NORTH CLACKAMAS WATERSHEDS COUNCIL

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January 20, 2025

Reva Gillman
Oregon Conservation & Recreation Fund Coordinator
Oregon Department of Fish & Wildlife

CC: Dr. Leslie King, Oregon Fish & Wildlife Commission
Steve Niemela, North Willamette Watershed District Manager
Ben Walczak, District Fish Biologist
Dave Stewart, Stream Restoration Biologist
Jim Brick, Lower Columbia Implementation Coordinator
Susan Barnes, Regional Conservation Biologist
Andrew Spyrka & Paul Olmstead, ODFW Private Forest Accords Program

Dear Reva and others at ODFW:

The North Clackamas Watersheds Council is pleased to submit our final report for Oregon Conservation & Recreation Grant # OCRF 2023-21 Fish Habitat Protection with Thermal Infrared Imagery. ODFW support for this project was critical in gathering information on the precise location of cold water refugia that is essential to maximizing the habitat uplift of many projects, and has already influenced the design of the Kellogg Creek Restoration & Community Enhancement Project and the Elk Rock Island Side Channel Project. These are both large-scale restoration efforts, and support from the Conservation and Recreation Fund has allowed us to maximize the ecological uplift of these projects.

Thank you. The fish, wildlife, and people of Oregon are all beneficiaries of our partnership.

Sincerely,

Neil Schulman
Executive Director

# OCRF Grant Project Completion Report

*Oregon Department of Fish and Wildlife*

## *Introduction*

**Project Name: OCRF 2023-21 Fish Habitat Protection with Thermal Infrared Imagery**

**Project Location:** Lower Willamette River and Tributaries

Other (please explain).
Thermal Imaging Used at 3 significant sites to inform restoration design and strategy and planned for a fourth in Summer 2025:

- Kellog Dam Impoundment (Kellogg Creek Restoration & Community Enhancement Project, Willamette River/Kellogg Creek confluence fish passage and restoration)
- Willamette River Side Channel at Elk Rock Island/Spring Park
- Minthorn Springs Wetland

### Oregon Conservation Strategy Species *

List the Oregon Conservation Strategy Species and Oregon Conservation Strategy Opportunity Areas that the Project benefited.

- Chinook Salmon (*O. tshawytscha):* LCR ESU Fall and Spring, Willamette SMU Spring
- Coho Salmon *(O. kisutch):* Lower Columbia SMU
- Pacific Lamprey *(E. tridentatus):* Willamette Valley
- Northern Red-legged Frog *(R. aurora):* Willamette Valley

## *Final Report Questions*

### Project Statement*

Briefly describe what the project accomplished and the problem(s) it addressed. Make a clear and concise statement; avoid jargon and acronyms.

The project was created to address the problem of stream temperature and its effects on aquatic life, and specifically to identify with precision locations of cold water inputs so these areas could be restored and restoration designs of multiple projects could incorporate the locations of springs, groundwater connections, and vital cold water refugia, instream complexity, side channel restoration, and floodplain restoration and reconnection. These cold water refugia have been identified as increasingly important due to changing climactic regimes, and locating cold water sources and plumes precisely and incorporating this information into restoration design is essential to maximize the ecological uplift of instream habitat restoration.

With the support of the ODFW Conservation and Recreation Fund, the North Clackamas Watershed Council (the

Council) purchased a thermal imaging drone and flew critical restoration areas where restoration projects are either in design or planned, and then incorporated this information into the restoration design and planning processes (see attached report). Furthermore, the methodology was shared with the North Clackamas Interagency Working Group. Methodology and data interpretation was assisted by faculty and students in Portland State University's Environmental Science & Resources program.

The designs of two projects were altered based on the thermal imaging that identified cold water sources and plumes:

**Kellogg Dam Impoundment**: The Kellogg Creek Restoration & Community Enhancement Project is a large-scale, once-in-a-generation project that will remove Kellogg Dam, the #1 Priority Fish Passage Barrier in the state owned by ODOT (Oregon Fish & Wildlife Commission). The thermal imaging flight detected a significant cold water input into a cove in the current impoundment on the north side, on the property owned by the Milwaukie Presbyterian Church and already managed for habitat purposes. Initial design concepts restored this area to terrestrial habitat and placement of spoils. Based on this information (see attached memo) this area has now been identified for a back channel with large wood complexes in the restored Lower Kellogg Creek for rearing juvenile salmonids and lamprey.

**Willamette River Side Channel at Elk Rock Island/Spring Park:** The Willamette River Side Channel at Elk Rock Island/Spring Park project, currently at 30% design and scheduled for construction in 2026, will build large logjams in the only side channel/alcove on the Oswego stretch of the Willamette that is geologically constrained (USGS, 2018). The area is noted for springs (Spring Park) but their locations were unknown. Thermal imaging flights identified their location and plumes of cold water in the side channel during late summer 2024, when the Willamette often exceeds ODEQ temperature standards for salmonid rearing & migration and sometimes standards for migration corridor. (DEQ, 2008). We used this information to relocate large wood structures to be in the plume of cold water from the springs, maximizing their habitat value. This will be incorporated into the 60% design.

**Minthorn Springs Wetland (Tributary of Mt. Scott & Kellogg Creeks):** This site is 6.5-acre wetland owned by the Wetlands Conservancy, and it was a part of the Council's 2022 temperature study. During that study, the springs at this site had some of the coldest water seen. Unfortunately, the logger at the exit of the wetlands showed some of the hottest temperatures we saw in this study in 2022. This posed the question of whether hot water inputs were being discharged into the wetland by the adjacent industrial land, or was heating up over the site due to solar exposure and shallow water. Flights in September 2024 found that on the south side of the property where water drains out of the wetland into the southern culvert, we identified a plume of warm water mixing into the cooler water of the channel (see attached report, Figure 10). This mixing area could be seen in both the RGB and infrared images. It is uncertain at this time what the source of this plume might be; however, the Council will work with the Wetlands Conservancy, North Clackamas Parks & Recreation Department, and the City of Milwaukie to take a closer look at this site and determine the source of the warm water.

## Summary of Goals*

Describe how project goals, objectives, and/or milestones were completed. Discuss any measurable and achieved benefits (# of volunteers engaged, acreage restored, retrofits, planning documents created, research results, etc.).

The project met and or exceeded its goals and objectives, as follows:

| Goal/Objective | Result | Next Steps |
|---|---|---|
| **Locate cold water seeps/springs in Kellogg Lake Impoundment; incorporate into restoration design** | Cold water located, memo to design team will spark creation of side channel and habitat structures in this area (Council is part of Core Technical Team and Project Leadership Team) | Conduct amphibian surveys in this area (scheduled January 2025<br>Final project design January – August 2025 |
| **Locate Cold water springs in Elk Rock Island/Spring Park; ensure design protects and enhances functionality of cold water and directs recreational use away from critical cold water habitat** | Cold water located, structures will be moved and enlarged to relocate them in the cold water plume, enhancing habitat value significantly. Springs were located in a steep slope that is difficult to access, which naturally directs recreational use away from this area. | Final design complete August-September 2025; construction 2026. |
| **Identify source(s) of heat loading at Minthorn Springs and seek options to reduce heat impacts** | Location of heat plume identified | Council and Wetlands Conservancy working with agency partners to identify source and ways to mitigate impacts |
| **Create replicable methodology for drone-based TIR imagery** | Complete: see attached report. Methodology was shared with the Council's Interagency Working Group and Portland State University | Seek further opportunities to disseminate; symposia, professional meetings, etc. |
| **Make technology and methodology available to partners in restoration** | Technology made available to partner Watershed Councils and agencies, with interest from City of Gresham, City of Milwaukie, Clackamas Water Environment Services, and Johnson Creek Watershed Council | |

## Lessons Learned*

Describe lessons learned and challenges faced during the grant performance period. Examples being delays, contractual issues, permitting, funding, changes to the project Scope of Work or amendments, etc.

