MULTNOMAH COUNTY FISH PASSAGE ASSESSMENT

Final Report to:
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Executive Summary

Fish passage barriers at Multnomah County road crossings limit the distribution and movement of native salmon and trout, hindering salmon recovery and watershed health. Many road crossings were constructed before impacts on fish passage were known, while others constructed for fish passage have been rendered impassable by flood damage and channel changes or erosion. We updated and expanded Multnomah County's twelve year-old inventory of fish passage barriers at road crossings to support better-informed decision making on County road maintenance and repair. Numerous scientific reviews indicate that the repair/replacement of fish passage barriers at road crossings represents a simple, effective, and low-risk salmon habitat restoration strategy.

We conducted field surveys of 119 Multnomah County road crossings on fish-bearing streams, completed fish passage analyses, and prioritized crossings for repair/replacement based on barrier status (full versus partial barriers) and the length of upstream fish habitat. Of the 119 surveyed culverts, 44.5% were full barriers to fish passage, 39.5% were partial barriers, 11.8% represented non-barriers, and 4.2% were of unknown status.

Almost half (49.7%) of all identified full or partial barrier culverts failed to meet fish passage criteria due to slope, with 26.3% failing due to water surface drop, 21% due to excessive water velocities, 1.8% due to minimum water depths within the culvert, and 1.2% due to an internal obstruction. Over half (58.5%) of all full or partial barrier culverts failed fish passage criteria due to more than one factor, with culvert slope representing the primary barrier factor at 72.7% of crossings that failed to meet fish passage criteria.

We also scored culvert condition to identify those in need of maintenance regardless of their impacts on fish passage. We found 37.8% in good, 30.3% in fair, 29.4% in poor, 1.7% in very poor, and 0.8% in unknown condition. More than one third of all full barriers to fish passage are in poor condition and at risk of failure.

Among the highest ranked culverts prioritized for fish passage restoration are:

- the SE Stark Street crossing on Beaver Creek with nearly 30 km of upstream fish habitat,
- the SE Division Street crossing on Beaver Creek (near 302nd Avenue) with 5.4 km of upstream habitat,
- the SE Gordon Creek Road crossings on Trout and Buck creeks with 16.9 km and 12.3 km of upstream habitat, respectively, and
- the SE Deverell Road crossing on Buck Creek with 6.3 km of upstream habitat.

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Introduction

Background – Fish passage barriers at road crossings have been identified as a factor contributing to regional salmon declines, and a deficiency of information on fish passage barriers hinders efforts to prioritize and restore freshwater habitats. Anadromous salmonids such as ESA-threatened steelhead, coho and Chinook salmon, as well as native resident fish like cutthroat trout must migrate within and beyond watersheds to complete their life histories. Many road crossings on fish-bearing streams were constructed before impacts on fish passage were known or widely appreciated. A recent review of salmon restoration techniques highlights fish passage restoration at road crossing culverts as an effective, low-risk approach to boosting threatened salmon populations (Roni et al. 2002, Pess et al. 2005).

Multnomah County's existing inventory and data needs – Multnomah County conducted an inventory of County-owned culverts in 2000, in response to the listing of salmonids under the Endangered Species Act and in anticipation of the passage of House Bill 3002, which established fish passage criteria. The County, in partnership with ODFW, originally identified 48 culverts with fish passage problems, fourteen of which affected anadromous fish. This original assessment was based on professional judgment by ODFW biologists observing targeted culverts in the field. Identified barrier culverts were included in the ODFW Statewide barriers GIS database.

County staff developed a ranking system to prioritize repair or replacement of the identified barriers. This ranking system included scoring for metrics including: riparian cover, stream temperature, quantity of upstream habitat, construction cost estimates, a maintenance factor, and a projected impact factor. The original culvert ranking system served as the basis for the County's capital improvement program for culverts up until this present assessment.

Two considerations necessitated a review of the original culvert inventory from 2000. First, fish passage had not been quantitatively determined and new methods for culvert assessment could be applied to determine the degree of fish passability at County culverts. Second, knowledge of the extent of fish presence in Multnomah County streams had expanded and additional culverts needed to be added to the fish passage culvert inventory.

Goals and Objectives – The goal of this 2013 effort was to update Multnomah County's existing inventory and prioritization of road crossings with fish passage impediments. The objectives are to:

1. Conduct field surveys of County road crossings on fish-bearing streams;
2. Collect supplemental information at accessible private crossings that affect fish access upstream or downstream County crossings;
3. Complete hydraulic analyses and rate crossings for degree of passability by native fish;

4. Produce data summaries and a final report on fish passage needs at County road crossings; and
5. Prioritize fish passage improvements at County road crossings based on ecological factors.

Study area watersheds – Centered on the confluence of the Columbia and Willamette rivers, Multnomah County encompasses drainages from the Coast Range foothills in the west, across the lower Willamette Valley, and into the Cascade Mountains to the east. The County harbors diverse landforms and environments including steep uplands, valley floors, and floodplains with a mix of forest, wetland, and stream types. Urban development associated with the cities of Portland, Gresham, and other small jurisdictions is the dominant land use in lowland portions of Multnomah County, with a small area of agriculture in Beaver and Upper Johnson creeks to the east. Forestry and rural residential land uses dominate in upland portions of the County.

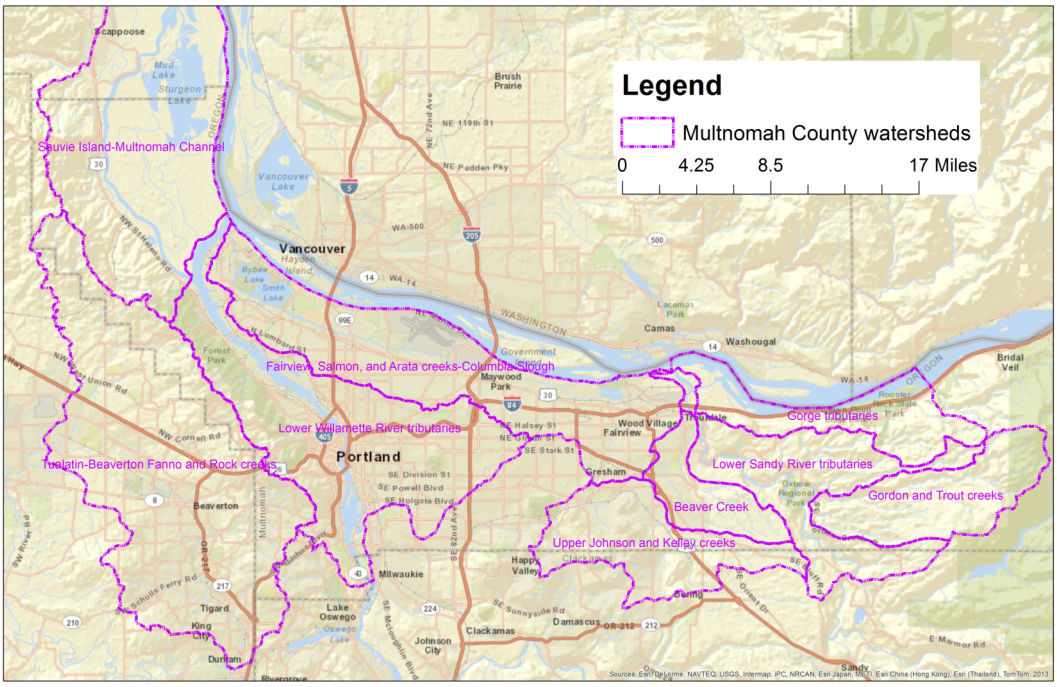
Historically, Multnomah County watersheds harbored a diversity of aquatic habitats ranging from small, steep mountain streams to low-gradient floodplain-wetland channels associated with the Columbia and Willamette rivers. Over the past 150 years, forestry, agriculture, urban and industrial development have transformed this natural legacy. Riparian and forested uplands were logged, lowlands converted for agriculture and urban development, and watersheds underwent extensive ditching, diking, hydropower, and road development that altered runoff patterns and processes.

Three species of salmon (Chinook, coho, and chum), two trout (steelhead and cutthroat), and a diversity of other native fish and aquatic fauna occupy Multnomah County watersheds. All three salmon as well as steelhead populations are listed as threatened under the Endangered Species Act within the Lower Columbia-Willamette Valley region.

