:

As previously discussed, limited directly relevant information is available regarding water temperature impacts of ICPs similar to those assessed herein.[3,4,7–10] Nevertheless, our results agree with small dam studies in other regions (e.g., that most small surface-outlet impoundments increase summer water temperatures up to several degrees Celsius).[3,4,8,9] Likewise, previous studies of many sites included herein reported that anthropogenic ICPs increased the average 7DADM by 2.1°C and the average number of summer days with water temperature standard exceedances by 35 days/year, from 58 to 93 days.[1,2] For beaver ICPs, this analysis aligns with Oregon reports that beaver dams show water temperature effects ranging from benefits (reductions) to no or modest increases,[17–19] while other reports suggest water temperature impacts and the need for further study.[12,13,20,21]

Critical questions

Based on this and related studies, some answers to the project's critical question and sub-questions are possible.

1. **Are human-constructed ICPs linked to in-stream water temperature increases in Oregon?**

   Yes, based on standard statistical hypothesis test interpretations, this is highly probable for ICPs with surface outlets in this study area (>95% confidence). In contrast, two of seven beaver ICPs showed significant T_{Gain}, and the two ICPs with subsurface outlets showed significant water temperature *decreases* (Tbl. 3, Fig. 2)

   a. **If yes, what is the nature and extent of these effects?**

Focusing on surface-outlet ICPs across monitoring seasons, 12 of 15 showed significant 7DADM T_{Gain}. Among these 12 ICPs, the median 7DADM T_{Gain} was 2.0°C (Fig. 2, Tbl. 3) and nine had median 7DADM T_{Gain} >1°C. Among this ICP type, only Kelley Cr 1 and Persimmon 2 had significant negative median T_{Gain}. Additionally, two ICPs with porous outlets (Errol 1 & 2) had significant T_{Gain} (respective medians: 1.63 and 3.65°C; Tbl. 3).

All but one surface-outlet ICP (i.e., Waldorf) had 7DADM T_{DS} data that exceeded the 18°C temperature standard. Across ICPs, T_{DS} exceedances were more frequent and drastic than T_{US}; indeed, T_{US} at four never exceeded the 7DADM standard (Fig 2.) 7DADM T_{Gains} were greatest in summer (Fig. 4). e.g., across all ICPs in July and August, respective median T_{US} and T_{DS} (°C) were ~18.3 and ~20.8, representing ~2.5°C T_{Gain}.

Although strong effects were evident in this study area, we cannot say if or how these results may extend to other Oregon regions and watersheds. Alongside broad geographic- and landscape-based variation, this study's mainly metropolitan extent suggests that effects of riparian shading and other potentially influential stream and watershed characteristics would require additional study. Nevertheless, our results indicate that the water temperature effects of surface outlet ICPs should be of concern.

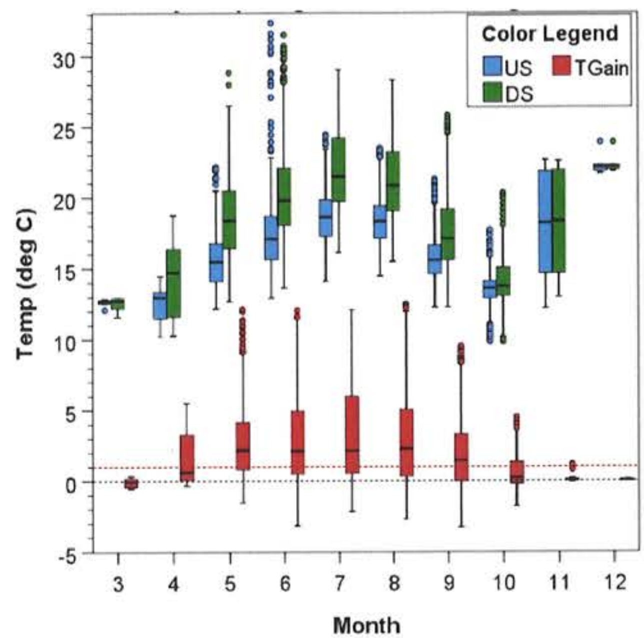


Figure 4. Boxplots of 7DADM T_{US}, T_{DS}, and T_{Gain} data (°C) by month.

b. If yes, what are the causative factors and which are most important? *e.g., influential conditions, design parameters, mechanisms.*

This question was not comprehensively or quantitatively addressed herein. A related study by City of Gresham reported a significant correlation between ICP surface area and T_{Gain},[1] which corresponded with suggestions that a primary ICP T_{Gain} mechanism is when ponded water receives additional sunlight due to reduced shading and increased water retention times.[3,4,12] Further study would likely be required to confirm. This may be possible with the current ICP water temperature data if additional catchment and ICP information were collected. If confirmed, this mechanism may also explain why subsurface outlets did not show significant T_{Gain} in this study. Summer thermal stratification was observed even in shallow ICPs,[1,2] meaning that subsurface outlets would draw deeper, colder water versus surface outlets.