The largest lesson learned was that drone-based TIR imagery is a very effective and efficient way of identifying both cold water and warm water sources compared to other methods. Two years previously, this would have required use of a helicopter, which would both cost-prohibitive and ineffectual in small streams with overhanging shade. Since a drone can fly below the canopy, this was highly effective. Similarly, walking the stream with a highly

sensitive probe requires more field time, extensive contiguous landowner permissions, and because it does not provide imagery that can be analyzed in detail at length later, creates a larger potential for missing significant inputs.

We did find that there were two unanticipated obstacles, both of which we were able to overcome:

1. **Landowner Communication:** Flying drones in populated areas, while common for recreational purposes and also for other commercial applications such as real estate, is best done in close communication with landowners and residents. This is a time-intensive and relationship-based process, and most residents do not follow drone flight regulations. While permission is not needed to fly above 300 feet, we intentionally secured buy-in regardless of height flown, since this was a means to both education of landowners and residents about stream health, restoration, and watershed science, and to avoid any conflict. This process, however, took enough time that when we decided to add an additional site to the project (See next steps, below) the landowner engagement took long enough that that flight was rescheduled for summer/fall 2026
2. **Analysis:** The analysis of drone data requires both significant software and technology capacity to manage large data packages, and time for the analysis. This took both an additional investment in software and more staff time than planned. The additional support provided by Portland State University interns and faculty was essential in managing the data analysis. Future projects will incorporate the time management learned from this past year.

## Next Steps*

Describe any next steps for the project, if any.

**Future Thermal TIR Projects**

Parmenter Ponds

Based on the success of this project, and additional data discovered in 2024, we will conduct flights of Parmenter Ponds on Kellogg Creek (as noted above) in summer/fall 2025 following landowner communication. 2024 eDNA use by salmonids, and temperature logger data from Kellogg and Mt. Scott Creeks indicated that Parmenter Ponds is likely a critical cold water refuge. It has cold water in the summer, and eDNA data indicated presence of Steelhead/rainbow trout during the summer months, when stream temperatures throughout the system are highest. This flight, as with the others, will identify sources of cold water and guide future restoration efforts. Conversations with landowners are underway with flights planned summer/fall 2025.01.20

Other areas we have identified for future use of drone-based thermal imagery to guide restoration are:

- **3 Creeks Protected Area on Mt. Scott Creek**: This area will see a major floodplain reconnection project implemented in 2025 IWWP by Clackamas Water Environment Services. Following completion, we would like to fly this area to assess success and identify any other actions that can magnify the habitat benefit.
- **Dean Creek:** Dean Creek is a known cold-water tributary of Mt. Scott Creek, and cold enough with sufficient flow to influence the temperature of Mt. Scott Creek. We are beginning stakeholder engagement along Dean Creek (funded by Oregon Watershed Enhancement Board) and preliminary mapping indicates potential room for restoration actions along the creek. Once we have advanced the stakeholder and landowner conversations, we will prioritize reaches for thermal imagery.

# *Attachments*

**Include all project data collected, such as surveys, reports, PDF maps, photo monitoring and planning documents. Upload any color photographs of the Project area(s) before and after the Project completion taken at the pre-set photo points as one document.**

Please find the attached Report and Technical Memo.

# *Certification*

Drafts of final reports for review may be submitted to ODFW.OCRF@odfw.oregon.gov

## Certifying Statement*

I certify that the above and attached information is true and accurate.

### Choices

Yes

## Applicant Authorized Representative Name*

*Character Limit: 200*

## Authorized Representative Title*

*Character Limit: 200*

# 2024 Thermal Infrared Drone Imagery to Assess Climate Resiliency in Restoration Design

January 2025

Written by: Amy van Riessen, North Clackamas Watershed Restoration Manager

*Supported by: ODFW's Conservation & Recreation Fund*

## Project Background

In 2022, North Clackamas Watersheds Council (NCWC or the Council) conducted the first year of the North Clackamas Watersheds Temperature Study and installed 28 temperature probes throughout the watersheds to collect summer water temperatures. During that study, the Council noticed that the assumed presence of cold-water seeps and springs potentially played an important part in regulating water temperatures. In areas with large temperature increases there seemed to be a relationship between impervious surfaces with limited shade and warm stormwater discharges. Thermal imaging was used to assist in identification and protection of cold-water resources, and identifying sources of warm-water discharge to facilitate removal or attenuation of these impacts. The Council intends to use this thermal imaging information to aid design of instream restoration project to maximize climate resiliency.

Coldwater fish such as salmonids are sensitive to elevated summer water temperatures; however, they can survive in cool-water refugia even when temperatures in the mainstem are at or above the recommended maximums. The DEQ established temperature standards for specific life history stages of salmon and steelhead (as seen below in Table 1). The standards are used in establishment for Total Maximum Daily Load (TMDL) criteria for water quality limited streams in Oregon, and are based on the 7-day average maximum (7dAM).

*Table 1- List of designated beneficial uses for salmonids and associated temperatures.*

| Beneficial use | 7dAM |
|---|---|
| 1. Salmon & steelhead spawning (during spawning use) | 55.4 F / 13 C |
| 2. Core coldwater habitat (year round) | 60.8 F / 16 C |
| 3. Salmon & trout rearing & migration (year round) | 64.4 F / 18 C |
| 4. Migration corridor for salmon & steelhead (year round) | 68.0 F / 20.0 C |

Restoration ecologists can look at spatial thermal imaging to identify the location of ground and surface-water inputs to the river channel, and to identify thermal pollution sources. Over the last decade, technological advances have made these imaging systems more stable, portable, and affordable. Through a grant provided by the ODFW Conservation & Recreation Fund, the Council was able to purchase a drone that is outfitted with both a RGB and infrared camera and fly three project sites the summer of 2024: The Kellogg Dam Impoundment, Elk Rock Island Back Channel, and Minthorn Springs Wetlands.

## Project Design

The goal of the drone flights was to identify the location of cold-water springs and warm-water inputs in restoration sites to ensure any work protects and enhances cold-water features and potentially treats warm water inputs. The imagery data is being looked at qualitatively, not quantitively, as the temperature data is just showing surface water temperatures taken at one point in time. The imagery was used to identity point-sources of hot and cold water to

maximize climate resiliency in the design of restoration work. The Council had three project areas identified for initial thermal infrared (TIR) aerial imagery:

1. ***Kellogg Dam Impoundment:*** This 14-acre impoundment behind Kellogg Dam will be restored when the dam is removed as part of the Kellogg Creek Restoration & Community Enhancement Project, with construction anticipated to begin in 2028. The Council, in partnership with American Rivers, the City of Milwaukie, and the Oregon Department of Transportation, is currently in the process of designing the restoration elements of the impoundment. Several historical documents have mentioned the presence of cold-water seeps/springs in the project area, and identifying and locating these cold-water inputs will allow us to protect and enhance this cold-water as a part of the restoration design. If there are point-source discharges occurring in the impoundment, those can also be treated as part of the design.