For the purpose of summarizing fish passage assessment data we resolved nine distinct watersheds, described below in Figure 1. These watersheds were represented as modified U.S. Geological Survey 6th-field hydrologic units, under which:

- Tualatin River tributaries (Rock, Beaverton, and Fanno creeks) were combined into one watershed,
- Latourell Creek and other Columbia River Gorge tributaries were separated from those in Washington State,
- Beaver Creek was separated from other Lower Sandy River tributaries,
- Gordon and Trout Creek were separated from other Lower Sandy River tributaries, and
- All other Lower Sandy River tributaries were combined into one watershed.

Figure 1. Multnomah County study area watersheds. Watersheds boundaries were modified from USGS 6th field hydrologic unit boundaries, land cover derived from Regional Conservation Strategy raster data (Intertwine Alliance 2012), and lengths of fish/nonfish stream adapted from ODF fish presence GIS data (ODF 2012). Salmon and steelhead presence is based on ODFW fish distribution data (ODFW 2013).



Watershed	Land Cover				Area (sq km)	Fish-bearing Stream Length (km)	Nonfish/ Unknown Stream Length (km)	Salmon and Trout Species Present [1]
	% Developed	% Agriculture	% Low Veg/ Open	% Forested				
Sauvie Island-Multnomah Channel	9.1	42.2	10.0	38.7	201	287.4	190.4	Chinook, coho, steelhead, cutthroat
Tualatin: Rock, Beaverton, & Fanno Creeks	38.8	7.5	11.3	42.4	248	234.2	69.5	coho, steelhead, cutthroat
Lower Willamette River Tributaries	52.3	0.4	6.7	40.6	168	67.4	170.2	cutthroat
Fairview, Salmon, and Arata Creeks	62.0	1.4	18.6	18.0	151	24.7	76.9	cutthroat [2]
Upper Johnson and Kelley Creeks	23.0	19.9	13.9	43.1	69	100.1	40.0	coho, steelhead, cutthroat
Lower Sandy River Tributaries	6.7	16.8	6.8	69.7	86	92.5	222.8	Chinook, coho, chum, steelhead, cutthroat
Beaver Creek	17.8	20.5	9.1	52.6	55	33.1	50.2	Chinook, coho, steelhead, cutthroat
Gordon and Trout Creeks	5.7	4.8	12.2	77.3	62	64.5	120.1	Chinook, coho, steelhead, cutthroat
Gorge Tributaries	9.6	16.6	14.6	59.3	33	20.1	25.0	Chinook, coho, steelhead, cutthroat

[1] Though salmon and trout species are found throughout the different watersheds, many surveyed culvert crossings were on small streams and/or upstream of impassable natural falls or cascades. Salmon and trout are listed as present within watersheds, though may not be present at individual crossings surveyed during this effort.

[2] Cutthroat trout presence in Fairview, Salmon, and Arata creeks is suspected but not confirmed.

Methods

Survey sample identification – To identify potential fish passage barriers at Multnomah County road crossings, we used ArcGIS to select road culvert crossings on streams from the County's existing transportation asset geographic information system (GIS) database. This query excluded bridge crossings as well as road ditch relief culverts (those not on streams) from our sample since these crossing types rarely impede fish passage.

In GIS, we intersected stream culvert crossings with an Oregon Department of Forestry GIS layer depicting the extent of fish bearing stream network (ODF 2013). Road culvert crossings on known fish-bearing streams were selected as well as those on larger streams classed as non-fish or unknown (where fish presence has not been established) with the potential to harbor fish. These supplemental reaches included low-gradient streams with watershed areas comparable to adjacent known fish-bearing streams. Oregon Department of Fish and Wildlife (ODFW 2013) fish distribution GIS data were not relied upon to identify fish-bearing stream networks because they were limited to anadromous salmon and steelhead and did not include the more widely-distributed cutthroat trout.

During the course of field surveys, we also identified and mapped private culverts close to County crossings, which were visible from public right-of-ways and had potential to impact fish passage. However, we did not conduct an exhaustive field inventory of private crossings due to constraints on access and available resources.

Survey methodology - We conducted field surveys of selected culverts following Washington Department of Fish and Wildlife fish passage assessment methods (WDFW 2009). Since the State of Oregon does not have an official fish passage evaluation methodology, we sought an approach that:

- explicitly addressed degrees of culvert passability (e.g. full and partial barriers),
- described specific barrier factors (e.g. culvert slope, outlet drop height, etc.),
- considered fish passage across a range of flow conditions, and
- had been tested, refined, and applied in a similar landscape setting.

Only the WDFW methodology met all these criteria, and at the recommendation of regional ODFW staff, we selected the WDFW approach for this Multnomah County effort.

Field surveys – We navigated to target crossings using field maps and a global positioning system (GPS) and confirmed fish habitat potential and stream access before initiating culvert surveys. Streams >0.6 m bankfull width and <16% gradient (sustained over 500 feet) were presumed to be fish-bearing.

On fish-bearing streams with access to culvert inlets and outlets, we observed and measured the stream and associated culvert(s), and took photographs. At County crossings with insufficient access to either the inlet or outlet, and at select private fish-passage barriers upstream and downstream of County crossings, we collected photos and observations from public road right-of-ways (ROWs) to support later barrier

prioritization. At two County crossings with inlet or outlets inaccessible behind a private fence, we made observations from the public road and used County as-built drawings to derive culvert length and slope information.

The WDFW fish passage assessment includes an initial level A survey of culvert dimensions, slope, and alignment relative to the stream channel, followed by a more detailed level B survey at a subset of crossings to collect additional data for hydraulic analyses to establish fish passability. Table 1 details culvert and stream attributes recorded during level A surveys, and table 2 shows additional data recorded during level B surveys.

Table 1. Culvert and stream attributes and descriptions recorded during the level A surveys, adapted from WDFW 2009. Categorical data is highlighted in bold.

Attribute	Description
Ownership	**County, private, or other** (where known)
Fish habitat criteria	**Mapped, physical, biological, or other**
Culvert condition	**Good, fair, poor,** or **very poor** based on visual inspection of pipe for damage, breaks, leaks, rust, debris plugs, and water erosion of the associated roadbed
Number of culverts	[the following 12 attributes are recorded for each pipe]
Shape	**Round, box, arch, squash** (pipe arch), **ellipse, other**
Material	**Concrete, corrugated steel/aluminum, structural plate steel/aluminum, plastic, other**
Span/Diameter	The horizontal dimension of the culvert. Expressed in meters to the nearest 0.01.
Rise	The vertical dimension of the culvert, only used for non-round pipes. Expressed in meters to the nearest 0.01.
Water depth in culvert	Depth of water inside the culvert, measured at the downstream end. Expressed in meters to the nearest 0.01 m.
Water surface drop	Distance from the water surface in culvert outlet to the downstream plunge pool. Water surface drop can also occur within the culvert and at the culvert inlet. Expressed in meters to the nearest 0.01 m.
Drop location	**Inlet, outlet, interior**. Indicate in comments section if water surface drop occurs at multiple locations and report measure for each.
Length	Culvert length, measured in meters to the nearest 0.1 m with a LaserTech Impulse 200 laser rangefinder.
Slope	Culvert slope, reported in percent to the nearest tenth of a percent (e.g. 4.3%) measured with the Impulse 200 laser rangefinder.
Countersunk	**Yes/no**, indicates when culvert is embedded (buried) at the outlet by a minimum of 20% of the culvert diameter/rise, and streambed material is present throughout the length of the culvert.
Apron	Indicates the presence and location of an apron: **none, upstream, downstream, both ends**
Fishway	Indicates the presence and type of fishway present. Note all that are present: **baffles, weirs, streambed control, other**. Also record the number, type (**concrete, metal, wood, rock, plastic, other**), location (**interior, upstream, downstream, both ends**), maximum water surface drops, and entrance pool sizes and depths for each weir and streambed control feature.
Road fill depth	Depth of road fill over culvert. Expressed in meters to the nearest 0.1 m.
Plunge pool length	Distance from the outlet of the culvert to the downstream control. Expressed in meters to the nearest 0.01 m.
Plunge pool width	Width of plunge pool at its widest point, measured at the scour line. Expressed in meters to the nearest 0.01 m.
Plunge pool maximum depth	Expressed in meters to the nearest 0.01 m.
Channel width	The average active channel width, measured upstream and downstream of the crossing. Expressed in meters to the nearest 0.01 m.
Culvert span to channel width ratio	The ratio of culvert width(s) (cumulative span or diameter) to channel width. Expressed as a decimal fraction between 0 and 1.
Barrier	Results of the level A and B fish passage evaluation: **yes** (culvert is a barrier)**, no** (culvert is not a barrier)**, unknown**.
Method	Fish passage assessment method: **level A, level B, professional judgment.**
Percent passable	Percent passable based on a combination of culvert slope, length, water surface drop, and span/diameter relative to stream hydraulics: **0, 33, 67,** or **100%.**
Barrier factor	Primary and secondary factors contributing to barrier problem: **water surface drop, velocity, depth, obstruction, other.**

Table 2. Culvert and stream attributes and descriptions recorded during the level B surveys, adapted from WDFW 2009. Categorical data is highlighted in bold.

