



Culvert Repair Programmatic Agreement 2019 Annual Report

Oregon Department of Fish and Wildlife | Oregon Department of Transportation
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Executive Summary

The Oregon Department of Transportation (ODOT) and the Oregon Department of Fish and Wildlife (ODFW) are implementing a five-year Culvert Repair Programmatic Agreement (CRPA) project that allows ODOT to make specific short-term repairs to culverts without having to meet full fish passage criteria at the repair location. ODOT now has the ability to make critical repairs to aging culverts in a cost-effective manner, while providing a benefit to Native Migratory Fish (NMF) over the status quo by improving fish passage at each site repaired. In addition, ODOT paid \$2.5 million into an ODFW-managed account that will fund the highest priority fish passage restoration projects off the state highway system.

ODOT's culvert inventory has revealed that approximately 10,500 culverts are in poor or critical condition and need to be repaired or replaced in the near term to maintain the safety and integrity of the state highway system. Based on current estimates, it would require over \$18.5 billion to replace all of the culverts under the state highway network. The typical design life of a culvert can range from 25 to 75 years. Based on current funding allocations, it would take 1,541 years to replace all of the culverts owned and managed by ODOT. Culvert repair work on fish-bearing streams has largely been deferred over the past 17 years due to the inability to meet fish passage design criteria with a repair and the lack of available funding for full fish passage criteria replacements. Culvert repairs typically can be completed for \$50,000 to \$250,000. Culvert replacement projects that meet fish passage criteria can cost from \$1.5 million to over \$12 million each.

In 2019, twelve culverts were repaired under the CRPA. The total cost for these repairs was \$2,734,000. The estimate to replace these culverts was \$34.7 million. ODOT was able to avoid nearly \$32 million of cost to address these culverts by using the CRPA. However, this cost avoidance should be evaluated relative to the design life provided by the approach. The repairs have added approximately 10-25 years of life to these culverts, whereas full replacements would have provided a new design life of 75 years. However, even given the difference in life span for the two approaches, life cycle costs are much lower for the repair option.

Fish passage improvements at the culvert repair projects used a combination of eliminating jump heights, increasing water depths, and decreasing water velocities. These projects improved access to 45 miles of potential habitat. Additionally, part of the \$2 million allocated to passage restoration was used to fund nine of the highest priority fish passage projects off the state highway system. A solicitation process for these projects was completed in 2018, and most of the selected projects were constructed in 2019. Access to over 313 miles of habitat was improved through these compensation projects. An additional request for proposals was completed in 2019 for the 2020 and 2021 in-water work periods.

The CRPA continues to showcase how interagency coordination and collaboration creates positive outcomes. This mutually beneficial agreement allows ODOT to make progress in maintaining the aging state highway system, while also providing on- and off-highway

ecological benefits to NMF. Taxpayer dollars are used efficiently for culvert repair work, and hundreds of miles of potential habitat for NMF are made more accessible.

Definitions

- **Backwatered:** When the water surface through the outlet of the culvert and downstream are equal.
- **Baffles:** A structure used to restrain the flow of water in a culvert to provide migrating fish a place to rest and create water depth during low flows.
- **Culvert:** A pipe or conduit used to convey water, utilities, livestock, wildlife or equipment, from one side of the road to the other.
- **Fish passage:** The ability, by the weakest NMF and life history stages determined by ODFW to require passage at the site, to move volitionally, with minimal stress, and without physical or physiological injury upstream and downstream of an artificial obstruction.
- **Fish rocks or fish blocks:** Large rocks (or concrete blocks) placed in a stream or culvert to improve habitat, create scour holes, and areas of reduced velocity. Placing structures in the stream also creates eddies or vortices in their wake.
- **High priority barriers:** Any barrier found on the [ODFW Fish Passage Priority List](#). Or determined by professional opinion to be a significant barrier to NMF migration.
- **Hydraulic conditions:** The conditions of the stream crossing in the context of water velocity, depth, complexity, vertical profiles, and capacity.
- **In water work period:** [Guidelines for timing of in water work](#), developed by ODFW and established to avoid impacts to the vulnerable life stages of native migratory fish including migration, spawning and rearing.
- **Invert:** The bottom portions of a culvert. Usually the first area of wear due to interaction with water and sediment transport.
- **NMF:** Native Migratory Fish species defined in OAR 635-007-0501 that includes 32 species of fish that migrate as for their lifecycle needs.
- **Perched condition:** When the outlet of the culvert is elevated above the downstream water surface creating a freefall condition.
- **Poor and critical culvert condition:** A culvert that scores a poor or critical has structural deficiencies that pose a danger to the traveling public, the environment, and the community connections, which warrant repair or replacement before a possible failure occurs.
- **Roughened channel:** An artificially built channel downstream of a culvert designed to alleviate a perch and match conditions in the surrounding streambed.
- **Soil arch:** The compacted soil that surrounds the culvert. This compacted soil holds the load of the above material and roadway traffic, relieving the pressure from the culvert itself.

- **Tributary:** A river or stream flowing into a larger river or lake.
- **Weir:** A low dam built across the stream channel or culvert designed to raise the water level upstream.

Background

ODOT and ODFW are implementing a five-year programmatic agreement for culvert repair in Oregon spanning 2018 to 2022. The Oregon Fish and Wildlife Commission approved the CRPA as a programmatic approval under Oregon fish passage rules (OAR 635-412-0020(3)b). This allows ODOT to make specific short-term critical repairs to aging culverts without meeting full fish passage criteria at the repair location, but still providing a benefit to NMF over the status quo by improving fish passage at each site repaired.

This agreement follows and expands on a previous three-year pilot project for western Oregon. Under the first pilot CRPA, **ODOT was able to avoid over 70 million dollars of cost to repair instead of replacing these failing culverts** [ODOT 2019](#). This new five-year agreement expands the service area to a statewide scale and allows the CRPA to be used on high priority fish passage barriers. With both CRPAs, ODOT and ODFW continue to advance the Oregon Plan for Salmon and Watersheds habitat restoration goals, while allowing repairs to critical transportation infrastructure in locations that are lower priorities for fish passage in a cost-effective manner.

As a condition of the agreement, ODOT agreed to pay \$2 million into an ODFW-managed account to fund high priority fish passage projects off the state highway system to offset delays in meeting full fish passage criteria at culvert repair locations. This payment allows ODOT to use the agreement on 40 projects, with the opportunity for ODOT to pay an additional \$50,000 for each culvert repaired once the first 40 are complete. ODOT also committed to continue funding the ODOT Fish Passage Program to address the highest priority fish passage projects on the state highway system. In addition, ODOT funded two transportation liaison positions within ODFW, to coordinate the agreement's implementation and develop a database of ODOT culverts that includes fish presence, passage information, and a prioritization model.

The CRPA agreement is a crucial tool allowing ODOT to make meaningful progress by addressing culvert infrastructure problems, while demonstrating a benefit to NMF. ODOT and ODFW have measured success by documenting the number and cost of culverts repaired under this agreement, as well as the benefits of incremental fish passage improvements provided at the repair sites. Additionally, NMF gain major benefits through off-highway high-priority fish passage compensation fund projects.

The rules, laws, and other reference material regarding NMF passage regulations can be found below:

- [Oregon Fish Passage Rules](#).
- [Oregon Plan for Salmon and Watersheds](#).

- [Oregon Fish Passage Statues.](#)

Programmatic Goals

The CRPA includes several key goals and sideboards for ODOT to conduct the culvert repair pilot program.

The goals of the CRPA include:

- a) Provide improved fish passage conditions at each culvert repair site.
- b) Address statewide fish passage priority barriers using the \$2 million fish passage fund in the most expeditious and efficient way practical.
- c) Improve state highway infrastructure conditions at each culvert repair site to address public safety.
- d) Generate information on the costs, impacts, efficiency, and effectiveness of the CRPA project approach.
- e) Develop a work plan to further identify resources and gather information on fish presence and barriers.

Programmatic Sideboards

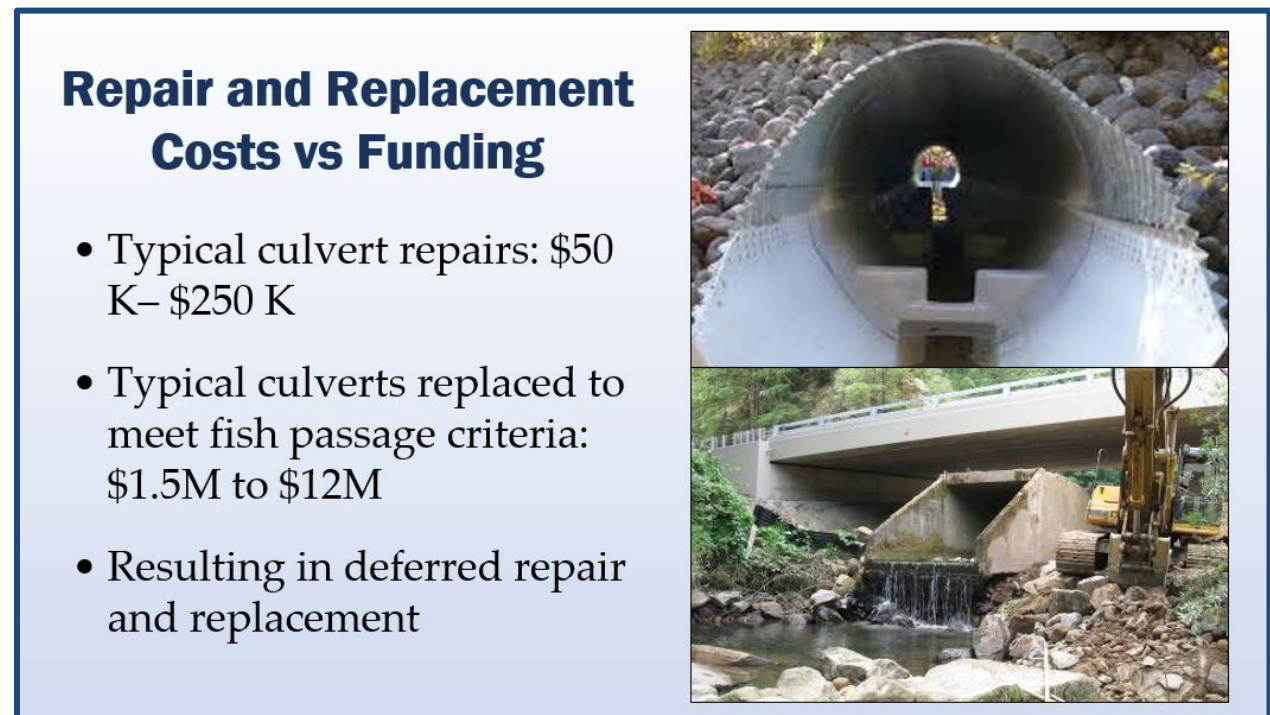
The CRPA allows repairs to culverts that meet all of the following criteria:

- Culverts must be located on ODOT-owned or operated stream crossings and can be located anywhere in the state.
- Culvert repairs may provide (up to) an additional 25 years of culvert life.
- Repaired culverts must include fish passage improvements, either at the repair site, or at the next fish passage barrier in proximity.
- Culverts can be rated as a high priority for fish passage, as determined by ODFW, provided all feasible passage improvements are conducted at the site.
- Culverts that provide access to Habitat Category 1 and tide gates are excluded. OAR 635-415-0025 (1) defines Category 1 Habitat and includes habitat that is irreplaceable, essential habitat for a fish or wildlife species, population, or unique assemblages of species.
- Sliplining is excluded from repair options.