2. ***Elk Rock Island Back Channel:*** This 3.5-acre restoration site is a side channel on the Willamette River that is purported to be spring fed and the adjacent park is named Spring Park. This project site is predominately owned by the City of Milwaukie with the land below Ordinary High Water (OHW) being owned by the Oregon Department of State Lands (DSL). The Council is currently designing a habitat restoration project in this side channel focusing on installation of large wood jams. Identification of the location of cold-water springs will allow the design to prioritize placing wood in areas with cold water seeps. This would provide cover in these areas of cold water refugia in the warm summer months.

3. ***Minthorn Springs Wetland:*** This site is 6.5-acre wetland owned by the Wetlands Conservancy, and it was a part of the Council's 2022 temperature study. During that study, the springs at this site had some of the coldest water seen. Unfortunately, the logger at the exit of the wetlands showed some of the hottest temperatures we saw in this study in 2022. This posed the question of whether hot water inputs were being discharged into the wetland by the adjacent industrial land, or was heating up over the site due to solar exposure and shallow water? Aerial infrared imagery will help to better understand the temperature dynamics at this site, allowing protection of the cold water coming from the springs.

The drone selected for this work was the DJI Mavic 3T. This drone is portable enough for field work and has two cameras, a Zoom camera for the visible light spectrum and an infrared camera for the thermal spectrum. The Mavic 3T's zoom and thermal cameras also support continuous side-by-side views on the controller for easy comparisons. The flight interface allows for pre-programming the flight paths and specifying image overlap, both of which is necessary for the creation of orthomosaic photos.

*Figure 1- Side by side viewfinder on remote controller of DJI Mavic 3T (image from DJI Enterprise).*

A "Small UAS Certificate of Registration" was acquired from the Federal Aviation Administration (FAA) to register the drone. All flights were done by a licensed drone pilot to comply with FAA regulations. The project sites were flown twice, collecting images in both the infrared and visual light spectrums. A flight plan was created using the flight planning software on the remote. All flights were flown at 300 feet above ground level (AGL). Front and side overlap for flights was set to 85%. The drone speed was slowed down to approximately 60% of max speed to minimize blur in the photos.

*Figure 2 - Drone pilots were all licensed by the FAA.*

The site photos were converted to .tiff files to be processed in Pix4D Mapper. The resulting orthomosaics were exported in.tiff format, allowing comparison of the visible light images with the infrared images.

# Results

## *Kellogg Dam Impoundment*

The Kellogg Creek Restoration & Community Enhancement Project plans to remove Kellogg dam and restore the dam's 14-acre impoundment. The project currently has a concept level restoration design and the final phase of the design process will begin in January 2025. The water impoundment behind Kellogg Dam was flown on August 13, 2024 by Inter-fluve, who developed the Phase 1 concept-level restoration design for the impoundment. After the flight, the Council was approached by Portland State University professor Jennifer Morse and student Dalton Palin regarding an undergrad thesis project. Dalton will be correlating the thermal imaging photos to the concept restoration design to analyze climate resiliency in the project design. This partnership will advance the Council's interests in conservation education and helping promote conservation and science workforce development while also contributing to needed real-world projects. Because of the size of the project area, and the complexity of the design of the restored impoundment, this analysis will play an important role in meeting climate resiliency goals. While waiting for the completion of the analysis by PSU, some initial observations can be made from the infrared images.

The lower impoundment where the channel widens and becomes shallower due to accumulating sediment creates conditions for significant warming. Temperatures in this

section exceed 20C, creating a thermal barrier to fish passage in the summer that would exist even if the existing fish ladder was improved upon to allow fish passage over the dam. Shade is limited in this portion of the impoundment due to the channel width which could be contributing to higher water temperatures. Continuous temperature monitoring upstream and downstream of the impoundment using instream loggers (NCWC, 2023 and 2024) have shown a 5 ˚ C increase in water temperatures through the project site. The infrared imagery is showing similar increases as the channel widens and becomes less shaded.

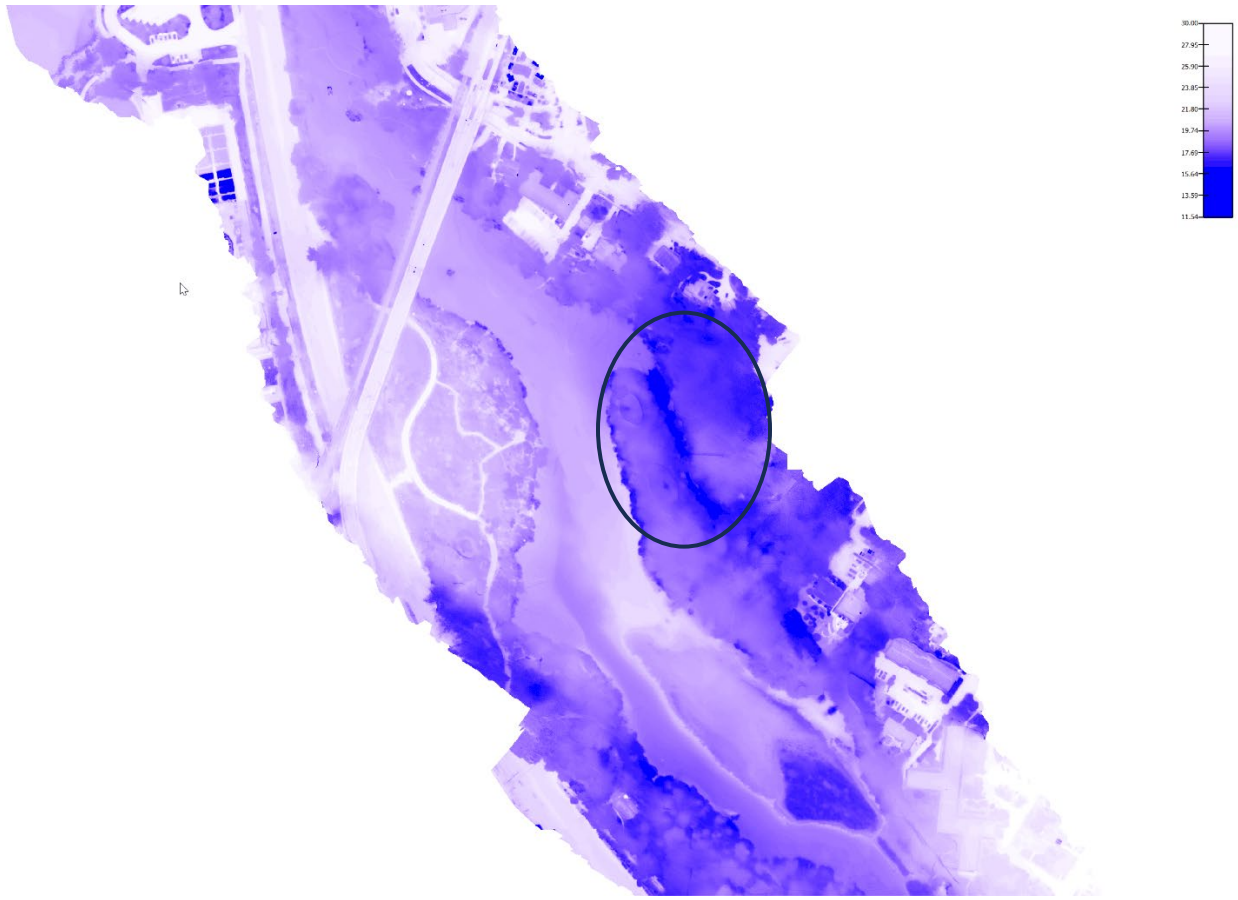


*Figure 3 - Infrared imagery of lower Kellogg impoundment highlighting cold water spring input.*

Imagery of the lower impoundment also indicated a sizeable plume of cold water coming out of the Milwaukie Presbyterian Church's property (circled on Figure 3). There is evidence of a spring on this property, and this imagery confirms that water is significantly cooler entering into the impoundment. This location seems to be an ideal opportunity for the creation of off-channel refuge habitat, to capture and maximize the utilization of the cold water by fish during the summer months. The original concept design does not include this feature. Therefore this information will be used to inform the next stage of the design process.