For level B surveys only:	
Corrugation	Dimensions of culvert corrugations (used in hydraulic model to compute roughness): **0.5 x 2.66, 1 x 3, 2 x 6, smooth**
Upstream invert elevation	Culvert inlet bottom elevation. Expressed in meters to the nearest 0.01 m.
Downstream invert elevation	Culvert outlet bottom elevation. Expressed in meters to the nearest 0.01 m.
Upstream culvert bed elevation	The surface elevation of any streambed material inside the culvert at the inlet. Expressed in meters to the nearest 0.01 m. If streambed material is absent, leave blank.
Downstream culvert bed elevation	The surface elevation of any streambed material inside the culvert at the outlet. Expressed in meters to the nearest 0.01 m. If streambed material is absent, leave blank.
Downstream control cross section	Typically at the head of the first riffle below the culvert outlet and associated plunge pool. The cross section included at least 7 stations where distance and elevation were recorded, from the top of the left bank (looking downstream) across the channel to the top of the right bank. Key stations included: top of banks, toe of banks, water edges, the thalweg, and other grade breaks. Expressed in meters to the nearest 0.01 m.
Downstream control water surface elevation	Elevation of water surface at downstream control. Expressed in meters to the nearest 0.01 m.
Scour line width elevation at the downstream control	Elevation of the scour line at the downstream control. Expressed in meters to the nearest 0.01 m.
Water surface elevation 15 m downstream of the downstream control	Water surface elevation of the channel centerline, 15 m downstream of the downstream control location. Expressed in meters to the nearest 0.01 m.
Channel substrate	Dominant substrate in the channel at the crossing: **riprap, boulder, cobble, gravel, sand, mud, bedrock.**

At crossings with multiple culverts we made separate measurements or observations of culvert shape, material, span/diameter, rise, water depth, water surface drop and location, length, and slope for each. Culvert, fishway, and stream dimensions were measured with a telescoping 7.6 m-long stadia rod. Elevations and slopes were measured with an Impulse 200 laser rangefinder mounted to a monopod staff. We used an 8.9 x 12.7 cm rectangular reflective target with the rangefinder on filter mode to enable precise measurement of distance and inclination through brush and across busy roadways. At each crossing we took 3-7 photos, typically of the upstream/downstream channel, and culvert inlet(s) and outlet(s).

Independent of our assessment for fish passage, we qualitatively assessed culvert condition based on:

- the presence and extent of roadfill erosion;
- culvert holes, leaks, or other loss of integrity;
- damage to the inlet or outlet;
- improper alignment with the stream channel; and/or

- excessive streambed cut or fill around the inlet or outlet contributing to diminished flow capacity.

Based on these factors we scored each culvert as good, fair, poor, or very poor.

Hydraulic analyses – For a subset of culverts we conducted more detailed analyses of site hydraulics across a range of flows to determine degree of fish passage. The U.S. Geological Survey StreamStats software (USGS 2013) was used to derive high and low fish passage flows for each crossing requiring a level B analysis, and FishXing software (version 3, USFS 2012) was used to model flow velocities, depths, and water surface drops in selected culverts based on computed high and low flows.

For each level B crossing, we used linear regression equations from Risley et al. (2008) to model the 10% and 95% exceedance flows based on watershed characteristics from StreamStats. Both Oregon and Washington define high and low fish passage flows as the 10% and 95% exceedance flows, respectively, for species-specific migration periods. For fall spawning coho salmon, October-December flow regimes may be the most relevant to determining passage for this species, whereas for spring-spawning cutthroat trout January-April may be a more appropriate flow analysis period.

Following Powers and Saunders (2003), we selected the January 10% exceedance flow as the high fish-passage design flow, since this month often represents the period of highest annual flows in Pacific Northwest watersheds. For low fish-passage design flows, we selected the October 95% exceedance flow because low flows during early fall may limit upstream migration for both juvenile and adult salmonids.

All of the crossings requiring hydraulic analysis were located within the USGS Oregon modeling region 2 (Willamette Valley) so we used the regression equations from Table 8 in Risley et al. (2008). For each crossing, we computed January 10% exceedance flows as

$$P10 = 1.026*10^{0.478}*(DA)^{0.935}*(P)^{0.458}$$

and October 95% exceedance flows as

$$P95 = 1.351*10^{-6.846}*(DA)^{1.208}*(P)^{2.942}*(SP)^{1.046}$$

where

P10	=	10% exceedance flows in cubic feet per second
P95	=	95% exceedance flows in cubic feet per second
DA	=	drainage area in square miles
P	=	mean annual precipitation in inches
SP	=	soil permeability in inches per hour

We input modeled 10% and 95% exceedance flows into FishXing as the high and low fish passage flows, respectively, and conducted model runs for each crossing based on hydraulic criteria for fish passage.

Fish passage criteria – The states of Oregon and Washington have established similar but slightly different guidelines for fish passage, which specify hydraulic criteria and flow ranges where fish passage is required. Both states:

- define upper thresholds for water velocities that depend on fish species/size and culvert length,
- specify minimum water depths and maximum jump heights, and
- identify the range of flows across which fish passage is required.

Table 3 compares select Oregon and Washington fish passage criteria for trout >15 cm and juvenile salmonids showing similarities and differences between the standards. While both states define parallel water velocity thresholds for trout >15 cm long, Oregon also defines lower thresholds for juvenile salmonids and sets maximum jump height at 0.15 m versus Washington State's 0.24 m standard. Washington State sets minimum water depths at 0.24 m as compared to Oregon's 0.20 m standard. Both states identify parallel ranges of flows over which fish passage is required. These distinctions are important to highlight because a culvert classified as a barrier according to WDFW criteria may be considered fish passable in Oregon and vice versa.

Table 3. Oregon and Washington fish passage criteria and flow parameter comparison.

Parameter	**Oregon juvenile salmonid**	**Oregon trout >15 cm**	**Washington trout >15 cm**
Max water velocity			
Culvert length (m):			
<18.3 m	0.61 cu m/sec	1.22 cu m/sec	1.22 cu m/sec
18.3-30.5 m	0.61 cu m/sec	1.22 cu m/sec	1.22 cu m/sec
30.5-61.0 m	streambed sim [3]	0.91 cu m/sec	0.91 cu m/sec
61.0-91.4 m	streambed sim	0.61 cu m/sec	0.61 cu m/sec
>91.4 m	streambed sim	0.30 cu m/sec	0.61 cu m/sec
Min water depth in culvert	0.20 m		0.24 m
Max jump height	0.15 m		0.24 m
High fish passage flow	10% exceedance flow for migration period		10% exceedance flow for migration period
Low fish passage flow	2 year, 7 day low flow, or 95% exceedance flow for migration period		2 year, 7 day low flow

Since the two states' standards are comparable and the WDFW fish passage assessment methodology was designed around Washington State fish passage criteria, we first implemented the assessment using Washington State criteria and then re-examined crossings in the context of Oregon's differing standards.

Summary and analysis of fish passage barriers – Field data and hydraulic analyses were examined in Microsoft Excel and ArcGIS. We used WDFW criteria for water surface drop, velocity, depth, and culvert slope (Table 4) to identify crossings as full, partial, or non-barriers to fish passage. Partial barriers were further subdivided by those that were 33% or 67% passable using a combination of field survey information and hydraulic

[3] For culverts greater than 30.5 m, ODFW requires designs incorporating streambed simulation to aid juvenile salmon passage. Streambed simulation is where substrate and flow conditions in the crossing structure mimic the natural streambed upstream and downstream of the structure.

analyses. For six crossings that required FishXing hydraulic analyses, we report model outputs detailing the percentage of flows between the high and low (10% and 95% exceedance) fish-passage flows that met criteria for fish passage.

Table 4. Criteria for assigning fish passability to culverts that were assessed as barriers, based on WDFW (2009, Table 3.3). When more than one parameter applies, the parameter that is more restrictive or limiting to fish passage applies.