2. Can we make regulatory recommendations for ICPs now?

This is ultimately a DEQ policy and management decision beyond the purview of this report, which may be determined best by a policy-technical group. That said, several *options* are initially evident based on Phase 1. Further study (Phase 2) may however be advisable to support certain options.

a. If yes, what are the recommendations and applicability? The following are example *potential* options:

- Continue to support OWRD efforts to obtain water right permits for ICPs.
- Recommend ICP water right permit denial unless permittee provides evidence that water temperature impacts are unlikely.

- Support voluntary ICP removal as a generally effective best management practice to reduce water temperature. Anecdotal evidence suggests that ICP dam removal or modification is a feasible, effective, and landowner-acceptable solution that also benefits fish passage. DEQ should consider promoting this.
- If new monitoring or modeling is planned, recommend forming a technical group to design the study (e.g., goals, roles, resource needs, data objectives, analysis methods) and to potentially review progress and output.

Recommendations for future work

- The downstream extent of water temperature increases was not assessed. Methods to assess this include temperature modeling and/or additional monitoring locations. *Note: the monitoring organizations typically used professional judgment to pre-select "well-mixed" downstream monitoring points, so we can assume the water temperature changes apply at least that far.*
- The broader geographic applicability (representation) of ICP water temperature effects was not assessed. The geographic applicability could be extended through desktop modeling (potential discussion topic) or new monitoring areas (e.g., different river basins, regions, etc.).
- "Control" sites (comparable sites without ICPs) in Oregon have not been extensively addressed. The water temperature data provided by local partners did include some data for two sites collected before and after ICP removal that provide a preliminary view (Tbl. 5). At the location with more data (Centennial), the median pre- and post-removal 7DADM T_{Gains} are notably different (5.0 and 1.2°C, respectively). The (more limited) Kelley Creek pre- and post- data (0.47 and 0.85°C, respectively) appear to show less of a dam removal effect.
    - *Note:* Hypothesis testing was not completed on these data as pre- and post- periods were different and could not be analyzed as matched pairs. Because some upstream-downstream T_{Gain} is likely even where ICPs are not present (due to increased sunlight exposure with downstream travel time and other factors),[3] it would be beneficial to collect and analyze additional, better matched "with-" and "without-dam" data to better-characterize the effects of ICP dam removal or modification.

Further study would likely be required to address the above considerations. This may be possible with the existing data if additional catchment and ICP information were collected. Local partners have expressed inclination to conduct such work. New monitoring sites and actions with a refined design may facilitate more robust analyses of potential influences. If this is pursued, it would be beneficial to engage in team-based design or prototype monitoring.

Conclusion

Overall, most studied human-constructed ICPs (14 of 17, omitting two ICPs with subsurface outlets) exerted significant water temperature effects at magnitudes of probable downstream concern. The significant T_{Gains} occurred during sensitive time periods, increased in the hottest months, and resulted in water temperature standard exceedances or exacerbations thereof. Among ICPs without significant median T_{Gain} (n=5), two had subsurface outlets (Kelly Cr., Binford Lk.) and two had among the highest median T_{US} of the study; note that increased T_{US} was reportedly linked to reduced ICP T_{Gain} effects.[1,4] From the current data and analysis, DEQ cannot yet conclude if similar effects occur in other regions and watersheds, and if so what are the major patterns and influences. However, direct solar radiation likely increases the temperature of ponded water in all areas of the state. DEQ also cannot say how far the downstream effects of a given ICP may persist.

References

(1) Holzer, Katie. *Effects of Inline Ponds on Stream Temperatures in the Johnson Creek Watershed.* http://www.jcwc.org/wp-content/uploads/2017/07/JCWC-Action-Plan-2015-2025.pdf.

(2) Jenkins, N. *Dam, It's Hot! Inline Pond Effects on Temperature in the Johnson Creek Watershed.* https://pdxscholar.library.pdx.edu/uerc/2019/presentations/6/.