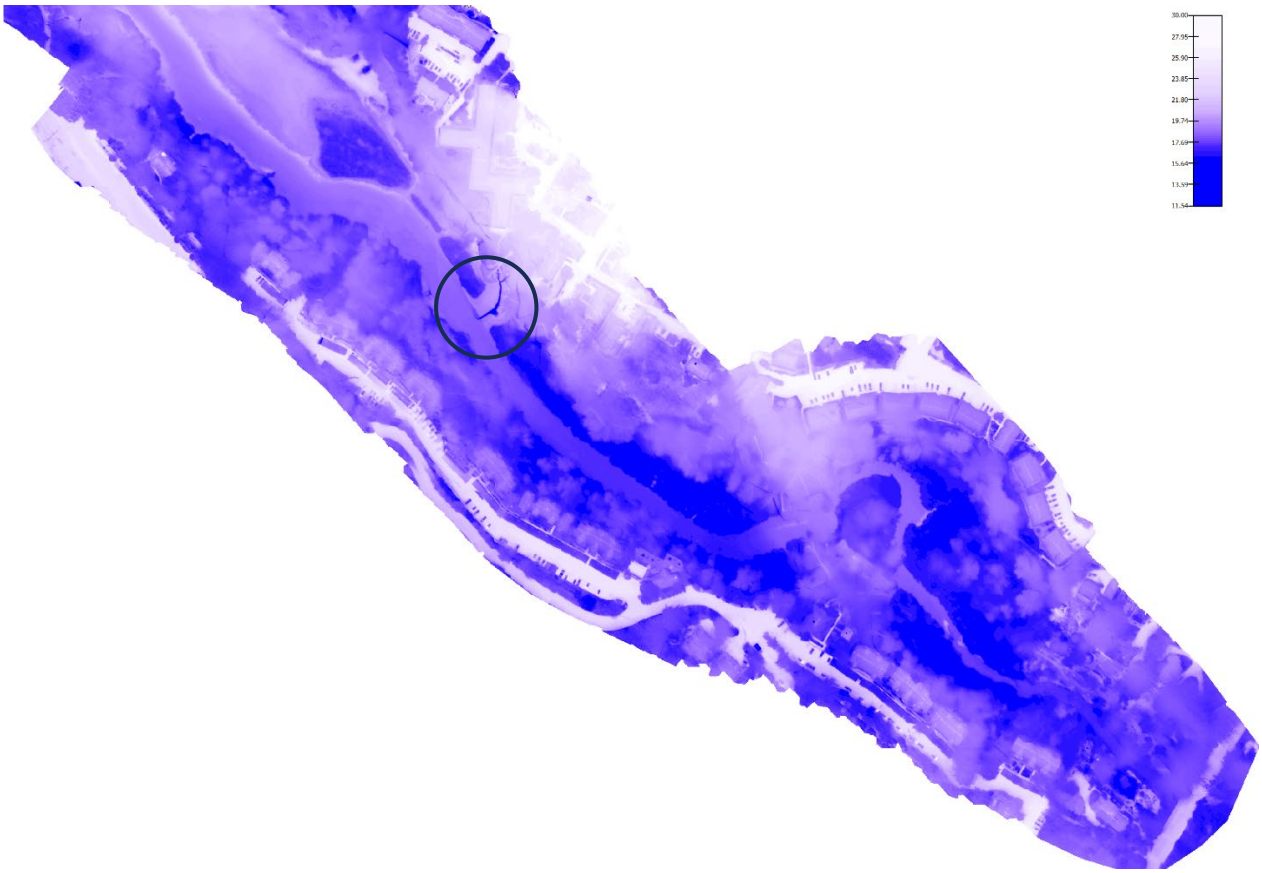

*Figure 4 - Infrared imagery of upper Kellogg impoundment.*

The channel in the upper impoundment starts to narrow down and has better shade coverage, which is reflected in lower in-channel water temperatures. There appears to be a cold-water spring contributing water into the channel south of Lake Village Apartments. This is also near the location of an existing sewer pipeline crossing the channel. This information will be brought to the design team to determine how we can maximize utilization of this cold water while maintaining stability of the existing pipe crossing.

## *Elk Rock Island Back Channel*

In partnership with the City of Milwaukie and North Clackamas Parks & Recreation District (NCPRD), the Council is working to design and implement a restoration project within the side channel of Elk Rock Island to enhance aquatic habitat. As part of this restoration work, we will be placing large wood throughout the side channel and floodplain. Large wood will slow the flow of water through the channel and provide fish with refuge during high flow events. These large pieces of wood will also help to provide cover and create pools for fish to rest and hide from predators. The project area is adjacent to Spring Park, which has been historically said to have springs in the area. Thermal imaging flights of the project area allow restoration engineers to maximum the benefit of those cold-water areas for fish by targeting those locations for the installation of large wood structures. The site was flown the afternoon of Friday, September 13, 2024 when very little water was in the back channel.