Parameter	Value	Range	Passability
Water surface drop	≥0.24 meters	≥0.24 m and <0.5 m	0.67
		≥0.5 m and <1.0 m	0.33
		≥1.0 m	0
Slope (culverts ≤ 18.3 m in length)	≥1%	≥1% and <2%	0.67
		≥2% and <4%	0.33
		≥4%	0
Slope (culverts > 18.3 m in length)	≥1%	≥1% and <2%	0.33
		≥2%	0
Velocity (level B hydraulic analysis results)	Velocity criterion for a 15 cm trout Culvert length (m) Velocity (mps) <30.5 ≤1.22 30.5-61.0 ≤0.91 >61.0 ≤0.61	<0.61 mps over criterion	0.67
		≥0.61 mps over criterion	0.33
Depth (level B hydraulic analysis results)	<0.30 meters	≥0.15 m and <0.30 m	0.67
		≥0.05 m and <0.15 m	0.33
		<0.05 m	0

Ecological prioritization – Multnomah County sought assistance with creating an initial prioritization of culverts for fish passage restoration based on ecological considerations. Other factors, such as cost, culvert condition, and social equity are to be included during a later phase stage.

To prioritize fish passage barriers at County road crossings, we grouped crossings into watersheds and ranked them by barrier status (full or partial) and length of upstream fish-bearing channels that would be made accessible to fish upon full restoration of passage. We modified the 6th field USGS hydrologic unit (or HUCs) as described above in the study area description, creating nine watersheds. Within each watershed full barriers were prioritized over partial barriers, and crossings with greater upstream length of fish-bearing stream ranked higher.

In select streams, we revised initial estimates of upstream fish-bearing stream habitat, from ODF fish presence and stream size GIS data, to better conform with known or presumed fish distribution. Streams with revised upstream fish habitat lengths included: Osborn Creek (Fairview, Salmon, and Arata creeks/Columbia Slough watershed); Jenne, Clatsop, and McNutt creeks (Upper Johnson and Kelley creeks watershed); Arrow and South Fork of Beaver Creek (Beaver Creek watershed), and Smith Creek (Lower Sandy River Tributaries watershed).

Results and Discussion

Survey sample identification
We identified 159 Multnomah County-owned culverts on streams with the potential to impede fish passage. This included 137 culverts on known fish-bearing streams, as well as 22 additional culverts on streams that are potential fish habitat, but mapped as 'non-fish' or 'unknown' by ODF (Table 5).

Field surveys
During the field phase we visited 159 crossings and conducted fish passage assessment surveys at 119 culverts. Crossings where full surveys were not completed included 16 with inadequate access, 14 on non-fish-bearing streams or wetlands, seven with bridges or where no crossing was found, and three with impassable falls at the crossing.

Table 5. Number of culverts identified to sample, surveyed, and missed (by situation).

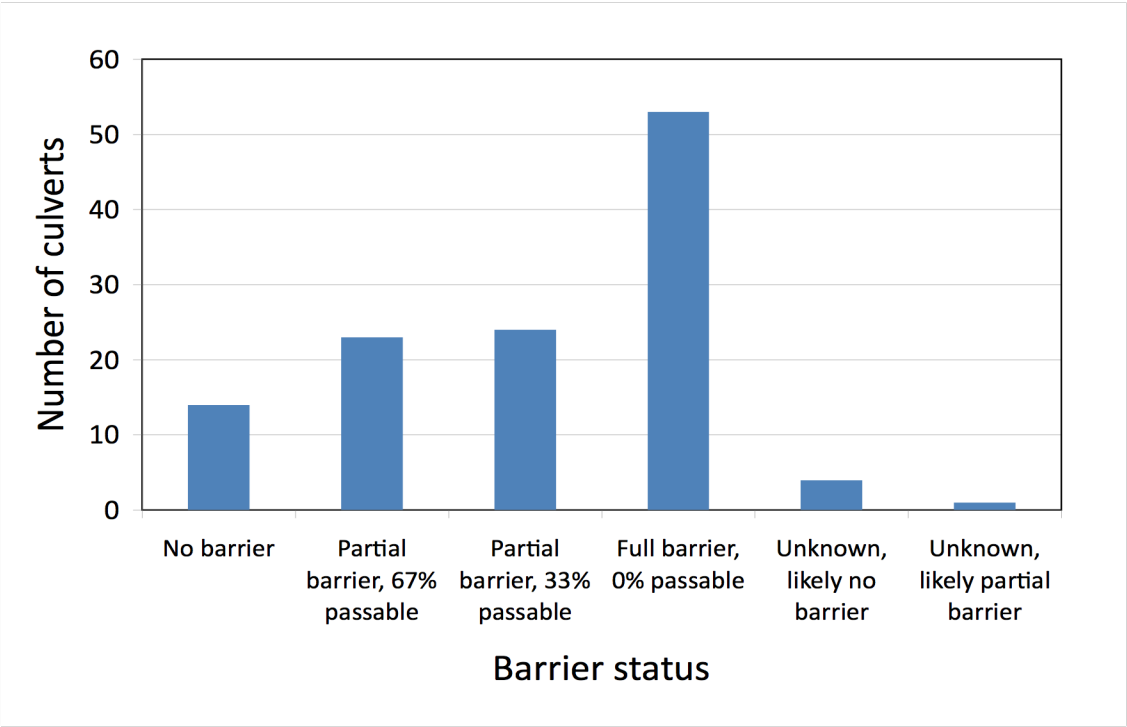
	Number of culverts
GIS sample identification	**159**
On fish-bearing streams	137
On potential fish streams	22
Field surveys	**159**
Surveyed	119
Level A/professional judgment	6
Level B – Fish Xing analysis	113
Not surveyed	40
Inadequate access	16
Non-fish streams/wetlands	14
Bridges/no crossing found	7
Impassable falls	3

Most field surveys were conducted during the period February 4-28, 2013 except for four crossing surveyed on March 28 and three on May 7, 2013. During the month of February 2013, cumulative precipitation measured 4.4 cm in Portland, Oregon (Airport Way #2 Rain Gage, 14614 NE Airport Way – City of Portland HYDRA Rainfall Network http://or.water.usgs.gov/non-usgs/bes/), contributing to relatively stable winter baseflows in target streams over the survey period. Appendix Table A details survey results for all crossings encountered during the survey, and Appendix Figures A, B, and C show the locations and fish passage status for crossings in western, central, and eastern Multnomah County, respectively.

Hydraulic analyses
Six of 119 surveyed culverts (5%) required more detailed WDFW level B hydraulic analyses to determine their fish passability (see Appendix Table B). This included two crossings on Beaver Creek (the two adjacent crossings at SE Division St and SE Troutdale Rd, "the Triangle"), and one each on Arata (at NE Sundial Rd), Big (at SE Littlepage Rd), Kelley (at SE Foster Rd), and Salmon (at NE Marine Dr) creeks. Appendix Table B contains FishXing model outputs for these six culverts.

Summary of fish passage barriers
Of the 119 surveyed culverts, 44.5% were full barriers to fish passage, 39.5% were partial barriers, 11.8% represented non-barriers, and 4.2% were of unknown status (Figure 2). Approximately one half (23 of 47) of the partial fish-passage barriers were rated 67% passable under the WDFW criteria, while the other half rated 33% passable. Based on our best professional judgment, four of the five culverts of unknown status were deemed likely non-barriers and the remaining culvert was deemed a likely partial barrier.

Figure 2. Fish passage barrier status of Multnomah County culverts (N = 119).



Almost half (49.7%) of all identified culvert barriers failed to meet fish passage criteria due to slope, with 26.3% failing due to water surface drop, 21% due to excessive water velocities, 1.8% due to minimum depths, and 1.2% due to an internal obstruction (Figure 3). Fifty-eight of 99 full or partial barrier culverts (58.5%) failed fish passage criteria due to more than one factor, with culvert slope representing the primary barrier factor at 72.7% of failing crossings. Water surface drop represented the second most common primary barrier factor, at 21.2% of all failing crossings.

Culverts generally passed or failed Washington and Oregon fish passage standards in parallel. Only one crossing – Sunshine Creek at Kane Rd/SE 257th Ave, – deemed a non-barrier by Washington State standards met criteria to be classified as a barrier under Oregon standards due to an internal break with a hydraulic drop of 0.21 m. In summary tables and figures, this crossing is identified as a non-barrier, but technically it qualifies as a minor barrier under Oregon State fish passage standards. Due to this culverts damaged condition, Multnomah County Road Services has already identified it for repair.