Note: Culverts that are not within current or historic NMF habitat are not subject to fish passage laws and regulations and may be repaired outside of this agreement. In addition, ODOT may choose to implement full ODFW criteria fish passage or use the existing exemption or waiver process for fish passage for culvert repair or replacement outside the CRPA.

Purpose and Need

Figure 1: Repair and Replacement Costs vs Funding Summary



Culvert Inventory

There are approximately 35,000 culverts under the state highway system; most were installed prior to 1970 and are nearing the end of their design life. ODOT began developing systematic information on culvert infrastructure and condition in 2013. By the end of the 2019 field season, ODOT completed culvert inventory on 51 percent of the state highway system, including all of the Highway Management Team's priority routes. Priority routes are the most important highways for freight movement, connectivity with major population centers, and emergency response.

The culvert inventory estimated approximately 30 percent, or roughly 10,500, of ODOT's culverts are in poor or critical condition and need to be repaired or replaced in the near term to maintain the safety and integrity of the state highway system. The cost to replace all of these culverts in kind would be well over \$1 billion. This cost would be substantially higher for the installation of larger culverts or bridges to meet fish passage criteria.

Figure 2: Photo of a critical condition corrugated metal pipe culvert with invert completely missing, rusted sides, and separated segments



Declining Transportation Funds

As the increased need for culvert repair and replacement is coming to light, federal funds for highway projects have been drastically reduced. The ODOT Large Culvert Program receives \$12 million annually for culvert replacements. Based on current costs, it would require over \$18.5 billion to replace all of the culverts under the state highway network. The typical design life of a culvert can range from 25 to 75 years. Based on current funding allocations, it would take 1,541 years to replace all of the culverts owned and managed by ODOT. Even with a new infusion of transportation funds from Oregon House Bill 2017, the need to be efficient with funding requires creative approaches for managing Oregon's culvert infrastructure.

Figure 3: Funding Level vs Sustainable Need



Fish Passage Rules and ODOT's Fish Passage Program

Oregon's fish passage law was updated in 2001. This law and the implementing regulations (OAR 635-412-0005(9) a-d) require ODOT to address fish passage whenever there is new construction, replacement, or major repair of a culvert in habitat currently or historically occupied by NMF. To meet fish passage design criteria, most existing culverts need to be replaced with much larger culverts or bridges.

ODOT has a proven record of enhancing fish passage and contributing to the Oregon Plan for Salmon and Watersheds. ODOT's Fish Passage Program will continue to reopen access to salmon habitat by installing large culverts and bridges in locations ODFW identifies as high priorities for fish passage. From 1997-2019, ODOT completed 153 voluntary fish passage projects and improved access to over 498 miles of NMF habitat. This is a voluntary investment in fish passage, because these projects were not completed as a result of a trigger event, an action such as construction which requires that fish passage be provided, or other regulatory requirements. ODOT continues to be committed to addressing high priority fish passage barriers on the state highway system, and as part of the CRPA agreement, has dedicated at least \$4.2 million annually towards these projects.

The Little Pine Creek culvert replacement project, Figure 4, completed by the ODOT Fish Passage Program, is one example of ODOT's commitment to improving fish passage and supporting the Oregon Plan for Salmon and Watersheds. The project replaced an undersized double-cell concrete box culvert with a 14-foot wide single-span concrete box culvert. The old box culvert was constructed with a concrete apron on the downstream side, creating a

significant jump and shallow / streaming flows, limiting upstream fish migration. The new box culvert was constructed with a natural stream simulation bottom, allowing for migration of all life stages of NMF at all flows. The Little Pine Creek fish passage project opened 2.2 miles of high-quality spawning and rearing habitat for ESA listed summer steelhead at a cost of \$1.3 million.

Figure 4: Little Pine Creek Culvert Replacement Project, Before and After, Completed in 2018

Description: The first photo shows Little Pine Creek before the replacement, a perched concrete box culvert with water cascading from it, causing a barrier for fish passage. The second photo is after the culvert replacement, showing a new 14-foot box culvert with the stream flowing through the new constructed roughened channel.



CRPA Process and Timelines

As a condition of the CRPA agreement, the agencies developed a streamlined project timeline. Construction of culvert repairs needs to coincide with regulated in-water work periods (IWWP), which usually occur during low flow summer months. The timelines developed allow for full opportunity to scope potential projects, conduct site visits, develop plans and allow for contracting processes.

- February 28, the year before construction (> 16 months from target IWWP): ODOT provides a list of potential CRPA projects to ODFW for review. ODFW conducts desk scoping for species and life history designations.
- June 1, the year before construction (12-13 months to IWWP): ODFW reviews and approves the draft list based on criteria of agreement, including;
 - a. NMF species historically and currently present.
 - b. Migratory timeframes of concern.
 - c. Existing fish passage impediments.
 - d. Recommendations to improve fish passage conditions.

- e. Recommended in-water work window.
- October 1, the year before construction (10 months to IWWP): ODFW and ODOT staffs conduct site visits to all potential projects. During these site visits, ODOT and ODFW collaboratively develop culvert repair and fish passage improvements for each site. Team members base the design plan on site conditions and constraints, hydraulic conditions, and the needs of NMF. Site visit summary forms are filled out and signed by both agencies, helping to guide design.
- February 28, the year of construction: (5 months to IWWP): ODOT provides culvert repair and fish passage design concepts to ODFW for review and comment. If Endangered Species Act (ESA) species are present, designs are also sent to the National Marine Fisheries Service (NMFS) for review and approval.
- March 31, year of construction (3-4 months to IWWP): ODFW (and or NMFS) reviews each incremental passage design and documents concurrence with the design approach.
- [Construction during IWWP](#): Projects constructed with oversight by ODOT and ODFW staff.
- Post-construction: Projects are continually monitored at 1, 3, and 5-year increments, usually following high flow events, by ODOT and ODFW staff to ensure that fish passage improvements are functioning as designed. If fish passage improvements do not function as intended, then ODOT and ODFW collaborate on an approach to fix fish passage elements during the next available IWWP or as approved by regulatory agencies.

A discussion on these timelines is provided under the lessons learned section of this report.

ODOT Major Culvert Maintenance Engineer

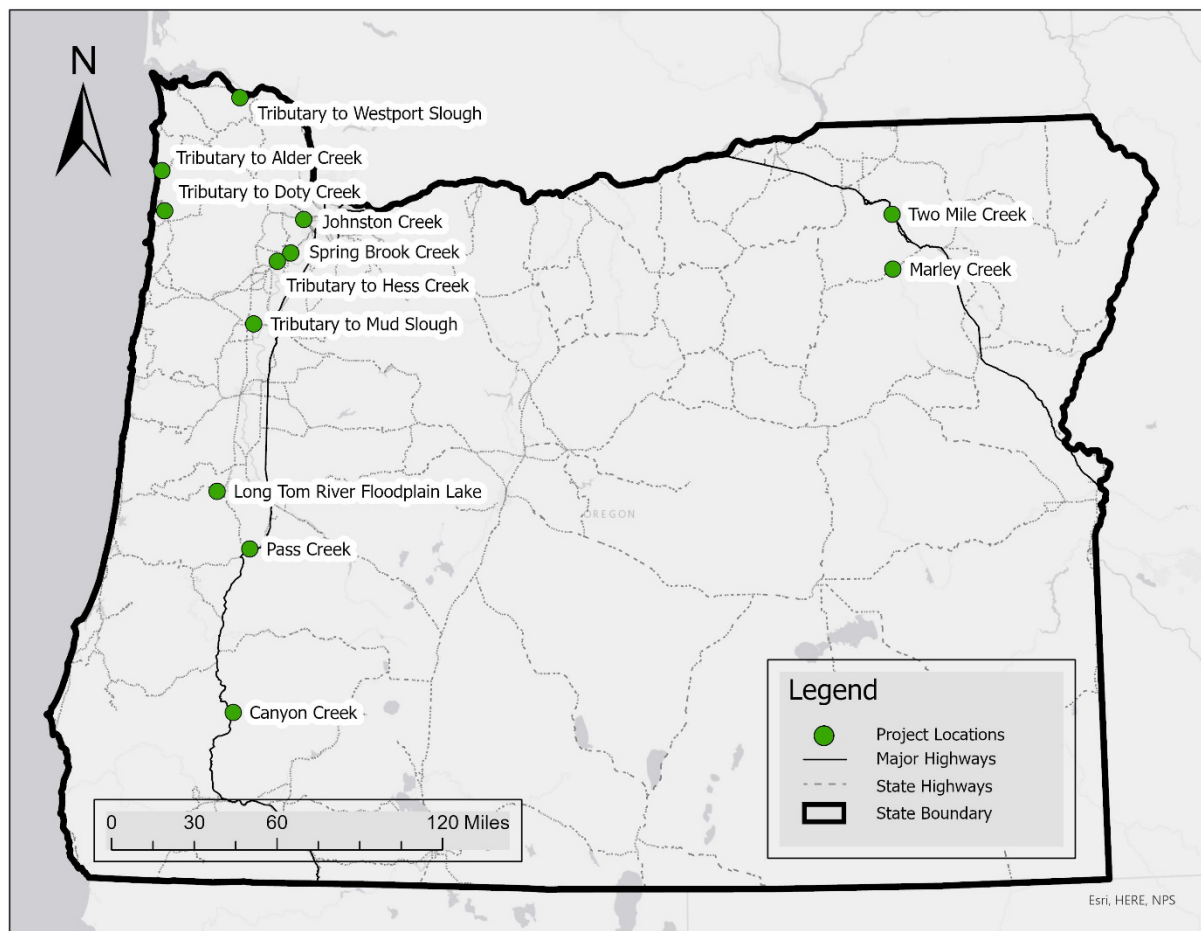
In 2018, the Geo-Environmental section of ODOT designated the Major Culvert Maintenance (MCM) Program to oversee culvert repairs across the state. A senior culvert maintenance hydraulic engineer manages the MCM program, which helps identify potential projects, recommends appropriate repair actions, and funds culvert retrofit projects. The program also guides engineers and designers specific to the CRPA agreement and works closely with the ODOT Fish Passage and Large Culvert programs. Due to the addition of this position, ODOT was able to identify and address time-saving and efficiency-increasing procedural processes. This led to the creation and implementation of new CRPA initiation forms for scoping, design and submittals, and the creation of a quality assurance and review process for submittals. These forms and procedures were developed and tested in 2018 and implemented for projects completed in 2019.