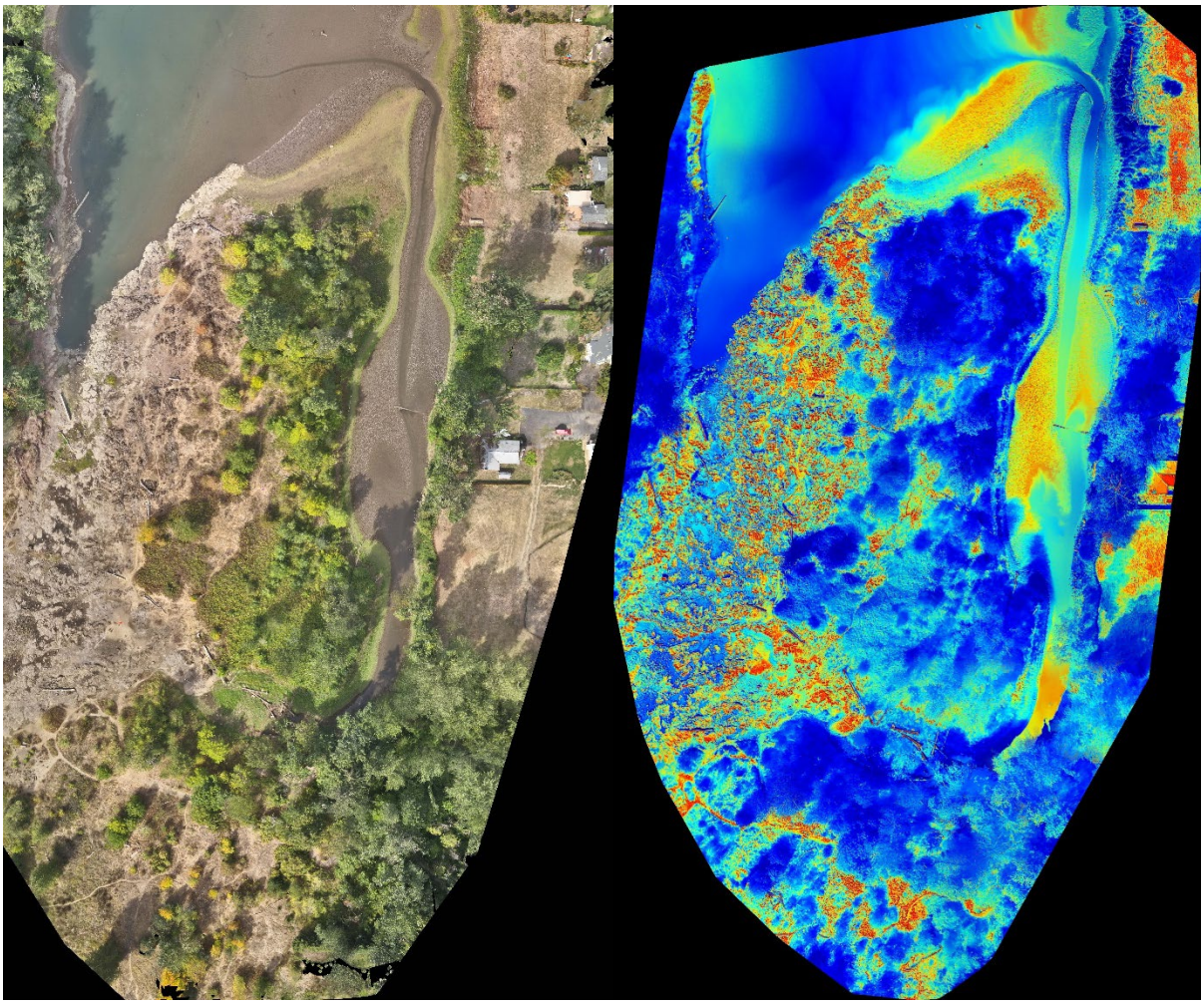

*Figure 5- Visible and infrared images of the Elk Rock Back Channel project site.*

The infrared imagery shows the impact vegetation and shade play in cooling the area, which has a positive impact for water temperatures and land temperatures for people and wildlife. Drone imagery also found the presence of cold-water seeps coming out of the banks at the south end of the channel, as seen in Figure 6.

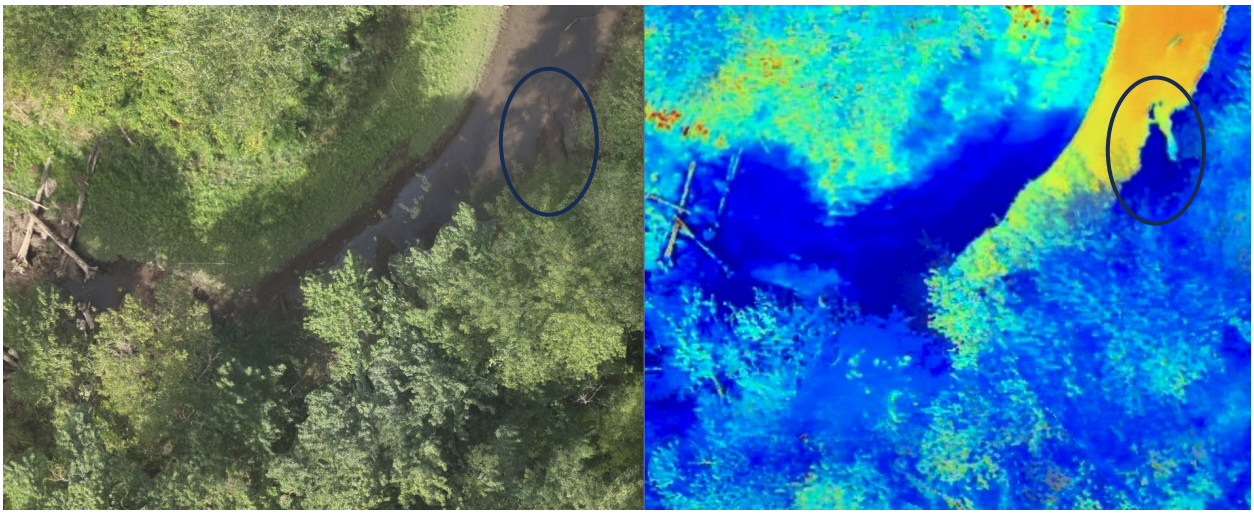

*Figure 6 - Location of cold-water springs on the south end of the project site.*

The 30% concept level restoration design did not have log jams that far south in the channel. To maximize climate resiliency associated with the restoration design, the logjams will be extended to the south, ensuring that instream cover is created in areas that also provide cold water refuge for juvenile salmonids in the summer months.

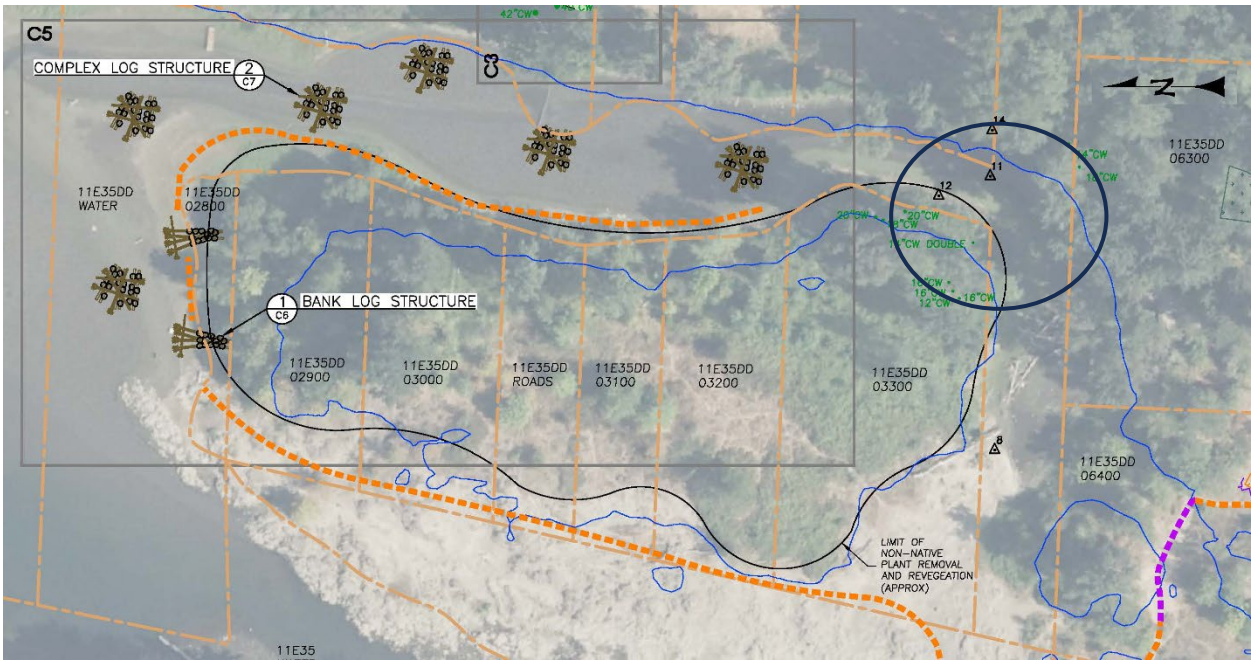


*Figure 7 - The 30% engineering design shows logjams in the northern parts of the channel. These log structures will be extended to the southern end of the project site to capitalize on the cold-water springs found with the infrared drone.*

## Minthorn Springs Wetland

Minthorn Springs Preserve is a 6.5-acre nature preserve owned by The Wetlands Conservancy that was created as a nature and water sanctuary when nearby wetlands were filled for development. The Conservancy's State-of-the-catchment Summary (2016) noted that the

water quality (including temperatures) in the wetland was considered poor. In 2022, the Council placed 2 temperature loggers in the wetland: one in the spring-fed inlet of the wetland (Site 18), and one at the outlet (Site 17). This continuous monitoring study showed that the inlet maintained a consistent 13-15 ˚ C all summer long, showing the coolest water temperatures in the watershed. However, the logger placed at the outlet of the wetlands showed some of the highest temperature in the watershed (NCWC, 2023).