Figure 3. Fish passage barrier factors for Multnomah County culverts (N = 167). Note that 1-3 barrier factors may be assigned per culvert so the total exceeds the number of assessed culverts.

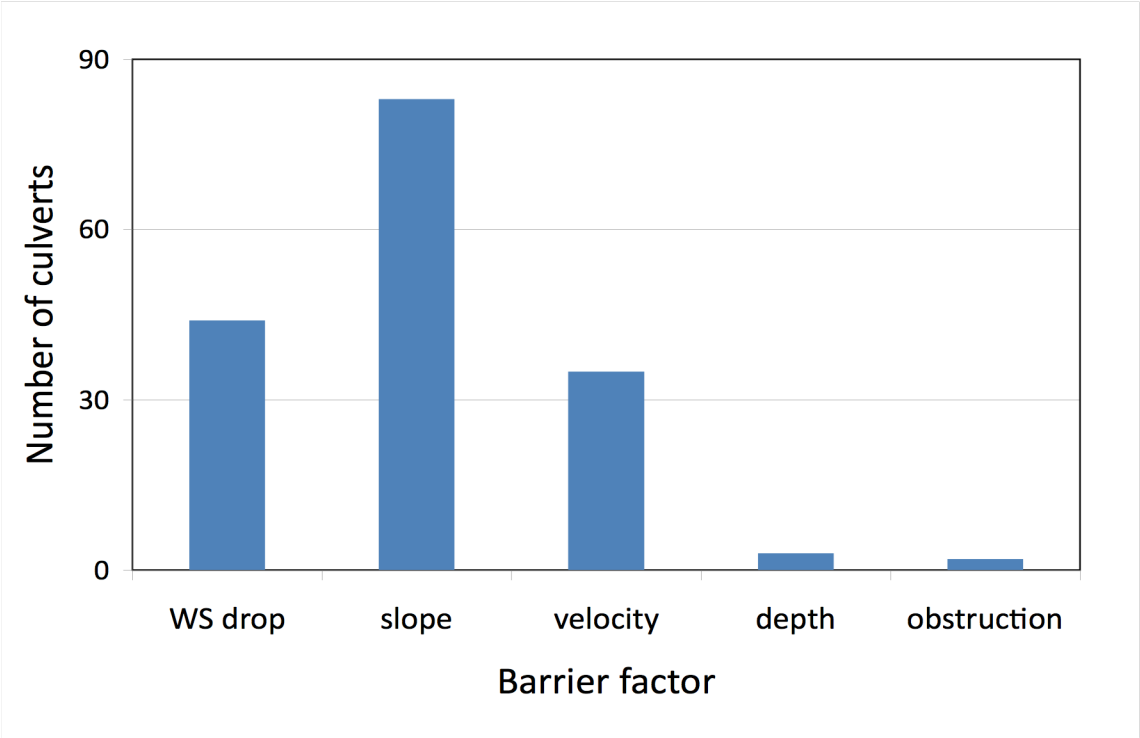
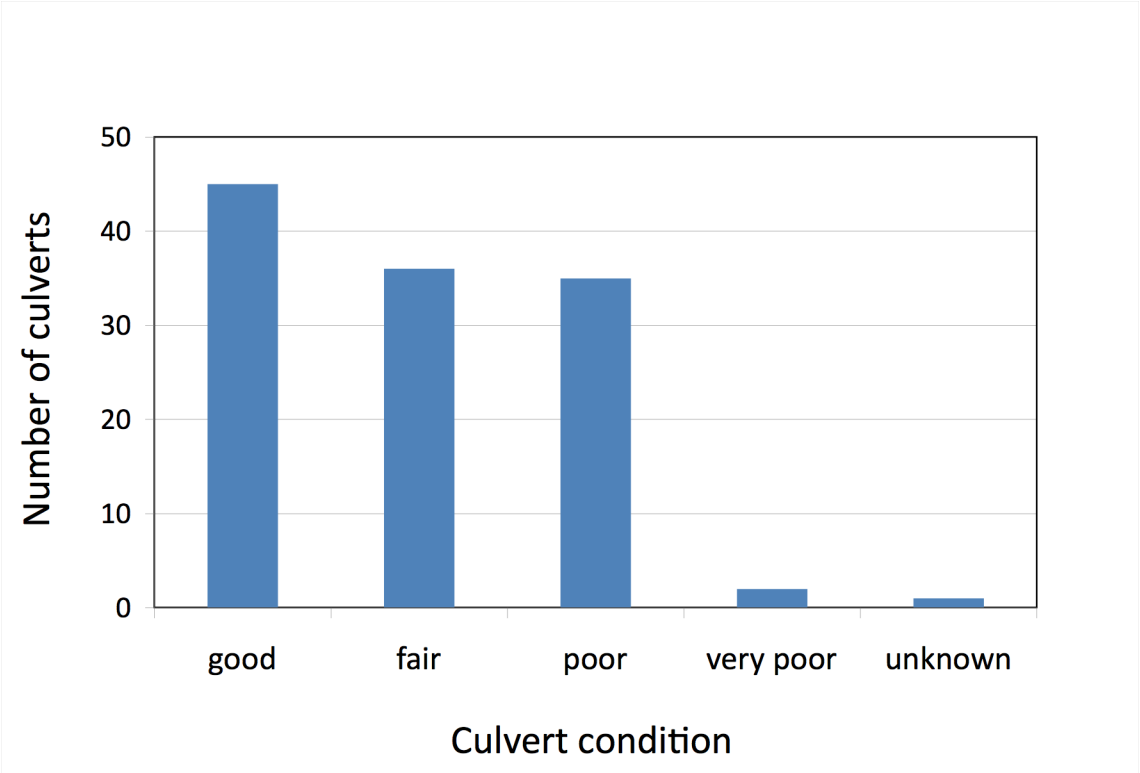


Figure 4. Culvert condition scores for Multnomah County culverts (N = 119).



Culvert condition varied across Multnomah County with 37.8% scoring good, 30.3% fair, 29.4% poor, 1.7% very poor, and 0.8% unknown (Figure 4). Our culvert condition scoring was conducted independent of the County Road Engineering program's scheduled inspections. Our definitions of good, fair, poor, and very poor culvert condition may vary from that used during County inspections. However, our visits likely represent the most current assessment of culvert condition, so they can be used to guide follow up inspections.

Ecological prioritization

Culverts prioritized for their relative importance to fish recovery in different watersheds are summarized in Appendix Figures D, E, and F, and in Appendix Table C. This ecological prioritization scheme is useful to Multnomah County Road Services staff directing limited road maintenance funds to culvert repair with the greatest benefit for imperiled salmonids. The prioritization scheme focuses exclusively on the ecological benefits to salmonids, and should be considered in combination with information on repair/replacement costs, culvert condition, and other factors under the County's capital facilities plan.

Among the highest ranked barrier culverts are crossings that are known fish passage problems as well as others, which have not previously been recognized as barriers for fish. The SE Stark Street crossing on Beaver Creek is considered a full barrier by the methods used in this study. This barrier compromises access to nearly 30 km of upstream habitat, and the SE Division Street crossing on Beaver Creek (near 302nd Ave) isolates 5.4 km of upstream habitat. Other Lower Sandy River tributary crossings with large potential habitat gains from culvert repair include the complete barriers under SE Gordon Creek Rd crossings on Trout and Buck creeks with 16.9 and 12.3 km of inaccessible habitat upstream, respectively. There is a second complete barrier on Buck Creek at SE Deverell Road that blocks fish access to 6.3 km of upstream habitat.

Although our prioritization scheme is simple and transparent, we emphasize that the priority ranking should be revisited and revised as better, more complete fish distribution data becomes available for Multnomah County streams. A principal challenge with our approach was errors and incompleteness in the ODF fish distribution data, which were used to compute the extent of upstream fish-bearing stream habitat. In particular, streams mapped by ODF in the Fairview, Salmon, and Arata creeks-Columbia Slough watershed and on Sauvie Island show no fish-bearing channels. Though Salmon and Arata creeks are inaccessible to anadromous salmon and trout due to tide gates, we suspect as-yet-undocumented cutthroat trout populations may occupy headwater reaches of these two streams. On Sauvie Island access to several kilometers of Dairy Creek is impeded by an obstructed culvert at NW Reeder Road.