(3) Mbaka, J. G.; Wanjiru Mwaniki, M. A Global Review of the Downstream Effects of Small Impoundments on Stream Habitat Conditions and Macroinvertebrates. *Environ. Rev.* **2015**, *23* (3), 257–262. https://doi.org/10.1139/er-2014-0080.

(4) Zaidel, P. A.; Roy, A. H.; Houle, K. M.; Lambert, B.; Letcher, B. H.; Nislow, K. H.; Smith, C. Impacts of Small Dams on Stream Temperature. *Ecological Indicators* **2021**, *120*, 106878. https://doi.org/10.1016/j.ecolind.2020.106878.

(5) Ham, J.; Toran, L.; Cruz, J. Effect of Upstream Ponds on Stream Temperature. *Environmental Geology* **2006**, *50* (1), 55–61. https://doi.org/10.1007/s00254-006-0186-4.

(6) Fairchild, G. W.; Velinsky, D. J. Effects of Small Ponds on Stream Water Chemistry. *null* **2006**, *22* (4), 321–330. https://doi.org/10.1080/07438140609354366.

(7) Chandesris, A.; Van Looy, K.; Diamond, J. S.; Souchon, Y. Small Dams Alter Thermal Regimes of Downstream Water. *Hydrol. Earth Syst. Sci.* **2019**, *23* (11), 4509–4525. https://doi.org/10.5194/hess-23-4509-2019.

(8) Seyedhashemi, H.; Moatar, F.; Vidal, J.-P.; Diamond, J. S.; Beaufort, A.; Chandesris, A.; Valette, L. Thermal Signatures Identify the Influence of Dams and Ponds on Stream Temperature at the Regional Scale. *Science of the Total Environment* **2021**, *766*, 142667. https://doi.org/10.1016/j.scitotenv.2020.142667.

(9) Lessard, J. L.; Hayes, D. B. Effects of Elevated Water Temperature on Fish and Macroinvertebrate Communities below Small Dams. *River Research and Applications* **2003**, *19* (7), 721–732. https://doi.org/10.1002/rra.713.

(10) Ecke, F.; Levanoni, O.; Audet, J.; Carlson, P.; Eklöf, K.; Hartman, G.; McKie, B.; Ledesma, J.; Segersten, J.; Truchy, A.; Futter, M. Meta-Analysis of Environmental Effects of Beaver in Relation to Artificial Dams. *Environmental Research Letters* **2017**, *12* (11), 113002. https://doi.org/10.1088/1748-9326/aa8979.

(11) OLDEN, J. D.; NAIMAN, R. J. Incorporating Thermal Regimes into Environmental Flows Assessments: Modifying Dam Operations to Restore Freshwater Ecosystem Integrity. *Freshwater Biology* **2010**, *55* (1), 86–107. https://doi.org/10.1111/j.1365-2427.2009.02179.x.

(12) Clark, T. R. Impacts of Beaver Dams on Mountain Stream Discharge and Water Temperature. **2020**. https://doi.org/10.26076/891b-18b3.

(13) Stevenson, J.; Dunham, J. B.; Wondzell, S.; Taylor, J. Dammed Water Quality – Longitudinal Stream Responses Below Beaver Ponds in the Umpqua River Basin, Oregon. *Ecohydrology* **2022**, *n/a* (n/a). https://doi.org/10.1002/eco.2430.

(14) Pearce, C.; Vidon, P.; Lautz, L.; Kelleher, C.; Davis, J. Impact of Beaver Dam Analogues on Hydrology in a Semi-Arid Floodplain. *Hydrological Processes* **2021**, *35* (7), e14275. https://doi.org/10.1002/hyp.14275.

(15) Talabere, A. G. Influence of Water Temperature and Beaver Ponds on Lahontan Cutthroat Trout in a High-Desert Stream, Southeastern Oregon. **2002**.

(16) Matthew R. Orr; Nicholas P. Weber; Wesley N. Noone; Megan G. Mooney; Taiontorake M. Oakes; Heather M. Broughton. Short-Term Stream and Riparian Responses to Beaver Dam Analogs on a Low-Gradient Channel Lacking Woody Riparian Vegetation. *Northwest Science* **2020**, *93* (3–4), 171–184. https://doi.org/10.3955/046.093.0302.

(17) Bouwes, N.; Weber, N.; Jordan, C. E.; Saunders, W. C.; Tattam, I. A.; Volk, C.; Wheaton, J. M.; Pollock, M. M. Ecosystem Experiment Reveals Benefits of Natural and Simulated Beaver Dams to a Threatened Population of Steelhead (Oncorhynchus Mykiss). *Scientific Reports* **2016**, *6* (1), 28581. https://doi.org/10.1038/srep28581.