*Figure 8 - Location of continuous temperature loggers in Minthorn Springs Wetland.*

The drone flights were conducted to try to determine if the increased temperatures are simply a function of solar radiation due to lack of shade and shallow water, or whether there are point source inputs of warm water into the wetland. The site was flown the afternoon of Friday, September 13, 2024.

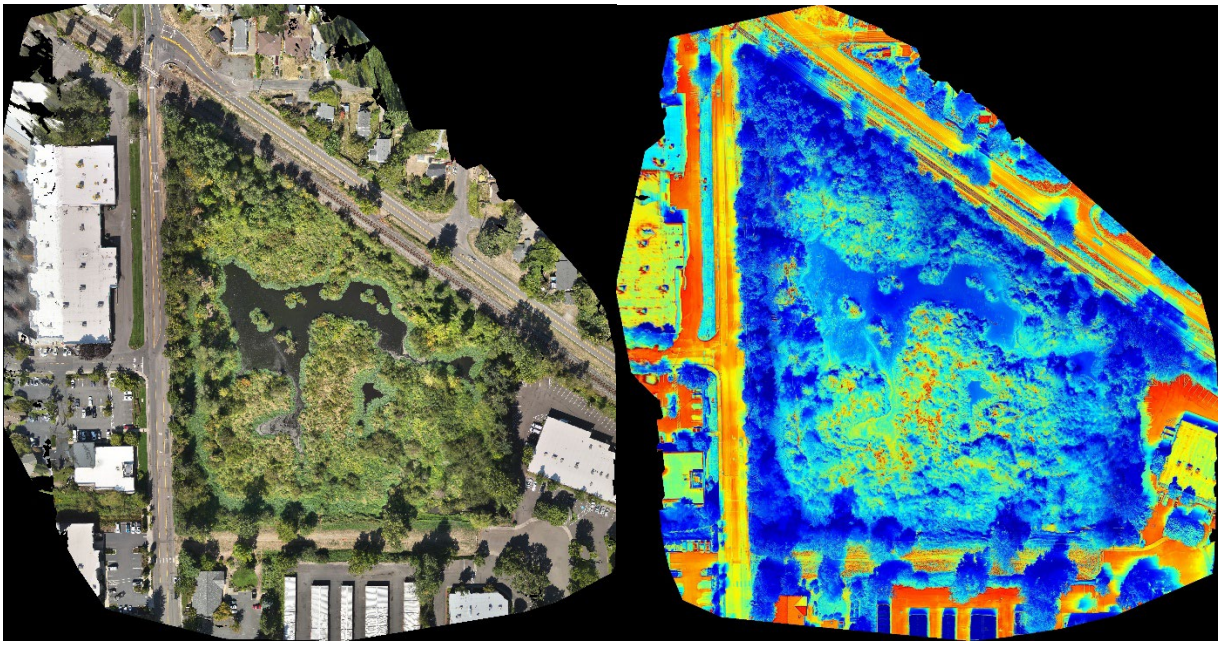

*Figure 9 - Visible and infrared imagery of Minthorn Springs Wetland.*

Temperatures at Minthorn Springs wetland are cooler around the perimeter of the property where there are more upland areas conducive to establishing shade trees. The center of the property is fairly saturated with water; therefore, it can be difficult to establish shade in this area. Some of the open water was also covered with emergent/floating vegetation during the time these images were taken which makes interpretation difficult. It may be worthwhile retaking these images earlier in the summer when water levels are higher and the wetland channels have not yet filled in with vegetation.

On the south side of the property where water drains out of the wetland into the southern culvert, we identified a plume of warm water mixing into the cooler water of the channel (see Figure 10). This mixing area could be seen in both the RGB and infrared images. It is uncertain at this time what the source of this plume might be; however, the Council will work with the Wetlands Conservancy and agency partners to take a closer look at this site and determine the source of the warm water.

The high temperatures recorded at Site 17 during the Council's ongoing temperature monitoring study (NCWC, 2023 and 2024) may have been influenced by the location of this warm water plume, making this temperature monitoring location problematic. Consideration will be given to moving the location of this temperature logger in successive monitoring years.

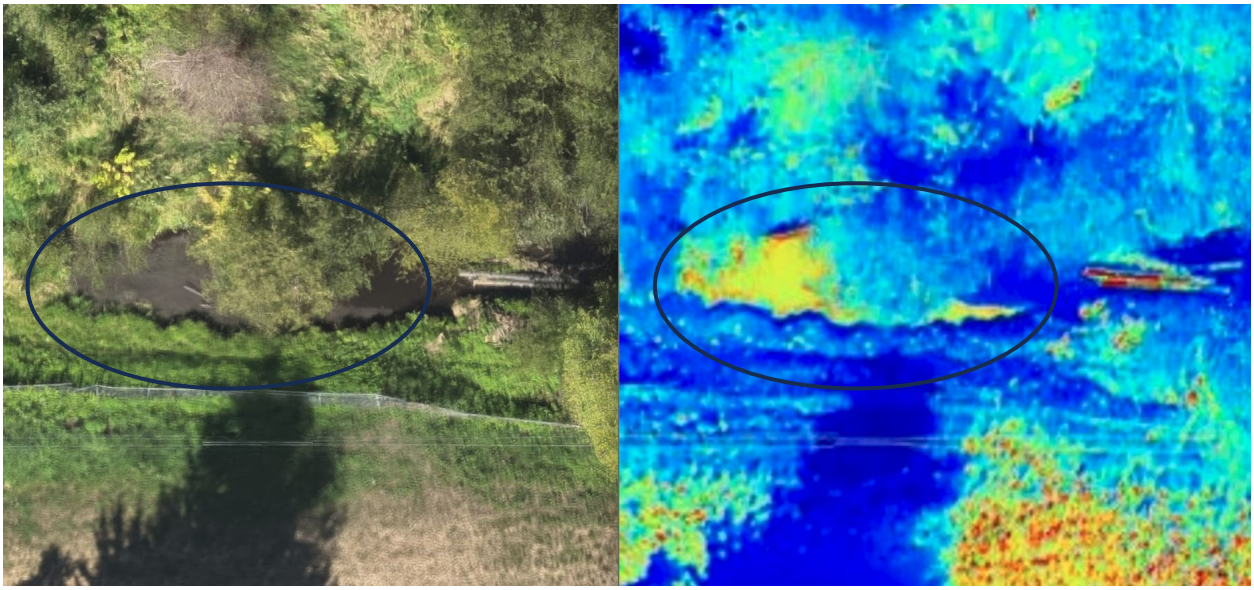

*Figure 10 - Location of warm water plume entering the southeast side of Minthorn Springs Wetland.*

## List of References

North Clackamas Watersheds Council. 2023. North Clackamas Watersheds Temperature Study – January 2023. Prepared by Amy van Riessen with 2022 Data.

North Clackamas Watersheds Council. 2024. North Clackamas Watersheds Temperature Study – February 2024. Prepared by Amy van Riessen with 2023 Data.