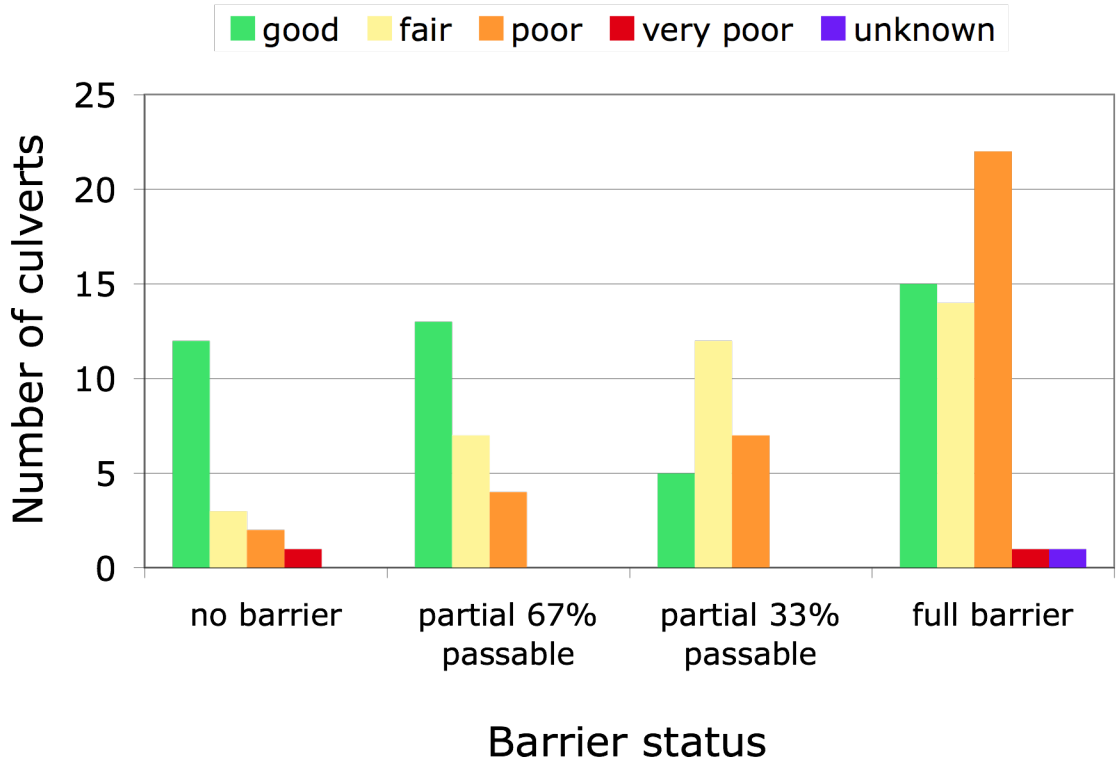
A secondary challenge with our prioritization scheme was unsurveyed crossings including private roads and driveways, as well as public crossings that were inaccessible during our field effort. Because we could not access these crossings for the survey we ignored their potential fish passage problems in our estimates of upstream habitat above the surveyed crossings. Many of these private crossings are likely full or partial barriers

and warrant targeted surveys following outreach to the associated landowners. In the Appendix tables and figures, we highlight unsurveyed crossings with the potential to impede access to greater than 2000 m of upstream fish habitat.

For a culvert prioritization to be most meaningful, it must include all culverts (public and private) and other anthropogenic structures that affect fish passage in the watershed – not simply within the County jurisdiction. For watersheds such as Johnson Creek and the Tualatin tributaries where a significant portion of the watersheds are outside the County's jurisdiction, culvert assessments must be completed in other jurisdictional areas to put the County's assessment in context with the other culverts in the watershed. Multi-stakeholder partnerships focused on landowner outreach, fish passage surveys and restoration like the effort led by Johnson Creek Watershed Council need extension to other County watersheds.

As Multnomah County staff move ahead with prioritizing and planning culvert replacements for the benefit of fish and wildlife, it is useful to consider other inter-related factors such as culvert condition. During the course of field surveys, we noted many older culverts nearing or at the end of their useful lifetime, which also posed complete barriers to fish passage. Comparing culvert condition to barrier status for the 119 survey locations (Figure 5) illustrates that greater than one third of all culverts that are full barriers to fish passage are also in poor condition and at risk of failure.

Figure 5. Culvert condition and barrier status, showing that a high proportion of culverts in poor condition represent full barriers to fish passage (N = 119).



When culverts fail, impacts to downstream habitats can be significant. For this reason, the condition of headwater culverts on non fish-bearing stream reaches – while outside the scope of this assessment – is an important factor to consider.

Conclusion

With this updated fish passage assessment of road culverts, Multnomah County is now better prepared to integrate fish passage restoration into its capital facilities planning. As additional surveys of private crossings and improved fish distribution information becomes available, this ecological prioritization scheme should be updated to help guide the County's road infrastructure planning and maintenance efforts.