(18) Weber, N.; Bouwes, N.; Pollock, M. M.; Volk, C.; Wheaton, J. M.; Wathen, G.; Wirtz, J.; Jordan, C. E. Alteration of Stream Temperature by Natural and Artificial Beaver Dams. *PLOS ONE* **2017**, *12* (5), e0176313. https://doi.org/10.1371/journal.pone.0176313.

(19) Machen, F. C. The Role of a Beaver in Shaping Stream Channel Complexity and Thermal Heterogeneity in a Central Oregon Stream. **2016**. https://doi.org/10.26076/0f50-c769.

(20) Majerova, M.; Neilson, B. T.; Roper, B. B. Beaver Dam Influences on Streamflow Hydraulic Properties and Thermal Regimes. *Science of The Total Environment* **2020**, *718*, 134853. https://doi.org/10.1016/j.scitotenv.2019.134853.

(21) Majerova, M.; Neilson, B. T.; Schmadel, N. M.; Wheaton, J. M.; Snow, C. J. Impacts of Beaver Dams on Hydrologic and Temperature Regimes in a Mountain Stream. *Hydrol. Earth Syst. Sci.* **2015**, *19* (8), 3541–3556. https://doi.org/10.5194/hess-19-3541-2015.

ATTACHMENT 4

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Director Ting Lu, Ph.D., P.E.

1120 SW Fifth Avenue, Room 405
Portland, Oregon 97204-1926
Information: 503-823-7770
Portland.gov/water

June 25, 2026

To: Renee France

From: Burke Strobel, Portland Water Bureau
Angie Kimpo, Portland Water Bureau
Roslyn Gray, Portland Bureau of Environmental Services
Stephanie Trujillo, Portland Bureau of Environmental Services[1]

Re: Cottrell Pond Restoration Project - Supplemental response to MCC 39.5590(C)(3)(b)

Case File T2-2025-0067

MCC 39.5590(C)(3)(b) requires a demonstration that development within the Alternative Analysis Site in the Riparian Area has been limited to the minimum area necessary to allow for the proposed use. As described in the application the proposed use provided through the Cottrell Pond restoration project (Project) includes 1) converting a "Degraded Riparian Corridor" to a "Good Riparian Corridor" condition; 2) restoring fish passage through the removal of the impounding dam; 3) improving the water quality in Johnson Creek through the decrease in water surface area and residence time to significantly decrease stream temperatures; and 4) retaining ecological functions such as breeding opportunities for native amphibians and floodplain retention of flood waters.

The development for this Project is limited to dam removal and subsequent grading necessary to achieve the restoration objectives. As explained in the application, the existing artificial dam and pond area is 51,200 sq ft (approximately 1.18 acres). To the east of the pond is a meadow dominated by invasive reed canary grass established under the influence of the artificial pond. Removal of the impounding dam and restoration of a natural stream channel requires grading and earth work to restore that existing impact area. The application identified a Project restoration grading area of 53,400 sq ft (approximately 1.22 acres), including the removal of most of the existing dam and grading to the east of the pond necessary to meet the proposed use. Additional design improvements, including changes suggested by ODFW, following submittal of the initial land use application allowed the restoration grading area to be further reduced to 51,200 sq (approximately 1.18 acres). These design improvements are represented in the current plan set. See Exhibits A.2 and A.12. For the collective reasons explained below, the Project development area is the minimum necessary to allow for the identified proposed use.

[1] As described in the attached resumes, each of the authors are experts in their respective fields. Each author listed is member of the project team that contributed to and reviewed the information contained in this memo.

The City of Portland is committed to providing meaningful access. To request translation, interpretation, modifications, accommodations, or other auxiliary aids or services, or to file a complaint of discrimination, contact **503-823-4000 (311), Relay: 711, or 503-823-7770**.

Traducción e Interpretación | Biên Dịch và Thông Dịch | 口笔译服务 | अनुवादन तथा व्याख्या | Устный и письменный перевод
Turjumaad iyo Fasiraad | Письмовий і усний переклад | Traducere și interpretariat | Chiaku me Awewen Kapas
Translation and Interpretation: **503-823-4000 (311), Relay: 711, or 503-823-7770 | portland.gov/water/access**

Good Riparian Corridor

A primary objective of the Project is converting the existing Degraded Riparian Corridor to a Good Riparian Corridor as those terms are defined in the code. Among other features, a corridor is considered degraded if greater than 10% of the area is covered by invasive plant species. As detailed in the Riparian Area Inventory, Assessment and Restoration Plan (Exhibit A-5), the existing condition is degraded with invasive coverage ranging from 15% to 68% across habitat types. The predominant invasive species in the riparian areas is reed canary-grass (*Phalaris arundinacea*). Reed canary-grass precludes the establishment and long-term viability of native plant populations.