To: Kellogg Design Team

From: Amy van Riessen, NCWC Watershed Restoration Manager

Date: 1/20/2024

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This memo summarizes the temperature study work completed by the North Clackamas Watersheds Council (NCWC) this summer associated with the Kellogg Creek Restoration and Community Enhancement Project. This summer NCWC supplemented our continuous logger monitoring with aerial imagery from an infrared drone. This flight was completed to identify climate resiliency opportunities in the design of restoration elements by pinpointing cold water inputs into the impoundment that can be maximized for fish. A thorough analysis of this aerial imagery is currently being completed by PSU undergraduate student, Dalton Palin. In the interim to receiving Dalton's report, I completed a cursory analysis of the imagery and wanted to inform you of my findings.

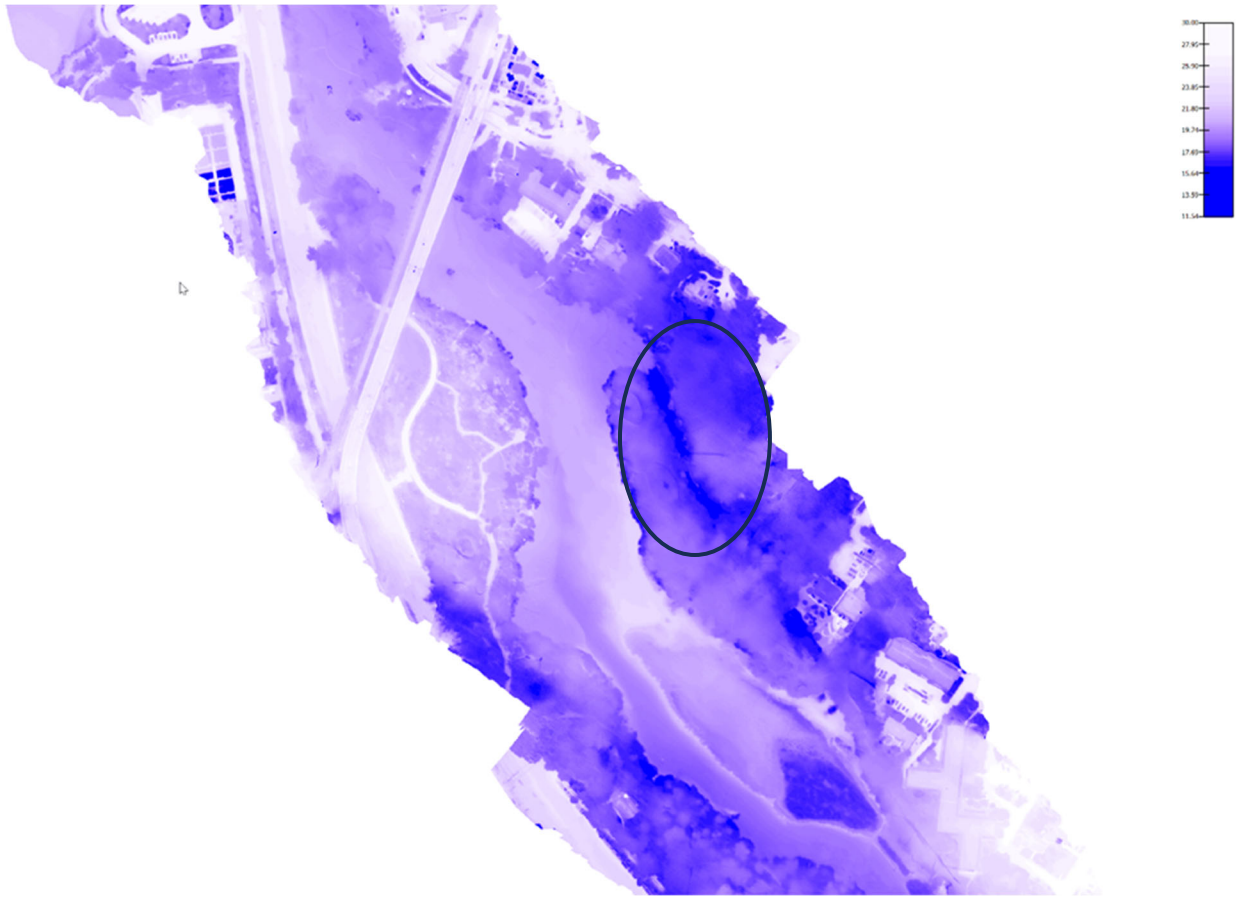

*Figure 1- Infrared imagery of lower Kellog impoundment showing cold water spring input.*

Behind our office located in the Milwaukie Presbyterian Church, there is a side channel that has water in it throughout the summer. The aerial imagery shows that surface temperatures in this channel are significantly cooler than the impoundment. We also installed a continuous temperature logger in this area (labeled below in Figure 2 as Site 42) and the results from that monitoring were consistent with the thermal aerial imagery.