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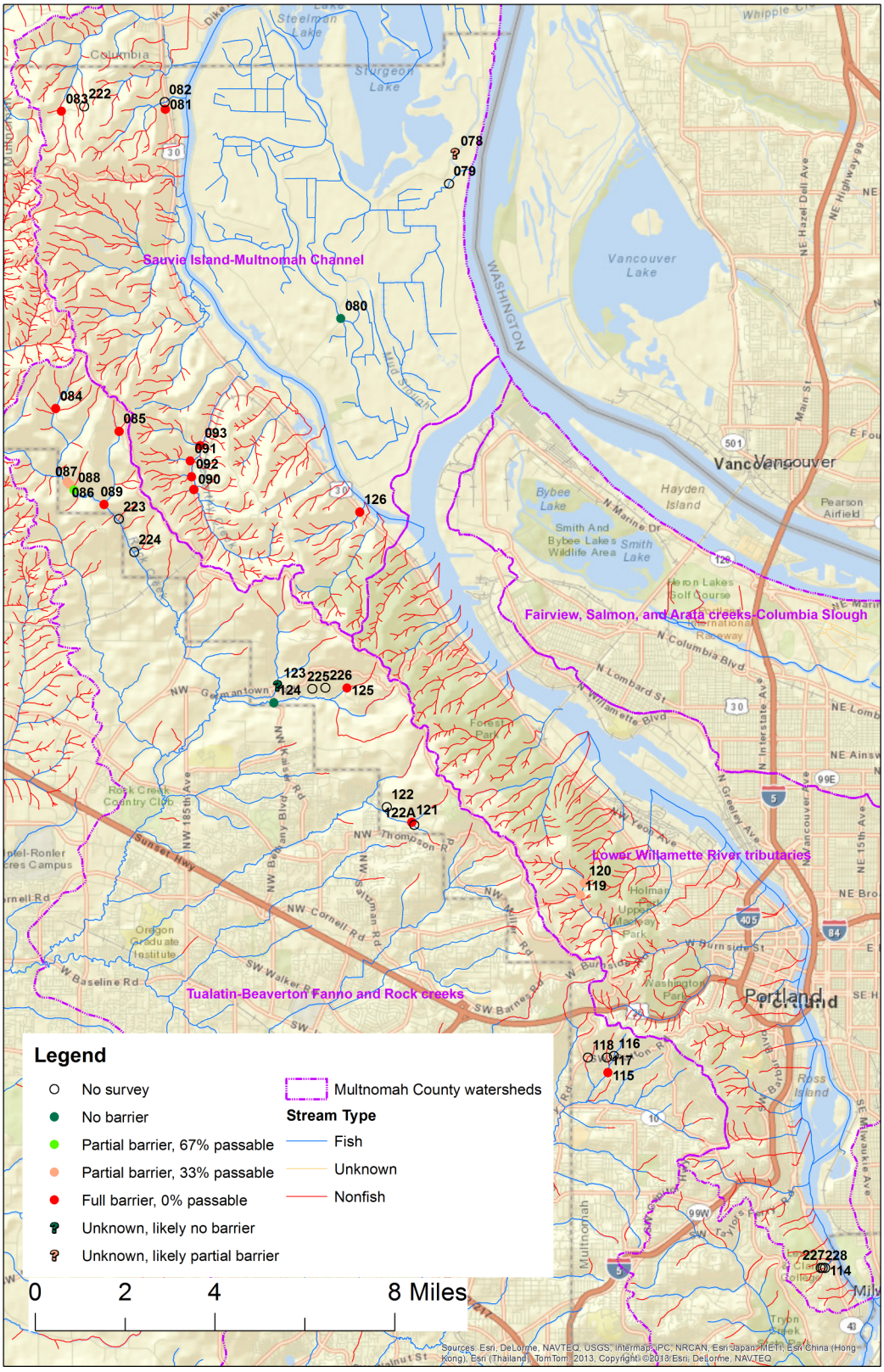
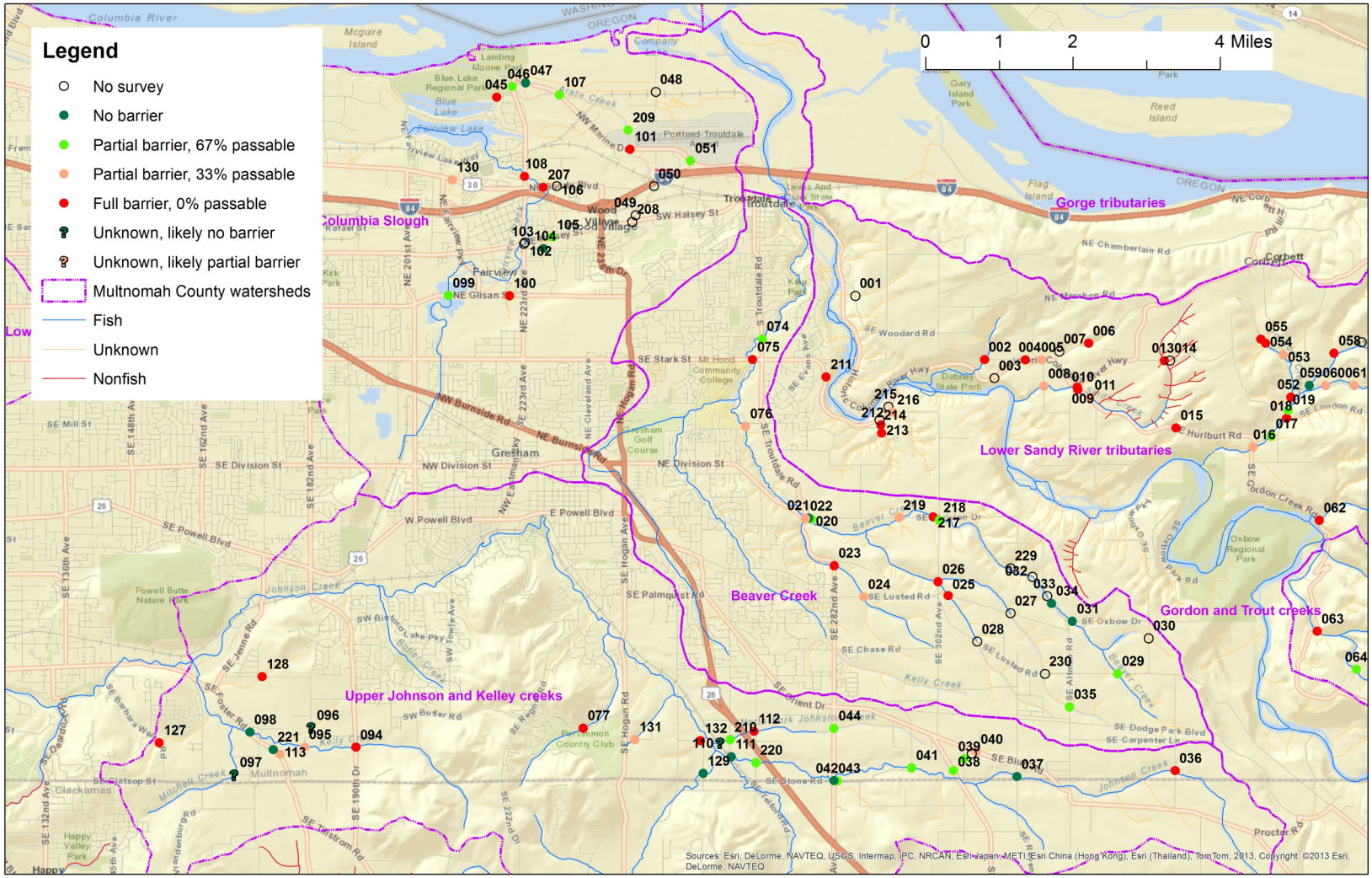
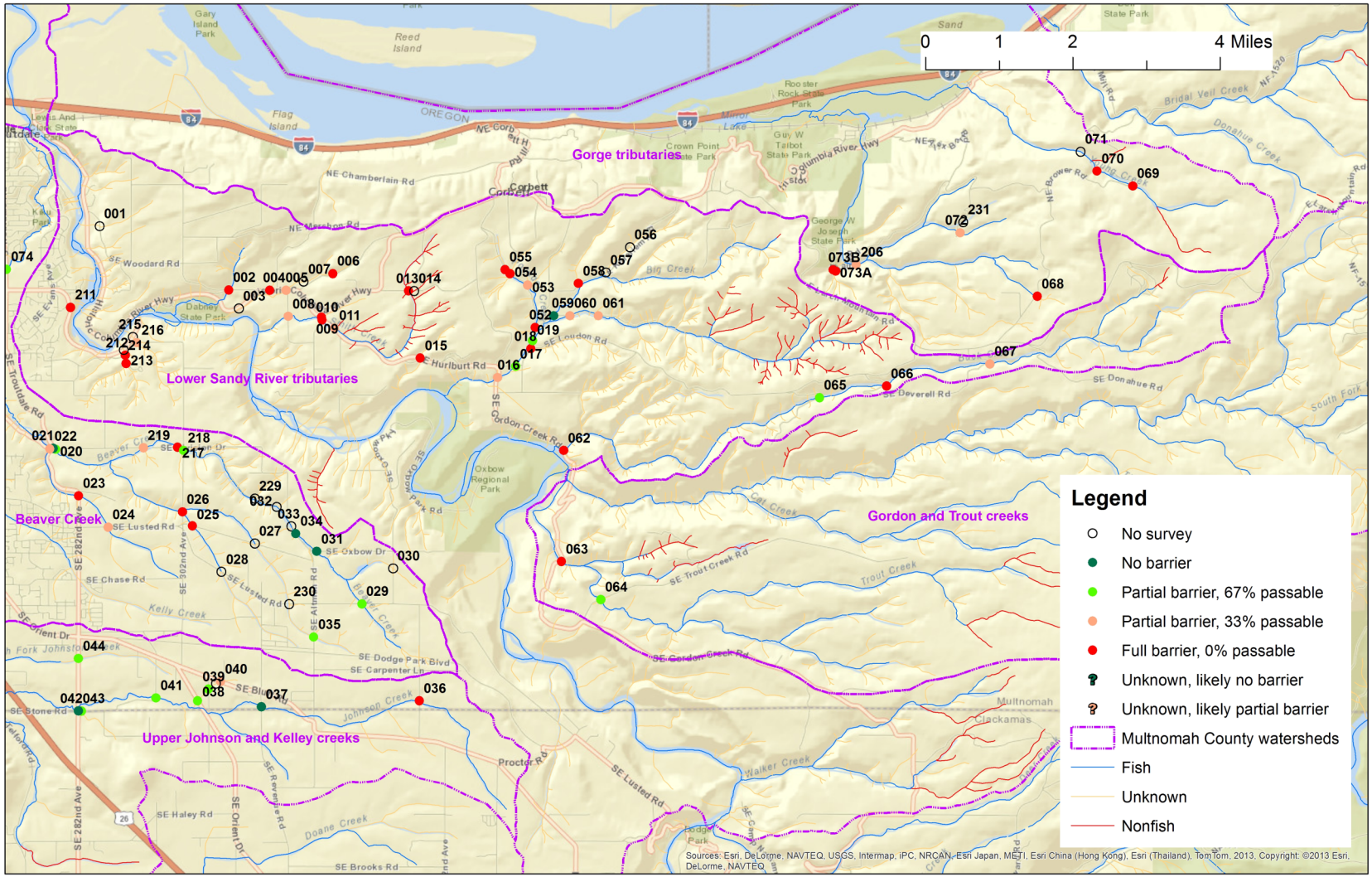
Appendix Figure A. Fish-passage barrier status of culverts in western Multnomah County.



Appendix Figure B. Fish-passage barrier status of culverts in central Multnomah County.



Appendix Figure C. Fish-passage barrier status of culverts in eastern Multnomah County.



Appendix Table A. All crossings surveyed during the Multnomah County fish passage assessment. See Appendix Figures A, B, and C for crossing locations. Seven private crossings and one City of Gresham culvert are highlighted in **bold** under the Road field.