2019 Culvert Repair Projects

The CRPA report includes projects the year construction starts; however, projects are not always finished in one year. Likewise, construction is not necessarily initiated the year projects are approved and these projects are included in subsequent reports.

- In 2019, ODFW approved ODOT to repair 14 culverts under the CRPA.
 - ODOT began construction at 10 locations during the year, while four were delayed until 2020.
- Two additional projects constructed in 2019 were approved in previous years.
- In total, 12 CRPA projects started construction in 2019, and are included in this report (Figure 5).

Figure 5: Locations of CRPA Projects that Began Construction in 2019



Culvert Cost Analysis and Repair Summary

The cost to repair the 12 culverts was \$2,734,000. The estimated cost to replace these culverts was \$34.7 million. Through the CRPA, ODOT mitigated costs of **nearly \$32 million** to address these culverts, see Table 1. However, this cost avoidance should be evaluated relative to the design life provided by the approach. The repairs have added approximately 10-25 years of life to these culverts, whereas full replacements would have provided a new design life of 75+ years. However, even given the difference in life span for the two approaches, life cycle costs are much lower for the repair option.

The 2019 projects were repaired with several different techniques.

- Six of the projects used an invert pave to add a layer of reinforced concrete in the bottom of the culvert to seal the invert, keep water in the culvert barrel, and provide a connection to complete the culvert circumference, thereby repairing the structural capacity of the pipe.
- Four projects used centrifugally cast concrete. In this technique, a thin layer of high strength concrete is cast by a spinning head to line the full diameter of the culvert.
- Additionally, two other repairs used a cured-in-place liner that adds a new continuous layer around the circumference of the culvert, resulting in restored structural capacity.

The latter two techniques seal the entirety of the pipe, keeping water inside of the barrel and the structurally compacted soil outside the culvert intact.

Table 1: 2019 Culvert Repair Cost Analysis

Stream Name	Hwy and MP	Diameter (ft)	Length (ft)	Repair	Full Fix Cost (approximate)	Repair Cost
Johnston Creek	OR 8, 4.97	11	81	Invert pave	\$5,500,000	\$903,000
Unnamed Tributary to Mud Slough	OR 22, 18.48	5	182	CCCP	\$3,500,000	\$98,000
Unnamed Tributary to Westport Slough	US 30, 68.7	1.5	95	CIPP	\$912,000	\$22,000
Spring Brook Creek	OR 99W, 20.85	3.5	132	Grout and CCCP	\$3,000,000	\$77,000
Unnamed Tributary to Hess Creek	OR 99W, 26.91	2.5	238	CIPP	\$4,100,000	\$70,000
Long Tom River Floodplain Lake	OR 126, 44.17	3 x 4.5	115	CCCP	\$1,200,000	\$77,000
Unnamed Tributary to Doty Creek	US 101, 61.46	3 x 4.5	83	CCCP	\$1,300,000	\$55,000
Unnamed Tributary to Alder Creek	US 101, 44.43	6	76	Invert pave	\$1,300,000	\$55,000
Canyon Creek	I-5, 95.07	13	90	Invert pave	\$1,400,000	\$267,000
Pass Creek	I-5, 167.04	8	210	Invert pave	\$4,300,000	\$200,000
Marley Creek	OR 244, 31.03	6.5	130	Invert pave	\$3,000,000	\$800,000
Two Mile Creek	I-84, 236.31	6	330	Replace inlet & invert pave	\$5,200,000	\$110,000

Fish Passage Improvements Summary

2019 CRPA projects used several fish passage improvement techniques during construction. Table 2 summarizes the fish passage improvements at each culvert location. Most of these techniques were used to buffer high water velocities, provide resting and variable flow conditions in the culvert, and provide more water depth during low flow to facilitate passage. Four projects included modifications downstream of the culvert outlet to backwater the culvert and reduce jump heights. One project removed a downstream barrier to fish passage by replacing an undersized culvert on private property with a culvert that fully met fish passage criteria.

The total miles of potential NMF habitat upstream made available is 47.33 miles. The project descriptions for each culvert repair are provided below.

Table 2: Fish Passage Improvement Analysis

Stream Name	Hwy and MP	Maximum Potential NMF Habitat Miles	Passage Improvement	Cutthroat Trout	Coho Salmon	Steelhead/ Rainbow Trout	Other NMF Species
Johnston Creek	OR 8, 4.97	4.92	Fish Rocks	Present	--	Present and ESA Listed	Pacific Lamprey
Unnamed Tributary to Mud Slough	OR 22, 18.48	5.05	Fish Rocks	Present	--	--	--
Unnamed Tributary to Westport Slough	US 30, 68.7	1.55 Acres	Boulder receiving pool	Present	Present	Present	Pacific Lamprey, chinook, chum, sockeye
Spring Brook Creek	OR 99W, 20.85	0.14	Replacing undersized downstream culvert	Present	--	--	Western Brook Lamprey
Unnamed Tributary to Hess Creek	OR 99W, 26.91	0.2	Boulder weir	Present	--	--	--
Long Tom River Floodplain Lake	OR 126, 44.17	0.75	Fish Rocks	Present	--	--	--
Unnamed Tributary to Doty Creek	US 101, 61.46	3.05	Fish Rocks	Present	Present and ESA Listed	Present	Chum – ESA Listed
Unnamed Tributary to Alder Creek	US 101, 44.43	6.9	Fish Rocks	Present	Present and ESA Listed	Present	--

Stream Name	Hwy and MP	Maximum Potential NMF Habitat Miles	Passage Improvement	Cutthroat Trout	Coho Salmon	Steelhead/Rainbow Trout	Other NMF Species
Canyon Creek	I-5, 95.07	15.15	Fish rocks and roughened channel	Present	Present and ESA Listed	Present	--
Pass Creek	I-5, 167.04	3.5	Fish Rocks and roughened channel	Present	Present and ESA Listed	Present	Pacific Lamprey
Marley Creek	OR 244, 31.03	5.89	Baffles and roughened channel	--	--	Present and ESA Listed	Redband
Two Mile Creek	I-84, 236.31	1.96	Fish baffles	--	--	Present and ESA Listed	Redband Trout

Project Descriptions

OR 8 MP 4.97 Johnston Creek Culvert Repair

Completed October 2020, Figure 6.

Pre-treatment Fish Passage Condition

This culvert drains Johnston Creek, a tributary to Beaver Creek. Johnston Creek passes under OR 8, approximately 1.5 miles west of the city of Beaverton in Washington County, Oregon.

These double barrel 80-foot long culverts are 11-foot diameter corrugated metal pipes (CMP). The two culverts are set at different elevations, with the Eastern most culvert carrying the low flow channel.

The structural conditions of these culverts was critical due to significant corrosion. The culverts were collapsing causing sagging and roadway cracking on the highway. A fatal accident occurred at this location due to a partial roadway collapse over the culverts. Significant repairs to the culverts would trigger Oregon's fish passage rules, and in August of 2018 ODOT declared these culverts an emergency and began the process of planning to address fish passage at this location under the CRPA. Internal cross-bracing to support the culverts was completed in the spring of 2019, with fish passage improvements and further repair work were implemented in 2020.

Hydraulic calculations showed flow conditions at the culvert had velocities over 2 fps and flow depths as low as 4 inches (flows ranging between 5 percent and 95 percent of the daily

exceedance stream discharge). This flow exceeded the ODFW fish passage criteria of 2 fps. Species using the habitat upstream of the culvert include cutthroat trout, ESA listed steelhead/rainbow trout and pacific lamprey. The culvert was a partial velocity barrier to these species, potentially blocking or delaying access to approximately 4.95 miles of habitat, including a sizable beaver wetland complex.

Post-treatment Fish Passage Condition

The degraded culverts were repaired with an invert pave that sealed and reinforced the failing corrosion and returned structural integrity to the culverts. Fish passage was improved with the addition of fish rocks in lower culvert. The repair work was completed in 2019, and the fish passage improvements were completed in 2020. These fish rocks were placed in the east culvert to decrease the velocities within the culvert and offer ample hydraulic variation for NMF. Post-treatment conditions were estimated to have velocities approximately 2.1fps, down from over 3 fps and flow depths of over 7 inches, thus improving access to the approximate 4.95 miles of upstream habitat.

Figure 6: Johnston Creek Culvert Repair, Before and After

Description: Two images, the first displays the culvert pre-repair. The second shows the culvert post-repair before water was returned to the system.



OR 22 MP 18.48 Unnamed Tributary to Mud Slough Culvert Repair

Completed August 2019, Figure 7.

Pre-treatment Fish Passage Condition

This unnamed tributary to Mud Slough runs through heavily impacted agriculture land before passing under highway 22 approximately 2.5 miles east of Rickreal, Oregon. This tributary

flows seasonally, going dry during the summer months, but transporting a 2-year peak flow of 59 feet³/s during the wet season. The aquatic habitat upstream of the culvert is suitable for seasonal use by cutthroat trout. The watershed drains an area of 1.78 square miles and contains 5.05 miles of potential habitat for cutthroat trout.

The 182-foot long, 5-foot diameter culvert is undersized for the 10-foot active channel width of the stream, and was a partial velocity barrier prior to treatment. The velocity of the culvert during high flows likely affected the ability of fish to migrate upstream during the time of year they would most likely utilize the habitat in the stream.

Although the culvert was rated in fair condition following initial inspections, subsequent inspection efforts determined that the amount of invert rusting was enough to warrant repair. Degradation of a culvert invert allows water to saturate the soil surrounding the culvert. It also erodes away the soil beneath the culvert and can lead to settling. If left untreated, these issues can lead to the roadway becoming unsupported and unsafe.