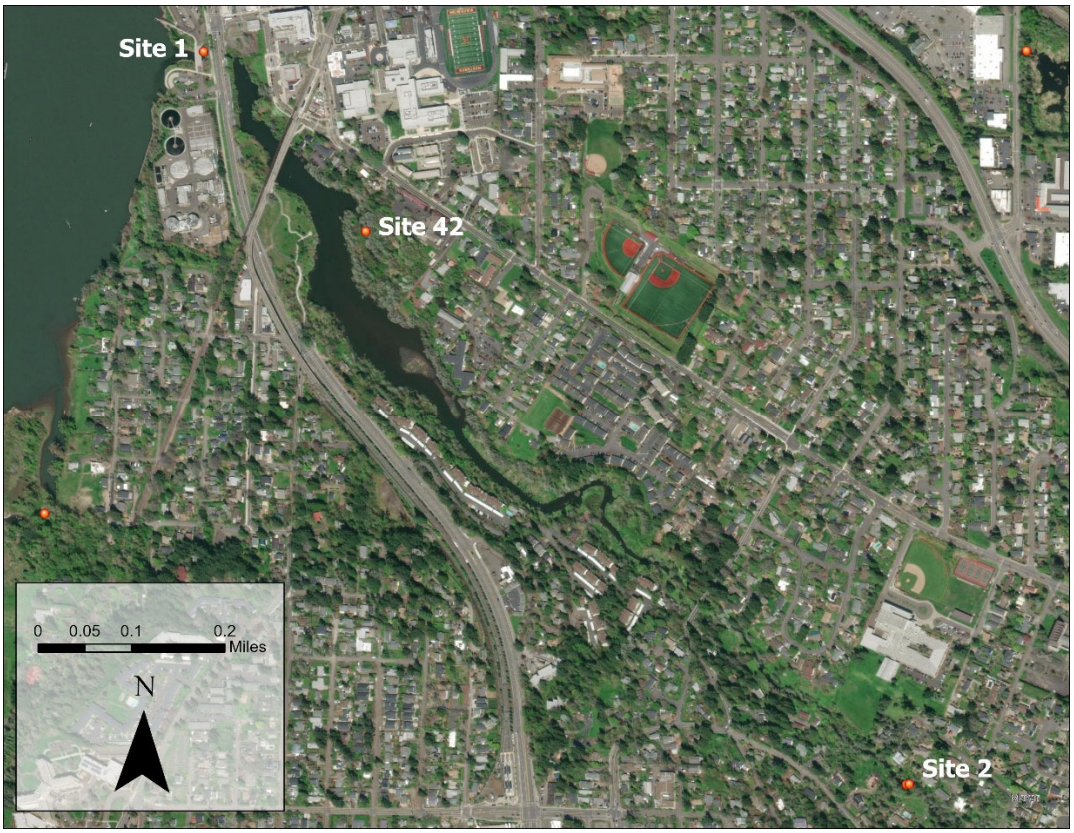


*Figure 2- Location of temperature loggers associated with Kellogg project.*

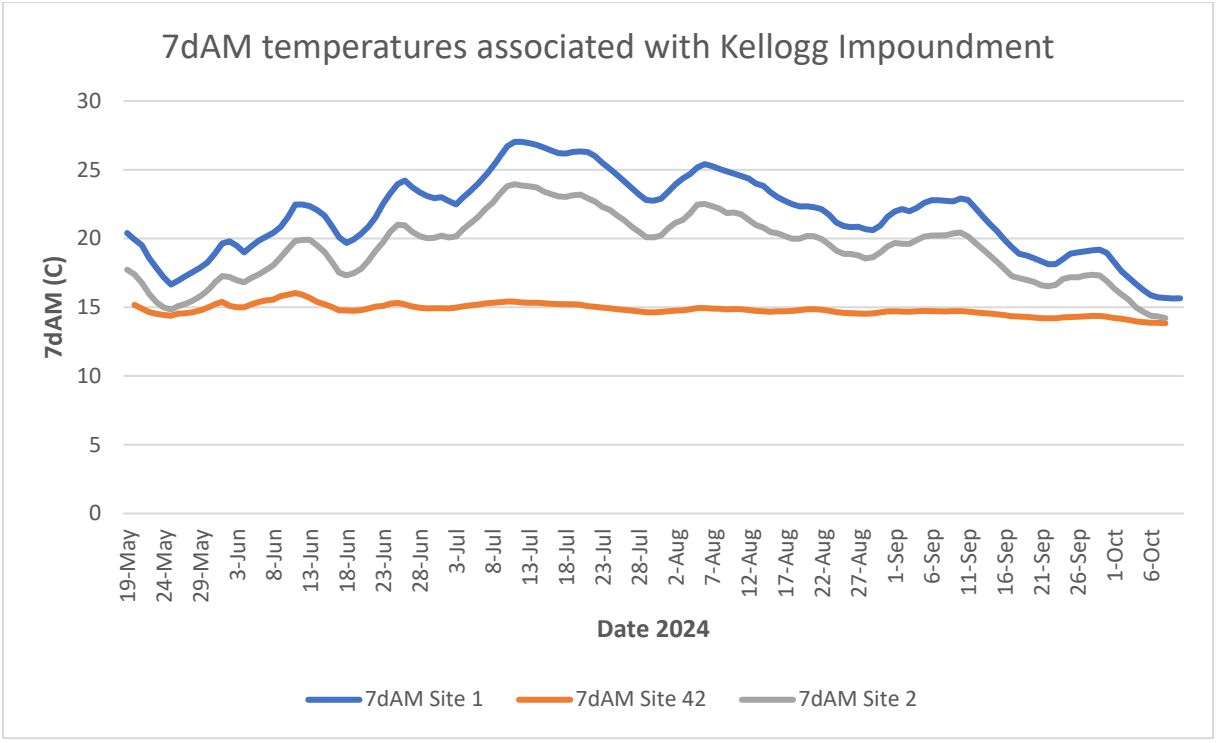


*Figure 3 - 7dAM temperatures recorded during the summer of 2024.*

The Oregon Department of Environmental Quality (ODEQ) established temperature standards for specific life history stages of salmon and steelhead (as seen below in Table 1). The standards are used in establishment for Total Maximum Daily Load (TMDL) criteria for water quality limited streams in Oregon (DEQ, 2008), and are based on 7-day daily average maximum temperature (7dAM).

*Table 1 - List of designated beneficial uses and associated temperatures.*

| Beneficial use | 7dAM |
|---|---|
| 1. Salmon & steelhead spawning (during spawning use) | 55.4 °F / 13 °C |
| 2. Core coldwater habitat (year-round) | 60.8 °F / 16 °C |
| 3. Salmon & trout rearing & migration (year-round) | 64.4 °F / 18 °C |
| 4. Migration corridor for salmon & steelhead (year-round) | 68.0 °F / 20 °C |

The 7dAM temperatures in this back channel consistently hovers around 15°C the entire summer (see Figure 3), identifying it as cold water refugia. In the current concept restoration plan (see Figure 4), this back-channel area is identified as a potential location for additional spoils. I propose that we protect this cold water for fish and incorporate an element of climate resiliency into the design. This back channel could be designed in a way to hold this cold water for as long as possible before having it enter into the main channel, potentially by extending the side channel along the north side of the floodplain. Ideally it would also include large wood complexes to provide instream cover for rearing juvenile fish to hide from predators. If we ran the back channel along the north bank, this would also have a dual benefit of delineating the private property to the north from the publicly owned open space, and create a natural barrier against trespassing onto private property.

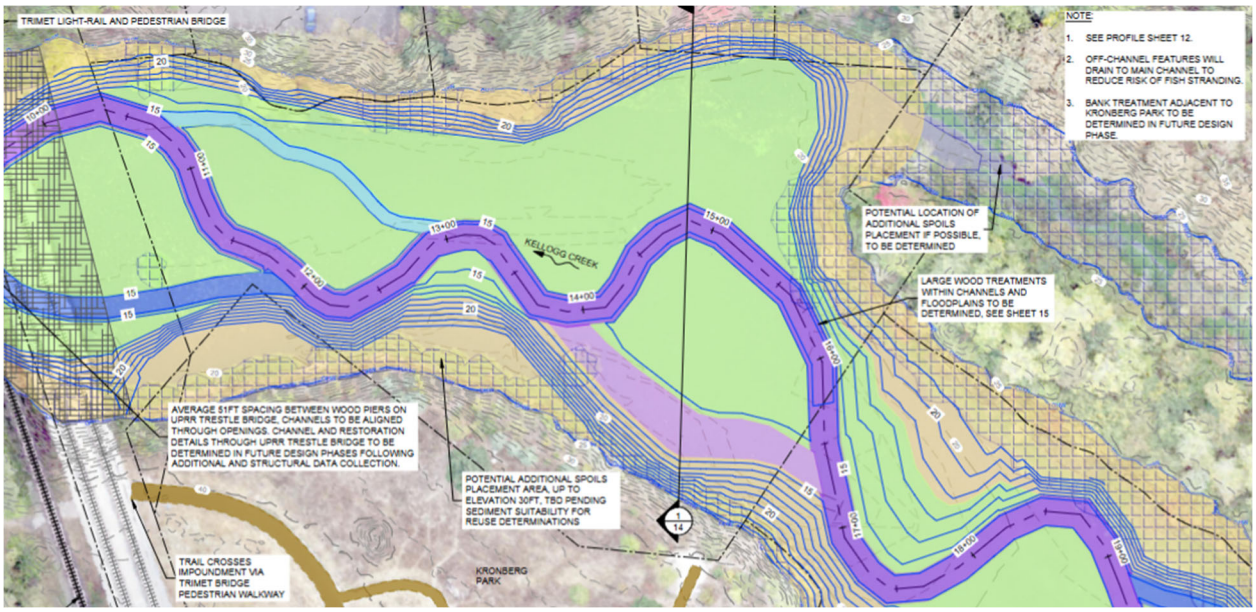


*Figure 4 - Concept restoration plan for this area (taken from Sheet 7).*

Just a final note that the continuous temperature monitoring data at Sites 1 and 2 are consistent with what we have seen in previous years (2022 and 2023), showing an increase in average temperature through the project area. The average temperature increase through the impoundment between Site 2 and Site 1 during the months of July and August last year was 3 °C (or 5.4 °F).