To achieve the Good Corridor benchmarks, the Project includes substantial riparian plantings adjacent to the restored creek area. The success of those plantings requires removal of extensive stands of the invasive reed canary-grass to the east of the pond, including excavation of root mats and associated soils. In this case, that contributes to the size of the overall riparian restoration grading area. However, the temporary soil impacts have been minimized, and the vegetative benefits far outweigh the temporary ground disturbance.

Fish Passage/Water Quality

Restoring fish passage and elimination of the pond to improve water quality both require the removal of most of the impounding dam and excavation of accumulated pond sediments to establish a stream with a consistently low-enough gradient and grade controls to meet ODFW fish passage criteria. Extending the length of channel restoration towards the eastern property line also minimizes steep gradients and reduces the risk of developing a headcut, which can create a fish passage obstacle.

MCC 39.6225(B)(3) requires all unsupported graded areas above the established stream banks to provide a slope that does not exceed 3 horizontal feet to 1 vertical foot. The restoration grading for the Project includes the creation of banks with slope grades appropriate for stability and maintaining the restoration objectives of improving water quality and floodplain retention. Reducing the restoration grading area further would result in steeper slopes that are inconsistent with the restoration objectives and proposed use.

Ecological Functions

As identified in the list of proposed uses and explained in the application, one of the objectives of the Project is restoration and retention of ecological functions including creation of wetland habitat suitable for the breeding of native amphibians but not invasive bullfrogs. While providing some habitat value for native amphibians, the existing pond primarily serves as exceptional habitat for invasive bullfrogs that favor permanently impounded water. This project will significantly improve habitat for native amphibian species by creating seasonal ponds along the north bank of the creek with hydrological connections to the creek. These ponds are designed to meet the breeding needs of native amphibians but will dry each summer and prevent the establishment of invasive bullfrogs. American bullfrogs remain in tadpole form for over a year and require perennial slow or still water, whereas native pond-breeding amphibians can complete their larval development within a few months and can use seasonal ponds. Bullfrogs are also voracious predators, eating anything they can catch and fit into their mouths, including other amphibians. Native amphibians will benefit from the Project by continuing to have suitable breeding habitat while experiencing reduced predation from invasive bullfrogs

Creating this type of habitat requires additional grading, including the creation of a riparian bench. At this site, offline seasonal ponds must be slightly higher than the adjacent stream, or groundwater infiltration would keep them filled. A seasonal side channel will keep the ponds filled through the spring but then go dry at the upstream flow split when the flow in Johnson Creek falls below a certain level in late July. This design requires a riparian bench to hold the ponds at a higher elevation than the adjacent stream and requires a flow split at the upstream end that is far enough upstream to allow the two parallel channels to diverge in elevation. In designing the ponds, the Project team consulted with amphibian experts and considered alternative pond numbers and configurations, selecting the design that would provide the desired ecological uplift while maintaining a natural stream channel and minimizing site disturbance. The Project team also considered and implemented guidance from the Oregon Department of Fish and Wildlife (ODFW) on pond configuration to promote connectivity for fish.

Finally, the extent of the riparian restoration area was dictated in part by the federal permitting pathway for restoration projects such as this one. Nationwide Permit (NWP) 27 requires the project design to emulate a selected reference condition. The reference reach chosen for the low-gradient, downstream portion of the reestablished stream channel is a forested stream segment approximately 800 feet upstream of the Project. The reference reach has a gradient similar to the downstream portion of the project and includes a floodplain, which is expected to naturally form under low-gradient conditions. A floodplain was incorporated into the Project design, as required by NWP 27, which contributes to the riparian restoration grading area. This design element, however, is entirely within the footprint of the inline pond being removed. A floodplain will contribute to the functional value of the Project by reducing the scouring energy of winter flows and providing some retention of flood waters.

Conclusion

The Project restoration grading area incorporates the elements that are necessary to meet the proposed use for the site, including dam removal, a stream channel that provides fish passage and improved water quality, seasonal riparian ponds for native amphibian breeding, and a functional floodplain. Those elements and grading of the surrounding slopes to comply with County requirements, including further reductions in the extent of grading following submission of the land use application, for the collective reasons provided above, result in the minimum area necessary to allow the proposed use and achieve the Project objectives.