Post-treatment Fish Passage Condition

The rusting culvert was repaired by a Centrifugally Cast Concrete to amend structural issues caused by rust. Fish passage was improved by the addition of fish rocks to slow water velocity, increase hydraulic diversity, and better facilitate fish passage during high flows. The fish rocks lowered the velocity in the culvert and allowed for variation of hydraulic conditions through the culvert to improve NMF passage conditions to the potential 5.05 miles of habitat upstream.

Figure 7: Unnamed Tributary to Mud Slough Culvert Repair, Before and After

Description: Two images, the first is the pre-repair view inside the culvert. The second image is of fish rocks inside of the culvert post-repair with water running through it.



US 30 MP 68.7 Unnamed Tributary to Westport Slough

Completed September 2019, Figure 8.

Pre-treatment Fish Passage Condition

This culvert conveys flows from a wetland complex and tidal flows from Westport slough under US 30 approximately 7.29 miles west of Clatskanie in Columbia County, Oregon. Westport slough is a side channel in the floodplain of the Columbia River.

The 18 inch diameter CMP is 95 feet long and drains an area of 1.55 acres of habitat and floodplain. The culvert's surveyed condition was considered critical due to corrosion. If left untreated, this could become a potential hazard to the traveling public due to water saturating and destabilizing the surrounding soil arch and roadbed, leading to settlement of the culvert that could leave the roadway unsupported.

The area around the culvert is tidally influenced. The culvert was backwatered during high tides, however there was a 4-12 inch perch at low tides. The height of the perch was determined by the height of the tide. The perch created a jump height, preventing cutthroat from accessing upstream floodplain habitat during low tides.

Post-treatment Fish Passage Condition

Fish passage was improved at the outlet of the culvert by building two boulder receiving pools. The culvert was repaired with a CIPP liner. This allowed for the degraded invert condition to be restored, keeping the water inside the barrel. Installing two downstream u shaped boulder receiving pools improved fish passage. These pools slow velocities during outgoing tides, backwatering the culvert for longer durations, and reducing the perched condition of the culvert at low tide. The resulting conditions improve fish passage and increase access to the 1.55 acres of upstream habitat.

Post-construction monitoring at this site determined that the boulder receiving pools did not fully seal and backwater the culvert to the designed plans. Adaptive management in 2020 included resealing the weir with fine material to backwater the culvert to designed condition. The site will continue to be monitored to ensure the weir functions as intended.

Figure 8: Unnamed Tributary to Westport Slough Culvert Repair, Before and After

Description: Three images, the first shows the outlet end of the culvert pre-repair with water running through it, the culvert is perched ~4 inches. The second image shows the outlet of the culvert post-repair with water running through it, the perch at the outlet of the culvert has been improved. The third photo shows the conditions at the outlet following adaptive management work in 2020, where there is no longer a perch.



OR 99W MP 20.85 Spring Brook Creek Culvert Repair

Completed September 2019, Figure 9.

Pre-treatment Fish Passage Condition

This culvert conveys a tributary of Spring Brook Creek under highway 99 west approximately 1.28 miles east of Newberg in Yamhill County, Oregon. Spring Brook Creek is a tributary to the Willamette River.

The culvert drains an area of 0.21 square miles which is heavily influenced by spring fed runoff, there are 0.14 miles of fish habitat for cutthroat trout upstream of the culvert. The culvert is an arch culvert with a box culvert on both ends. The box culvert sections are 3-feet high by 4-feet wide and the entire culvert is 132 feet long. The transitions between the arch and the boxes on each end were not sealed. The culverts surveyed condition is fair. Roadway fill had begun to leak into the culvert. The culvert also fills with sediment and needs to be cleaned yearly. If left untreated this condition is potentially hazardous to the traveling public due to road destabilization which leaves the roadway unsupported.

Conditions at the ODOT culvert under highway 99 were not a barrier to fish passage. However, approximately 30 feet downstream from this culvert is a private road crossing. The culvert on this road crossing was a 3-foot diameter culvert, which was undersized and placed at a stream elevation that was not conducive to fish passage. Conditions at this lower culvert presented a passage barrier to cutthroat trout downstream from the ODOT culvert.

Post-treatment Fish Passage Condition

Under the CRPA agreement, if fish passage cannot be improved at the repair site, fish passage can be improved at the next barrier upstream or downstream of the culvert to be repaired. At this location, fish passage was improved by replacing the next culvert downstream. The 3-foot culvert was undersized, creating a velocity barrier to fish passage. ODOT designed and installed a new culvert meeting hydraulic criteria for fish passage. The new 6-foot diameter corrugated plastic pipe meets full fish passage requirements, and improves access for cutthroat trout to 0.14 miles of habitat.

The ODOT culvert is planned to be repaired by grouting the joints between the arch culvert and the box culverts. Additionally a CCCP liner will be installed through the culvert. As of the writing of this report, the repair work had not been completed at this location due to ODOT Region contracting capacity.

After installing the new culvert downstream of the ODOT culvert, it was found that the elevations of the new structure were higher than designed. The difference of designed versus constructed elevations was not significant, and did not create a fish passage issue. As the site was monitored over time, it was observed that the new structure has not settled. While providing fish passage, it is not helping to flush out the ODOT culvert as anticipated. The site continues to be monitored annually to ensure volitional fish passage is provided.

Figure 9: Spring Brook Creek Culvert Repair, Before and After

Description: Two images, the first shows the outlet end of the private culvert pre-replacement with water running through it. The second image shows the outlet of the culvert post-replacement with water running through it.



OR 99W MP 26.91 Unnamed Tributary to Hess Creek Culvert Repair

Completed September 2019, Figure 10.

Pre-treatment Fish Passage Condition

This culvert conveys an unnamed tributary to Hess Creek under highway 99 west approximately 0.8 miles south-west of Dundee in Yamhill County, Oregon. Hess Creek is a tributary to the Willamette River. This culvert is a 2.5-foot circular CMP with concrete ends, and is 238 feet long. In this location, the tributary has an estimated active channel width of seven feet. The culvert was considered to be in critical condition due to rust in the CMP sections, and disjointed segments on the outlet section. The rusted sections of CMP can lead to water piping (water flowing on and around the outside or damaged sections of the pipe), that, if left untreated, could allow water to saturate the soil surrounding the culvert. This could cause the culvert to settle and the soil to erode, ultimately leaving the roadway unsupported.

Fish passage issues included a small perch at the culvert outlet and high velocities due to the slope. This perched condition likely prevented or delayed access for cutthroat trout to the 0.20 miles of available upstream habitat.

Post-treatment Fish Passage Condition

Fish passage was improved by the addition of three downstream boulder weirs. These weirs backed water up at the outlet of the culvert and reduced the jump height for cutthroat migrating upstream.

Post treatment monitoring has shown that some of the weirs have not sealed as designed. While the culvert outlet continues to be backwatered, the loss of surface flows through the weirs have created increased jump heights over the weirs themselves. Work will be completed in 2021 to introduce more stream material to re-seal the weirs.

Figure 10: Unnamed Tributary to Hess Creek Culvert Repair, Before and After

Description: Two images, the first shows the outlet end of the culvert pre-repair illustrating the perched condition. The second image shows the outlet of the culvert post-repair with one downstream boulder weir. The boulder weir has backed up water and reduced the perched condition.



OR 126 MP 44.17 Long Tom River Floodplain Lake Culvert Repair

Completed August 2019, Figure 11.

Pre-treatment Fish Passage Condition

This culvert connects two parts of a wetland / lake that is segmented by highway OR 126. The culvert is a CMP arch inside of a concrete outer liner, and is 48 inches wide, 36 inches tall, and 119 feet long. The culvert was considered to be in fair to poor condition due to distortion, barrel damage and rust throughout its length.

These issues, if left untreated, could compromise the safety of the roadway due to the surrounding soil arch eroding away through the open joints caused by the distortion, ultimately leaving the above roadway unsupported.

The lake and floodplain habitat is used by cutthroat trout, and the ability of these species to navigate the culvert is primarily determined by lake and floodplain elevations. 0.75 miles of habitat exists on the upstream side of the highway. During periods of heavy rain, however; higher velocities resulting from differences in the floodplain and lake water surface elevations could lead to reduced fish passage at this location. In addition, shallow sheet flows can occur during low flow periods, reducing the window for fish to pass the culvert.

Post-treatment Fish Passage Condition

The rusting culvert was repaired with centrifugally cast concrete to increase the stability. Through this repair, the surrounding soil arch is no longer exposed to the flowing water and, in turn, at risk of erosion. The deteriorating rusted sections were sealed through this process, adding years of service life to the culvert.

Fish passage was improved by the addition of fish rocks to slow water velocities during high flows, and increase depth during lower flows to increase the amount of time that the culverts are passable.

Figure 11: Long Tom River Floodplain Lake Culvert Repair, Before and After

Description: Two images, the first looks at the end of an arch culvert pre-construction, where the culvert invert is showing signs of rust and deterioration. The second image is post-repair, and looks in the end of the arch culvert. The interior of the culvert shows new concrete around the perimeter, and fish rocks placed on the inlet.



OR 101 MP 61.46 Unnamed Tributary to Doty Creek Culvert Repair

Completed August 2019, Figure 12.

Pre-treatment Fish Passage Condition

This culvert carries an unnamed tributary of Doty creek under US 101 near Bay City. This CMP culvert is 54 inches wide, 36 inches tall, and 83 feet in length. The original inspection of the culvert rated it in good condition, however; subsequent survey documented a rusted invert and channel scour at the inlet and outlet ends. If left untreated, the soil below the culvert could erode allowing the culvert to settle into that open space. Ultimately then allowing water to flow around the culvert, saturating and eroding the above soil and roadbed to leave the roadway unsupported.

During periods of high flow, velocities through the crossing were observed to be high, creating a passage barrier for fish migrating upstream.

Native Migratory Fish species at this location include cutthroat trout, ESA Coho salmon, steelhead and rainbow trout, and chum salmon. 3.05 miles of habitat is available for these species upstream of US 101.

Post-treatment Fish Passage Condition

An invert pave was used to repair the culvert, allowing the bottom of the culvert to be resurfaced and hold the water inside the culvert. Fish passage was improved through the addition of fish rocks. These rocks create flow variations and slow water velocities to improve fish passage during high water events. In addition, the rocks consolidate low flows, creating more depth during low flow periods.

Post construction monitoring revealed a small, preexisting perch was slightly exacerbated at the outlet of the culvert due to the addition of the concrete invert liner. This raised the water surface elevation inside the culvert, exacerbating a jump for upstream migrating fish to enter the culvert. Adaptive management of the site was completed in 2021, where the concrete liner on the outlet section was ground down to reduce the perch. The site will continue to be monitored to ensure fish passage improvements function as intended.

Figure 12: Unnamed Tributary to Doty Creek Culvert Repair, Before and After

Description: Two images, the first is the inside of the culvert pre-repair. The second is inside the culvert post-repair. Here we can clearly see fish rocks installed.



OR 101 MP 44.43 Unnamed Tributary to Alder Creek Culvert Repair

Completed September 2019, Figure 13.

Pre-treatment Fish Passage Condition

Alder Creek crosses under US 101 near Nehalem, Oregon. At this location, there are two 72-inch diameter CMP culverts, set at different elevations. Both culverts are 76 feet long. During low flows, the creek is conveyed through the lower of the two culverts, and the second culvert is activated during moderate and high flows. The higher culvert was found to be in poor condition due to distortion, open joints, a rusted invert, and outlet scour. If left untreated, these conditions could allow water to saturate the surrounding soil arch and roadbed. If allowed to worsen, this could then lead to settlement of the pipe and erosion of the soil, ultimately leaving the roadway unsupported.

Alder Creek contains cutthroat trout, ESA Coho salmon, and steelhead/rainbow trout, and has a potential of 6.9 miles of habitat located upstream of the culvert. One of the most pressing fish passage issues was velocity during moderate and high flow events.

Post-treatment Fish Passage Condition

The culvert was repaired with an invert pave. This resurfaced the culvert's invert, lowering the previous concern of saturation, erosion, filled the voids in the culvert, and addressed the lack of support for the roadway. Installation of fish rocks improved fish passage at this culvert. These provided hydraulic breaks and lowered water velocity. By reducing the velocity and increasing depths through the culvert, and creating hydraulic variation within the culvert, there is improved fish passage to the 6.9 miles of upstream habitat.

Figure 13: Unnamed Tributary to Alder Creek Culvert Repair, Before and After

Description: Two images, the first is looking inside the culvert pre-repair. The second is looking inside the culvert post-repair. We can see the paved invert of the culvert and installed fish rocks post-project.



I-5 MP 95.07 Canyon Creek Culvert Repair

Completed August 2019, Figure 14.

Pre-treatment Fish Passage Condition

Canyon Creek is a major tributary of the South Umpqua River, and is located near Canyonville, OR. This culvert repair was completed under an off ramp of Interstate 5 near milepost 95. The culvert is large CMP culvert that is 134 inches wide, 144 inches tall, and 113 feet long. The culvert was rated in poor condition due to invert degradation, general barrel damage, and outlet scour. Previously, the culvert had a paved invert installed as a repair, and the repair had degraded over time due to high rates of sediment load in the system.

The culvert had a significant (2') perch at the outlet, and high velocities during moderate and high flow events. In addition, shallow sheet flows were common during periods of low flow.

Upstream of the crossing, there is approximately 15.15 miles of potential habitat available, however; more passage barriers do exist upstream of the crossing. Cutthroat trout, Coho salmon, steelhead, Pacific lamprey and rainbow trout all utilize Canyon Creek in this location.

Post-treatment Fish Passage Condition

To repair the culvert, a section of the old concrete invert was first removed. A rebar cage was constructed and installed in the bottom of the culvert, and new concrete invert liner was installed. To address the large jump at the culvert outlet, 140 feet of the downstream channel was reconstructed, backing water up to the culvert outlet. Fish passage was further improved

by the addition of fish blocks in the barrel of the culvert which reduced high flow velocities, provided refuge locations, and increased low flow depths.

Figure 14: Canyon Creek Culvert Repair, Before and After

Description: Two photos, the first shows the outlet end of the culvert with water running through it, this clearly illustrates the perched condition of the culvert. The second photo shows standing water at the post-repaired outlet of the culvert, and fish blocks placed through the culvert.



I-5 MP 167.04 Pass Creek Culvert Repair

Completed September 2019 Figure 15.

Pre-treatment Fish Passage Condition

This culvert conveys Pass Creek under I-5 approximately 6.0 miles south-west of Cottage Grove in Douglas County, Oregon. Pass Creek is a tributary to Elk Creek in the Umpqua River basin. This culvert is an 8-foot circular CMP and is 214 feet long. In this location, Pass creek has an estimated active channel width of 15 feet. The culvert was considered to be in poor condition, mainly due to invert damage, water piping (water flowing on and around the outside or damaged sections of the pipe), and some end treatment issues that, if left untreated, could allow water to saturate the soil surrounding the culvert. This could cause the culvert to settle and the soil to erode, ultimately leaving the roadway unsupported.

Fish passage issues included a one foot perch at the culvert outlet, high velocities during high water events, and shallow depths during low flow events. These passage issues prevented or delayed access for cutthroat trout, Coho salmon, steelhead, and rainbow trout to the 3.5 miles of available upstream habitat.

Post-treatment Fish Passage Condition

The culvert was repaired with a 6-inch paved invert. This restored the invert integrity, resolved the water piping issues, and improved the end treatment to help keep the water flowing through the culvert and not around it and in the surrounding soil. A roughened riffle was installed downstream of the culvert to backwater the culvert outlet, alleviating the jump height. Installing fish rocks at 5-foot intervals throughout the culvert improved fish passage. The fish rocks increase flow depths during low flow, create eddies and flow complexities within the culvert, and reduce velocities during high flow.

Figure 15: Pass Creek Culvert Repair, Before and After

Description: Two images, the first shows the outlet of the culvert and a perch creating a jump height pre-repair. The second image shows water running through the culvert backwatered with no jump height post-repair.



Note on Pass Creek Culverts

This project on Pass Creek is part of a series of culvert improvements done along a two-mile stretch of I-5. In 2017, a culvert at mile point 165.9 was repaired under the CRPA. Two culverts were repaired under the agreement in 2018, and were located at mile points 165.97 and 166.69. In 2019, the project at mile point 167.04 was completed, and another project is planned at mile point 167.17 in 2020. Pass Creek flows south along I-5. Therefore, the increasing mile points correspond to movement upstream in the Pass Creek watershed. The amount of habitat above each culvert is reported in each CRPA report.

OR 244 MP 31.03 Marley Creek Culvert Repair

Completed October 2019, Figure 16.

Pre-treatment Fish Passage Condition

This project is located under Hwy 244 on Marley Creek, near Starkey, Oregon. It was one of the first projects in the Eastern side of the state completed under the CRPA agreement. As a high priority fish passage barrier, significant work was completed to improve passage conditions through the culvert.

The CMP is a 130' long 78" diameter culvert. The culvert was found to be in poor condition due to rusted invert, distortion, and separation. With time, these conditions could lead to collapse of the culvert, water outside the barrel, and the erosion through the open joints of the surrounding soil arch and roadbed, eventually leaving the roadway unsupported and unsafe.

The culvert had two major fish passage issues; a large perch at the outlet, and high velocity in the crossing during moderate and high flows. ESA listed summer steelhead and redband trout were the focal NMF species for this location, and 5.89 miles of potential habitat is available upstream of the culvert.

Post-treatment Fish Passage Condition

The culvert was repaired with a centrifugal cast concrete liner, which sealed the joints and the cracks and covered the degrading invert. Through these repairs, water is now staying within the culvert and lessened the pre-repair structural concerns. Along with the liner, rounded corner baffles were installed to provide hydraulic complexity in the culvert and slow water velocities. These baffles also consolidate flows during low flow periods, adding depth to help facilitate fish passage.

In addition, a large portion of the downstream stream channel was rebuilt to backwater the culvert outlet. A roughened channel was installed for 150 feet downstream to meet the gradient required to eliminate the jump into the culvert.

The project experienced a 50-year flow event in the winter following completion, and post project monitoring found loss of surface flows due to voids in the newly constructed stream channel downstream of the culvert. Additional fine sediment was added to the project in the summer of 2020, and the project is currently being monitored to ensure fish passage conditions are maintained.

Figure 16: Marley Creek Culvert Repair, Before and After

Description: Two images, the first shows water running through the perched culvert pre-repair. The second image shows water backwatered to the culvert outlet with alternating baffles post-repair.



I-84 MP 236.31 Two Mile Creek Culvert Repair

Completed September 2019, Figure 17.

Pre-treatment Fish Passage Condition

This culvert carries Two Mile Creek under Interstate 84 near Meacham, Oregon. This CMP culvert is 72 inches in diameter, and 258 feet long. The culvert was ranked as fair condition following initial survey, however; the inlet portion of the culvert collapsed in the winter of 2019. Further inspection at that time revealed a rusted invert, separation, and general barrel damage. With time, these conditions could lead to the further collapse of the culvert, water outside the barrel, and the erosion through the open joints of the surrounding soil arch and roadbed, eventually leaving the roadway unsupported and unsafe.

1.96 miles of habitat is available upstream of the culvert, and ESA listed summer steelhead and redband trout are present in Two Mile Creek at this location.

Post-treatment Fish Passage Condition

The culvert was repaired with a concrete invert pave, which sealed the joints and the cracks and covered the degrading invert. Through these repairs, water is now staying within the culvert and lessened the pre-repair structural concerns. Along with the liner, corner baffles were installed to provide hydraulic complexity in the culvert and slow water velocities. By

decreasing velocity and increasing depth there is now improved access for NMF to the 1.96 miles of upstream habitat.

Figure 17: Two Mile Creek Culvert Repair, Before and After

Description: Two images, the first shows water running inside of the culvert pre-repair. The second image shows the paved invert of the culvert with corner baffles post-repair.



Monitoring Strategy and Adaptive Management

ODFW and ODOT developed a monitoring strategy that evaluates fish passage performance at each of the repaired culverts. Monitoring documents pre-project conditions (see Project Initiation Forms – Appendix 2), and post-project conditions (photographs shown in Project Descriptions), and initial evaluation of fish passage improvements (see Project Descriptions). ODOT monitors the fish passage improvements at each project to verify that they function as intended. As part of the CRPA agreement, monitoring is completed after winter and spring channel-forming high flow events in years 1, 3, and 5 post-construction.

ODOT remains responsible for ongoing maintenance to ensure the improved passage continues to function at all CRPA sites. However, once monitoring deems the fish passage improvement at a culvert is successful, assessments are less frequent. For monitoring in 2019 and previous years, monitoring has involved an ODFW liaison and the ODOT aquatic resources lead visiting each CRPA at least twice a year during different flows to determine if the CRPA project is successful or in need of modifications. When monitoring reveals a site where fish passage improvements do not meet the designed standard, additional work is planned to bring the sites into compliance. Alternatively, like the Hwy 244 Marley Creek culvert, sites continue to be monitored to determine the extent of fish passage improvements, and to ensure that those improvements are maintained over time. ODOT is currently developing a standardized monitoring form to aid in tracking and reporting the results of each repair.

Lessons Learned

Several opportunities to improve the implementation of the agreement were apparent in 2019 and are discussed below.

Information Management

Scoping and identifying projects for the CRPA each year is challenging and takes extensive amounts of time. ODOT's culvert inventory is unfortunately incomplete and does not contain substantial information on fish presence or habitat availability for all culverts on the highway system. Due to this information gap, field visits with ODFW and ODOT biologists are required to make final determinations regarding fish presence at each proposed repair location. With a more complete data set, identification and selection of repair projects could be accomplished more efficiently.

Out of Barrel Treatments

Several projects included out of barrel treatments to improve fish passage. Some out of barrel treatments include rock weirs or a roughened channel at culvert outlets to address jump heights into the culvert. The installation and performance of the channel spanning weirs provided several lessons learned and will help inform future implementation of similar structures. These lessons include:

- A project manager should be on-site to ensure the project is implemented as designed and ensure the contractor uses the correct materials as described in the specifications. There were issues with the correct fish rock size on the Pass Creek culvert. When rocks are associated with an invert pave or a centrifugally cast repair, it is very difficult to replace the rocks and have them stay in place into the future. Similarly, the rock weir materials provided by the contractor on the Unnamed Tributary to Hess creek were delivered under specified size, resulting in the project needing adaptive management in subsequent years to perform as intended.
- Have an engineer, hydrologist, and or biologist on-site during weir construction to help field fit structures to provide the desired hydraulic relief while also allowing for low flow passage channels for fish migration. Weirs can themselves become additional passage barriers if not installed correctly.
- Continuously monitor the weir at low and high flow events. Many of these structures require several high water events to seal fully and settle. They may require adaptive management work to ensure the weirs continue to function in years following installation.
- Utilize appropriate size and type of streambed substrate materials to prevent subsurface flow, localized scouring, and loss of weir materials during high flow events.
- Design and construct the weirs to backwater the culvert outlet at elevations that include the repair work in the culvert, such as the new concrete layer, fish rocks, and other

infrastructure added as part of the culvert repair. Install weirs at a higher backwater elevation above the insert than designed to account for settling, especially in tidal or fine substrate heavy work areas.

- Elevations should be taken of key features following initial installation. The Hwy 99 Unnamed Tributary to Springbrook Creek project is an example of where the culvert was installed above designed elevations. This was due to challenges with installation of temporary water management during construction. Although some settlement was anticipated, the site appears to remain at the same elevation as installed. While not a fish passage concern for this location, anticipating settlement in design and construction could have implications for both culvert and roughed weir projects.
- Projects implemented for the CRPA from 2016 through the current projects, appear to be more successful when out of barrel treatments are roughened channels rather than rock weirs.

In-Barrel Treatments

Eight of the twelve culvert CRPA projects implemented in 2019 included in-barrel treatments for fish passage improvements. Most treatments consisted of baffles or fish rocks. All in-barrel treatments were effective at improving fish passage.

In one location, I-5 Pass Creek, fish rocks were installed smaller than designed. This was due to an error during construction, and once installed, would be a significant effort to replace. While the smaller rocks still function to improve fish passage conditions, larger rocks would increase these benefits. It is recommended that fish rocks be inspected before installation to ensure they are sized to match the approved design specifications.

Pre-project Meeting with the Contractor

Hold a pre-project meeting with the contractor prior to project implementation to discuss the following:

- Temporary water management.
- Fish salvage timing.
- Equipment staging.
- Site-specific constraints.
- Project area access.
- Materials needed, as described in the specifications.

This meeting allows the contractor to ask site-specific questions and develop a detailed plan with ODOT construction personnel prior to work beginning.

Hydraulic Modeling

CRPA projects can benefit from hydraulic modeling. Due to the lack of hydraulic modeling done before repair, there was little to no documentation of the exact water velocities. In turn,

projects lacked numeric evidence that velocity was a fish passage issue and that it was improved after repair. When hydraulic modeling is done before treatment ODOT and ODFW can ensure that there is capacity for in-barrel treatments, along with documenting that velocities are an issue for fish passage and will be improved with treatment.

Timelines

Overall, the timelines identified in the CRPA agreement streamlines project development and delivery compared to full culvert replacement projects. On some projects, the timelines have been more difficult to meet, and are usually associated with sites requiring extended time for scoping, engineering, and planning.

Desk and field scoping of potential projects continues to become more efficient as ODOT staff become more familiar with the sideboards of the agreement. Engineering guidance has been developed specific to these types of culvert retrofits, and overall design timelines have improved. For projects that do not require right of way easements or purchase, utility relocation, or other work outside of the culvert barrel, this timeline has been found to be effective in streamlining coordination and project delivery.

A few projects have been delayed outside of the timeline specified in the agreement. Federally-funded corridor projects, some with over 100 culverts, take much longer to scope and design compared to single culvert projects. Projects requiring right of way for channel work or access can be delayed up to a year or more. Federal permitting processes can also delay design and approval due to increased review and turnaround times. The construction of some culvert retrofit approaches, such as centrifugal cast concrete, require special equipment and knowledge to install, leading to limited or no bids during the public bid process. Culvert emergency repairs typically do not allow for full scoping and or design due to the need to quickly address public safety concerns.

As more projects are completed under the CRPA, ODOT and ODFW staffs are finding more ways to cross walk the timelines of the agreement to federally-funded corridor projects. Projects potentially requiring right of way, survey, utility, or federal permitting coordination are identified early in the desk and field scoping process, allowing for extended timelines and planning. More contractors are bidding on culvert repair projects as technologies and construction approaches become more prevalent in the contracting field. This timeline should be revisited in future agreements; however, overall it has been found to be effective in streamlined project development and delivery.

Culvert Paving and Outlet Perch

Four of the culverts repaired in 2019 used an invert pave. In other words, lining the bottom of the culvert with concrete; this is shown in Figure 18. This method restores the culvert's structural integrity, seals any perforations, and covers rusting corrugated metal pipe. When hydraulic capacity exists, up to 6" of concrete with supportive rebar is installed on the invert and up the sides of the culvert throughout its length. One of the lessons learned in this repair

approach is that extending the new concrete to the culvert's outlet can create a perched condition in relation to the receiving pool, particularly during low flow periods, which means that the jump height for fish to access the culvert and any upstream habitat has increased by potentially 6" plus. One example of this potential challenge was at US 101 Doty Creek, where the increased perch height resulted in less than expected backwater conditions. Adaptive management was completed to feather the outlet invert liner to alleviate any increase in existing jump height at the culvert outlet.

If this treatment is proposed to repair a culvert in the future, it is advised that the potential perch be considered during scoping and design. This issue can be alleviated through the additional use of an out of the barrel treatment. A rock weir downstream to backwater the outlet or tapering the concrete repair as the concrete is placed in the outlet section are two suggestions.

Figure 2: Invert Pave Example



Outreach

In 2019, four of the five ODOT regions completed CRPA projects. While regions 2 and 3 had completed CRPA projects in previous years, 2019 was the first year regions 1 and 5 included these types of projects. The CRPA is a beneficial tool designed to be used statewide. With further outreach across the state, more project planners will understand the applications of the agreement. With this additional outreach effort, planners can more readily select appropriate projects when they are available.

Additional outreach efforts from both ODOT and ODFW can help highlight the unique and successful approaches of this partnership. Future repair agreements will need support from

both agencies, and outreach targeting the cost efficiency and benefits to NMF can help inform future funding and staffing needs. Likewise, outreach efforts showcasing the agreement to the general public can help provide transparency into the effort to maintain the state highway system in an ecologically and fiscally responsible manner.

Compensation Projects

The CRPA included a provision that ODOT provides ODFW with \$2 million to address the highest priority fish passage projects in the state off of the ODOT system. This funding is to offset the delay in achieving full fish passage criteria at the culvert repair locations. In addition to the passage improvements at each repair location, the compensation package demonstrates a clear benefit to NMF over providing full passage at each of the repair locations at this time.

In 2019 ODFW requested grant applications for projects to fund with the compensation funding. ODFW evaluated these proposed projects for benefits to NMF, based on:

- Habitat quantity and quality.
- Species composition.
- Funding need.
- Cost/benefit ratio.
- Contribution to fish conservation and recovery.

Projects identified in the 2019 ODFW Fish Passage Priority List and/or a Conservation and Recovery Plan were given preference. Nine projects were selected for funding (Figure 19, Table 3). When all nine projects are complete, they will provide access to 110.6 miles of good and excellent quality habitat for many species of NMF (Table 4). The compensation projects will be described in detail in the CRPA completion report at the end of the pilot project.

Figure 3: Locations of the ODFW Compensation Fund Projects Selected in 2019.

Description: Map of Oregon showing the locations of the ODFW compensation fund projects selected in 2019.

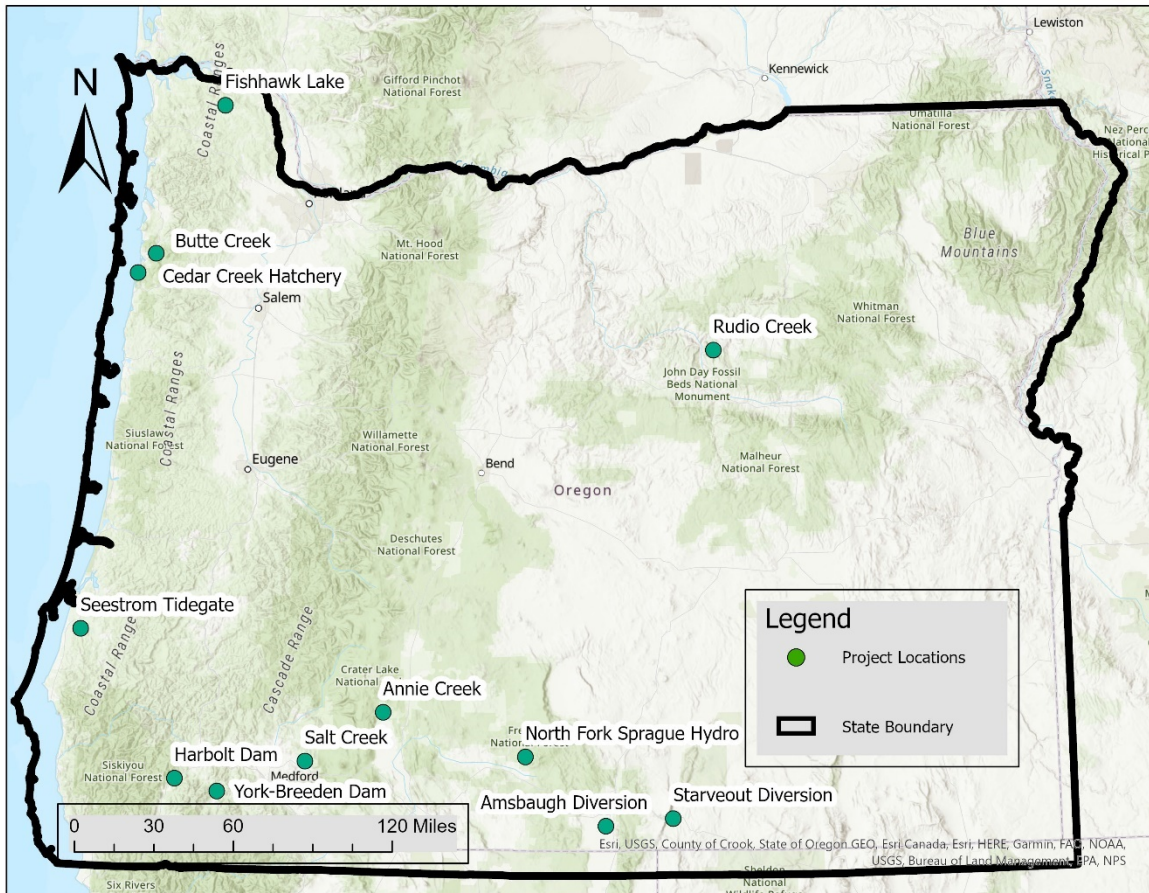


Table 3: ODFW Compensation Projects Synopsis for the CRPA

Table includes each project, the completion date, the benefit to NMF, the project and the project location.

Project Name	Habitat Access Provided to NMF (miles)	Project Expected Cost	Funds Contributed by ODOT	County
Annie Creek	3.1	\$356,970	\$63,897	Klamath
Neskowin, Hawk and Butte Creeks	3	\$263,224	\$105,289	Tillamook

Project Name	Habitat Access Provided to NMF (miles)	Project Expected Cost	Funds Contributed by ODOT	County
Cedar Creek Hatchery	18	\$1,800,000	\$100,000	Tillamook
Fishhawk Lake	34.4	\$156,617	\$105,238	Clatsop
Harboldt Dam	15	\$294,267	\$100,000	Josephine
North Fork Sprague Hydro	35		\$75,000	Klamath
Rudio Creek	11.8	\$104,497	\$44,225	Grant
Salt Creek, C2 Cattle Company	7.5	\$171,549	\$46,650	Jackson
Seestrom Tidegates	270 acres of floodplain	\$2,101,338	\$100,000	Coos
Starveout Diversion	3	\$550,844	\$50,000	Lake
Thomas Creek Amsbaugh Diversion	35	\$87,595	\$25,595	Lake
York-Breeden Dam	62.5	\$777,738	\$75,000	Josephine

Table 4: Fish Species Summary for ODFW Compensation Projects

Table includes the project site and the NMF species present, a check mark indicates presence.

	Species									
	Cutthroat	Redband	Winter Steelhead	Summer Steelhead	Coho	Fall Chinook	Spring Chinook	Bull Trout	Pacific Lamprey	Other
Site										
Annie Creek		✓		*			*	✓		
Neskowin, Hawk and Butte Creeks	✓		✓		✓	✓			✓	Chum Salmon
Cedar Creek Hatchery	✓		✓	✓	✓	✓	✓		✓	Western Brook Lamprey
Fishhawk Lake	✓		✓		✓				✓	
Harboldt Dam	✓		✓	✓	✓	✓			✓	
North Fork Sprague Hydro		✓						✓		
Rudio Creek		✓		✓			✓			
Salt Creek	✓		✓	✓	✓	✓				
Seestrom										
Tidegates	✓		✓		✓	✓				
Starveout Diversion										Warner Redband Warner Sucker
Thomas Creek-Amsbaugh Diversion		✓								Modoc Sucker Pit Roach Goose Lake Sucker Goos Lake Tui Chub Goose Lake Lamprey
York-Breeden Dam	✓		✓		✓	✓			✓	Klamath Small Scale Sucker

* Habitat will be available to these species if reintroduction is completed.

Conclusion

In 2019, the CRPA project continued to be a valuable method of extending the working life of failing and degraded culverts on ODOTs highway infrastructure, while providing enhanced passage for NMF.

Annual cost avoidance of over \$31 million dollars was realized through the ability to fix culverts under a streamlined programmatic process. Access to over 19 miles of habitat were enhanced for NMF at culvert enhancement locations. Also, twelve projects were selected through the ODFW-managed compensation fund that, when completed, will provide improved habitat access for NMF to over 313 miles of stream habitat.

Continued monitoring and reporting of the success of the CRPA program will inform future adaptations and program development. The agreement demonstrates successful interagency cooperation in maintaining the highway system for the traveling public, saving taxpayer dollars, and improving access to critical aquatic habitat for ESA listed species.

Appendix 1: Culvert Repair Programmatic Agreement

**ODOT CULVERT REPAIR
PROGRAMMATIC AGREEMENT PILOT PROJECT
Final 12-8-2017**

The parties to this Programmatic Agreement, (hereafter "Agreement") are the Oregon Department of Fish and Wildlife (ODFW), and the Oregon Department of Transportation (ODOT), both agencies of the State of Oregon.

I. PURPOSE

1. It is the policy of the State of Oregon to provide for upstream and downstream passage for native migratory fish in all waters of this state in which they are currently or have historically been present, as described in Oregon Revised Statute (ORS) 509.585, Oregon Administrative Rule (OAR) 635-412-0020, and envisioned by the Oregon Plan for Salmon and Watersheds (Executive Order 99-01).
2. It is the Mission of ODOT to provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians.
3. Pursuant to ORS 509.585 and OAR 635-412-0020, certain actions, or "trigger events,"¹ at "artificial obstructions"² where native migratory fish (as defined in OAR 635-412-0005(32)) are currently or were historically present require the review and approval of fish passage by ODFW or the Oregon Fish and Wildlife Commission (OFWC) prior to those trigger events occurring. OAR 635-412-0020(3)(b) allows ODFW to grant "programmatic approval" of a fish passage plan for multiple artificial obstructions of the same type.
4. ODOT owns and operates a number of culverts as part of its transportation system. ODOT desires the opportunity to conduct repair activities on their culverts to meet the original life expectancy of the culvert structure. These activities (Appendix A) may constitute a fish passage trigger event as defined by OAR 635-412-0005(9).
5. This Agreement is intended to serve as the ODFW fish passage approval for the short-term repairs of ODOT culverts associated with this pilot project that meet the requirements and conditions of this Agreement (including Appendix A).
6. The goals of this Agreement include:
 - a) Provide improved fish passage conditions at each culvert repair site
 - b) Address statewide fish passage priority barriers using the fish passage fund (defined in Section III(3) of this agreement) in the most expeditious and efficient way practical
 - c) Improve State highway infrastructure conditions at each culvert repair site to address public safety
 - d) Generate information on the costs, impacts, efficiency, and effectiveness of the culvert repair pilot project approach
 - e) ODOT and ODFW will develop a work plan and identify resources to develop information on fish presence and barrier status on the State highway system and include this information in the ODOT State Highway Drainage Facility Management System (DFMS)

¹ "Trigger events" for the purposes of this Agreement shall mean, with respect to an "artificial obstruction" (defined in OAR 635-412-0005(3)) located where native migratory fish are currently or were historically present: "construction" activities (defined in OAR 635-412-0005(9)), "fundamental changes in permit status" (defined in OAR 635-412-0005(25)), or "abandonment".

² "Artificial obstruction" means any dam, diversion, dike, berm, levee, tide or flood gate, road, culvert or other human-made device placed in the waters of this state that precludes or prevents the migration of native migratory fish.

II. APPLICABILITY

1. This Agreement applies to ODOT, including its independent contractors, when repairing ODOT owned culverts. It does not apply to other State or local agencies, or private persons.
2. This Agreement applies when ODOT culvert repair actions covered by this pilot project constitute a "trigger event" to Oregon's Fish Passage Policy. The Agreement identifies and determines how ODOT shall proceed as per the terms of this Agreement. ODOT remains responsible to address and comply with fish passage laws for activities and situations not covered by this Agreement.
3. Under this Agreement only ODFW may determine that native migratory fish are not currently and were not historically present at a site; however ODOT may assume presence of native migratory fish.
4. This Agreement applies to culverts that meet all of the following criteria:
 - a) Culverts located within the State of Oregon;
 - b) Culverts not identified on the ODOT ten year passage implementation plan.³
 - c) Culverts located in or which would prevent access to Habitat Category 1⁴ habitat are excluded.
 - d) Culverts with tide gates are excluded.
 - e) Full traditional culvert slip-line repair treatments are excluded.

III. PROVISIONS OF THE AGREEMENT

1. ODOT will be permitted to conduct the culvert repair activities described in appendix A through the 5-year term of this Agreement. Culvert replacements are not authorized by this Agreement.
2. ODOT will ensure that fish passage improvements⁵ occur at each culvert repaired under this Agreement, with the goal of maximizing native migratory fish passage to the extent feasible at each site. Culverts identified as a high fish passage priority on the current ODFW-ODOT Culvert Fish Passage Priority list are eligible for repair under this programmatic provided that fish passage is significantly⁶ improved as part of the repair project.

³ ODFW and ODOT will jointly develop a 10 year passage implementation plan for ODOT to address fish passage at High Priority sites utilizing the ODOT Fish Passage Program funds. Projects not identified on this implementation plan are eligible for the Culvert Repair Programmatic Agreement.

⁴ Habitat Category I is defined in OAR 635-415-0025(1) and include habitats that are irreplaceable, essential habitat for a fish or wildlife species, population, or a unique assemblage of species and is limited on either a physiographic province or site specific basis, depending on the individual species, population or unique assemblage.

⁵ Fish passage improvements may include but are not limited to the following treatments: weirs, baffles, fish rocks, roughened channels, rock weirs, or other treatments within or outside the culvert that decrease water velocities, increase water depths, or reduce jump heights. ODFW-ODOT Liaison will work with ODOT to ensure site specific fish passage improvements are appropriate for the fish species and site conditions. If fish passage exists and cannot be further improved at ODOT's culvert repair site, fish passage improvements may occur at the next passage barrier up or downstream of ODOT's culvert as negotiated on a case by case basis. The goal of addressing passage up or down stream of ODOT's culvert is to ensure that a cumulative net benefit is realized by the fish population at the trigger site.

⁶ For High Priority Fish Passage Barriers ODOT will address everything possible and necessary at the project site to improve fish passage without replacing the structure itself. This includes improving outlet conditions (where applicable) to address jump height into the culvert and/or provide a backwater condition at the culvert outlet.

3. ODOT will provide ODFW fish passage restoration funds to offset the delay in full fish passage at the repair culverts as a result of this Agreement. This passage restoration fund account will be funded with \$2 million dollars at the beginning of the agreement to offset the delay in passage for the first 40 culverts repaired under the agreement. For each culvert repaired after the first 40, ODOT will contribute an additional \$50,000 dollars to the fund. ODOT anticipates repairing approximately 20 culverts each year under the five year agreement for a projected total of 100 culverts repaired and \$5 million dollars of restoration funding.
4. ODFW will manage and administer these funds to specifically address high priority fish passage projects statewide regardless of ODOT ownership and independent of geographic location. ODFW will use generally accepted accounting practices to manage these funds and shall ensure these funds are allocated in the most expeditious and cost effective means while maximizing benefit to native migratory fish.
5. ODOT will continue to fund at least \$4.2 million annually into the ODOT Fish Passage Program for the term of this agreement. This funding is separate and in addition to the ODFW fish passage restoration funds described in section III (3) and funding for the liaisons described in section III (8) of this agreement. The ODOT Fish Passage Program funding will be used to address the ten year passage implementation plan administered by ODOT.
6. During the year prior to the target year for proposed culvert repairs: By February 28th (typically 16 months in advance of the target in-water work window), ODOT will provide ODFW a list of potential culverts to be repaired during the following year's in-water work period under the terms of this Agreement for each year of the Agreement. ODFW will review and approve the list based on criteria in Section II.4.a-e above, by June 1st, or within 90 days of receiving the list. By October 1st ODFW will provide ODOT with the following information for each potential repair project at the repair site:
 - a) Native Migratory Fish Species historically and currently present
 - b) Migratory timeframes of concern
 - c) Existing fish passage impediments
 - d) Recommendations to improve fish passage conditions
 - e) Recommended in-water work window
7. ODOT and ODFW will collaboratively develop fish passage improvements for each repair site, based on site conditions and constraints, hydraulic conditions, and the needs of Native Migratory Fish. ODOT will provide fish passage design concepts to ODFW for review and comment by February 28th of the year of proposed culvert repairs. ODFW will review each incremental passage design and document concurrence with the design approach by March 31st, or within a month of receiving the fish passage design concepts.
8. ODOT will fund two ODFW/ODOT Liaison positions to help implement this Agreement.
9. Culvert repair actions not authorized by this Agreement require specific approval by ODFW if the repair actions meet the trigger definition. This Agreement does not preclude ODOT from pursuing other options to address or comply with fish passage laws at ODOT structures.
10. ODOT is responsible for obtaining all other state and federal permits and permissions necessary for completion of activities approved by the Agreement.

11. All in-water work associated with this Agreement will occur during the appropriate ODFW in-water work window, or as negotiated.
12. This Agreement in no way purports or authorizes take of a federally listed species.
13. Pursuant to OAR 635-412-0035 (1 and 10) ODOT is responsible for following all best management practices during construction/maintenance activities to protect fish, wildlife, and their habitats. These BMP's include but are not limited to, adequately dewatering and isolating worksites, performing fish salvages, and providing adequate downstream passage, bypass, and screening if necessary.

IV. POST-PROJECT OBLIGATIONS

1. **Maintenance.** ODOT is responsible for all maintenance required such that culverts repaired under this Agreement continue to provide the improved level of fish passage that was achieved under this Agreement.
2. **Inspection and Record-Keeping.** ODFW may inspect any road-stream crossing for which ODOT is responsible (ORS 509.625 and OAR 635-412-0020(3)(b)(D)). If inspection of a culvert repair site installed under this Agreement indicates that fish passage improvements are not functioning as intended, ODFW shall notify ODOT. ODOT shall work with ODFW to determine the cause and, during a work period approved by ODFW, expeditiously rectify problems as necessary (OAR 635-412-0020(3)(b)(E)).
3. **Monitoring and Reporting.** ODOT and ODFW will implement a monitoring plan prior to project construction that will include pre and post repair project site analyses of fish passage conditions. ODOT, or its designee, shall monitor and report all repair projects implemented under this agreement to verify that fish passage improvement(s) function as intended. Monitoring shall be completed after winter and spring channel forming high flow events in years 1, 3, and 5 after completion of each culvert repair and fish passage improvement. Monitoring shall identify native migratory fish species and life stages affected at each culvert repair site and the quantity and quality of habitat above each barrier. Monitoring shall consist of a best professional judgment assessment by a qualified fisheries biologist of fish passage conditions. This includes noting any water surface jumps, channel adjustments, streamflow velocity characteristics, channel bed stability, scour occurrence, and other relevant data to ensure the project is functioning as designed for fish passage. Pre- and post-treatment photographs of each site shall be included in the monitoring reports. If monitoring indicates that fish passage is not being provided consistent with project intent, ODOT shall consult with ODFW, determine the cause, and during a work period approved by ODFW, expeditiously rectify problems as necessary (OAR 635-412-0020(3)(b)(E)). If in the final year, post-project assessment reveals a successful project and that fish passage has not deteriorated, then the project will be removed from the post-project monitoring obligations. ODOT remains responsible for the ongoing maintenance necessary to ensure the improved level of fish passage continues to function until the next trigger event.
4. **Annual Report.** By February 1st of each year of the Agreement, ODOT shall provide an Annual Electronic Report on all culverts repaired under this Agreement. The Annual Electronic Report shall consist of:
 - a) Narrative discussion of program activities,
 - b) Map of culverts repaired under program,
 - c) Description and date of repair action(s) performed at each culvert under the Agreement,
 - d) Description of how fish passage was improved at each culvert repaired under the Agreement,

- e) Project specific monitoring results from monitoring efforts identified in # 3 above,
 - f) Estimate of fish habitat upstream of each culvert, and
 - g) List of species present at each culvert.
 - h) Analysis of estimated annual cost savings of culvert repairs made vs. the cost of culvert replacements.
5. Final Report. At the conclusion of the pilot project each agency shall provide a final report.
- a) ODFW shall provide a final pilot project analysis and report on the effect(s) of the pilot project on fish passage. The report will include: site locations, native migratory fish species, quantity and quality of habitat upstream of barriers for both the:
 - I. effects of the culvert repairs and the fish passage improvements made at each repair site, and
 - II. fish passage improvements implemented with the fish passage funds (defined in Section III(3) of this agreement), administered by ODFW.
 - b) ODOT shall provide a final project report on the effect(s) of the pilot project on maintaining the highway infrastructure. The report will include: number of culverts repaired, improvements to infrastructure condition, the cost effectiveness of repairs relative to infrastructure benefits, and an analysis of the cost savings of culvert repairs made vs. the cost of culvert replacements.
 - c) These reports will be used to develop a strategy to address the culvert infrastructure issue(s) on the State highway system and the needs of native migratory fish. Final reports shall be complete by June 30, 2023.
6. Coordination Meetings. Staff from ODOT and ODFW affected by this Agreement, will meet annually, or as otherwise deemed appropriate, to collaboratively review projects implemented under this Agreement and evaluate adaptive management measures, as appropriate.

V. GENERAL PROVISIONS

1. Notice. The parties' contact persons for all notices provided for under this Agreement, except as specifically provided otherwise, are as follows:

Agency	ODFW	ODFW Technical	ODOT	ODOT Technical
Name	Greg Apke	Pete Baki	William Warncke	Wade Holaday, P.E.
Title	ODFW Fish Passage Coordinator	ODFW/ODOT Liaison	ODOT Fish Passage Program Team Leader	ODOT Culvert Maintenance Engineer
Address	4034 Fairview Industrial Dr. SE Salem, OR 97302	4034 Fairview Industrial Dr. SE Salem, OR 97302	4040 Fairview Industrial Dr. SE Salem, OR 97302	4040 Fairview Industrial Dr. SE MS #6 Salem, OR 97302-1142
Phone	503-947-6228	503-947-6234	503-986-3459	(503) 986-4046
E-Mail	greg.d.apke@state.or.us	Pete.Baki@state.or.us	William.M.Warncke@odot.state.or.us	Wade.HOLADAY@odot.state.or.us

Either party may change a designated contact person at any time by providing written notice to the other party.

2. Amendments. Amendments to this Agreement may be made within applicable laws at the mutual agreement and signature of the ODFW Fish Screens and Passage Program Manager and the ODOT Environmental Resources Unit Manager.
3. Term. This Agreement is entered into on the date of last signature by and between ODFW and ODOT, both representing the State of Oregon. This Agreement expires Dec 31, 2022.
4. Termination. This Agreement may be terminated at any time through mutual agreement by the parties or by either party after a 30-day written notice. If terminated, culverts previously

repaired consistent with this Agreement will not be subject to additional fish passage requirements beyond maintenance as described in IV(1), until an additional trigger event may occur.

RUP
1/19/18



1/18/18

Date

Highway Division Administrator
Oregon Department of Transportation



Date

Chair, Oregon Fish and Wildlife Commission

Appendix A

Examples of ODOT culvert repair actions* allowed under the Culvert Repair Programmatic Agreement that currently trigger fish passage laws

Strip line
Spot and localized repairs
Spray on coating
Cured in place technology
Spiral wound
Pave invert
Add or extend end treatments
Replace interior sections of culvert**
Replace road pavement and sub base above culverts

*The intent of the culvert repairs allowed under the programmatic agreement is to provide (up to) an additional 10 to 25 years of culvert life. The actual life of the culvert and repair will depend on site specific conditions. These repairs are considered short-term fixes, not in effect a culvert replacement that provides a new design life.

** This technique is intended to replace 1 to 3 segments of a pipe that have broken or failed prematurely. It is not intended to replace the majority of the pipe.

Culvert repair techniques not listed above are allowed provided they fully meet all requirements of this agreement. Culvert repair techniques not listed above will be discussed by the ODFW and ODOT contacts identified in section V prior to implementation.

Full traditional Slip-line culvert repairs are specifically excluded from this Programmatic Agreement.

Appendix 2: Project Initiation Forms for 2019 Culvert Repairs (Available Upon Request)



Oregon Department of Fish and Wildlife

3406 Cherry Avenue NE | Salem, Oregon 97303-4924
503-947-6000 | 800-720-6339 | www.dfw.state.or.us



Oregon Department of Transportation

355 Capitol Street NE, MS11 | Salem, Oregon 97301-3871
888-275-6368 | www.oregon.gov/ODOT