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
001	LSR	Unnamed tributary	SE Woodard Rd	2	Round		152, 91					0.0%							No survey		good		
002	LSR	Bonnie Brook Creek	SE Woodard Rd	1	Round	CST	62		2.5	both	23.9	8.0%	4					1.9	Full barrier	HD, S	poor	723	4
003	LSR	Unnamed tributary	**PRIVATE** driveway-Springdale Job Corps Ctr	1	Round	CST													No survey		unknown		
004	LSR	Unnamed tributary	Historic Columbia River Hwy	1	Round	CST	122	0.04	0.08	outlet	20.6	5.5%	2.4		inlet		1.8x1.9x0.25	1.7	Full barrier	S	good		
005	LSR	Unnamed tributary	Historic Columbia River Hwy	1	Round	CST	92	0.2			24.6	2.1%	1.4					1.4	Partial, 33%	S	fair		
006	LSR	Unnamed tributary	SE Bell Road	1	Round	CST	62	0.07	0.1	inlet	28.3	4.2%	3.3					1.4	Full barrier	S	poor		
007	LSR	Unnamed tributary	**PRIVATE** in-channel pond	1	Round	CST													No survey		unknown		
008	LSR	Smith Creek	SE Northway Road	1	Round	PCC	122	0.15	0.18	outlet	16.6	2.2%	2.3				6.9x7.2x0.95	3.9	Partial, 33%	S, V	good	596	10
009	LSR	Unnamed tributary	SE Hurlburt Rd	1	Round	PCC	62	0.07			35	5.8%	4.2				3.4x3.1x0.29	1.4	Full barrier	S, V	fair		
010	LSR	Smith Creek	SE Christenson Rd	1	Round	CST	122	0.08	1.09	outlet	21.8	4.0%	3.3				8.8x7.5x1.12	2.2	Full barrier	HD, S	fair	12	5
011	LSR	Smith Creek	SE Hurlburt Rd	1	Box	CPC	122x93	0.04	0.08	outlet	21.5	1.8%	2				6.4x5.9x0.75	2.3	Partial, 33%	S	fair		
013	LSR	Smith Creek	SE Smith Road	1	Round	PCC	92	0.24			35.6	2.6%	5.6					3.5	Full barrier	S	good		
014	LSR	Unnamed tributary	SE Curtis Dr	1	Round	CST	62												No survey		unknown		
015	LSR	Unnamed tributary	SE Hurlburt Road	1	Round	CST	61				50.3	5.1%							Full barrier	S	unknown		
016	LSR	Big Creek	SE Gordon Creek Road	2	Box	CPC	235x150, 190x125	0.05	0.55	debris	32.8	1.0%	3		outlet		15x5.7x0.3	6.2	Partial, 33%	S, HD	fair	12949	6
017	LSR	Big Creek	SE Hurlburt Road	3	Round	PCC	122	0.24	0.17	apron	20	0.5%	2.3		outlet		13x10.5x1.02	5.9	Partial, 67%	HD, V	fair	12616	12
018	LSR	Unnamed tributary	SE Littlepage Road	1	Round	CST	76	0.02	0.67	outlet	16.9	7.4%	1.9					1.3	Full barrier	S, HD	poor		
019	LSR	Big Creek	SE Littlepage Road	1	Box	CPC	124x184	0.11	0.1	both	11.7	0.7%	0.1				10.1x6.9x0.78	6.7	Partial, 67%	V	good	10855	13
020	BEAV	Beaver Creek	SE Division Street	4	Round	PCC	122	0.33			26.5	0.7%	3.5				10.2x5.2x0.7	6.7	Partial, 67%	V	good	11456	11
021	BEAV	Beaver Creek	SE Troutdale Road	4	Round	PCC	122	0.25			26.5	0.5%	2.5				10.8x6.8x0.57	6.8	No barrier		good	11503	

[4] Watershed: LSR = Lower Sandy River, BEAV = Beaver, UJK = Upper Johnson/Kelley, FSA = Fairview/Salmon/Arata, GT = Gordon/Trout, GOR = Gorge, SIMC = Sauvie Island/Multnomah Channel, TUAL = Tualatin, LW = Lower Willamette.
[5] Material: CST = corrugated steel, PCC = pre-cast concrete, SST = structured steel plate, PVC = plastic, CPC = cast-in-place concrete.
[6] For records with one number, dimension is the culvert diameter. For records with two or three numbers separated by commas, these are diameters of the different culverts. For records with one or more sequences of numbers separated by an "x", the first number is the span and the second is the height.
[7] Water depth in culvert at the outlet.
[8] The depth of the culvert beneath the road surface, to the top of the culvert.
[9] The depth of culvert burial in streambed substrate.
[10] Weirs = weirs upstream or downstream of culvert, baffles = baffles or flow dissipaters within the culvert.
[11] Percentages indicate severity of partial barriers: 67% = mostly passable, 33% = marginally passable.
[12] Barrier factors: HD = hydraulic drop, S = culvert slope, V = water velocity, D = water depth in culvert, O = obstruction. The primary barrier factor is the first listed.
[13] Priority rank: culvert replacement/repair ranking by watershed. 1 = top priority, 2 = second priority, etc. ? = culverts with mapped upstream habitat that were not surveyed due to access limitations, but which should be prioritized for outreach and follow up surveys.

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
022	BEAV	Arrow Creek	SE Division St	1	Round	PCC	122	0.08	0.25	outlet	18.4	1.7%	2.7		outlet			4.4	Partial, 33%	HD, S, V	fair	3126	8
023	BEAV	Arrow Creek	SE 282nd Ave	1	Round	PCC	122	0.03	0.35	outlet	33	3.2%	6				8x4.3x1.27	3.5	Full barrier	S, HD, V	fair	2085	4
024	BEAV	Arrow Creek	SE Lusted Rd	1	Round	CST	134	0.02	0.9	outlet	24.4	0.8%	4.1				7x4.7x1.15	3	Partial, 33%	HD, V	poor	1404	9
025	BEAV	SF Beaver Creek	SE Pipeline Road	1	Round	PCC	105	0.04	0.65	outlet	30	0.0%	3.5				7x5.3x1.25	3.2	Full barrier	HD, V	poor	830	5
026	BEAV	MF Beaver Creek	SE 302nd Ave	1	Round	SST	154	0.15	0.8	outlet	38.3	2.7%	9				11.5x8x1.9	5.6	Full barrier	S, HD, V	fair	2459	3
027	BEAV	MF Beaver Creek	SE Pipeline Rd	1	Round	PCC	92												No survey		unknown	9	?
028	BEAV	SF Beaver Creek	SE Lusted Rd	1	Round														No survey		poor		
029	BEAV	Beaver Creek	SE Lusted Rd	1	Round	PCC	92	0.2			16.5	1.8%	1.1				4.3x2.3x0.24	1.8	Partial, 67%	S	good	936	13
030	BEAV	Unnamed tributary	SE Hosner Rd	1	Round	CST	62												No survey		unknown		
031	BEAV	Beaver Creek	SE Oxbow Dr	2	Squash	SST	93x50	0.55			22	0.1%	2.9				8.9x4.7x0.9	4.4	No barrier		good	2477	
032	BEAV	Beaver Creek	**PRIVATE** driveway at 31108 SE Oxbow Dr	1	Round														No survey		poor	3406	?
033	BEAV	Beaver Creek	**PRIVATE** driveway at 32220 SE Oxbow Dr	1	Round	PCC	92												No survey		unknown	3033	?
034	BEAV	Beaver Creek	SE Oxbow Dr	2	Round	CST	92, 62	0.55			18.4	0.2%	0.7					1.9	No barrier		good	2901	
035	BEAV	MF Beaver Creek	SE Altman Road	1	Round	CST	62	0.15	0.13	outlet	12.2	2.0%	1.2				6.5x2.1x0.56	1.9	Partial, 67%	S, V	fair		
036	UJK	Johnson Creek	SE Cottrell Road	1	Round	CST	92	0.43			18.4	2.0%	2.6				2.5x2.6x0.44	1.9	Full barrier	S, V	poor	2352	2
037	UJK	Beaver Creek	SE Pleasant Home Rd	2	Round	CST	122	0.95			12.5	0.0%	0.7					4	No barrier		fair	4963	
038	UJK	Unnamed tributary	SE Orient Drive	1	Round	PCC	122	0.18			14.8	1.3%	0.8					1.6	Partial, 67%	S	good		
039	UJK	Unnamed tributary	SE Clark Rd	1	Round	PVC	92	0.5			20.5	2.9%	0.7				3.5x2.3x0.59	1.8	Partial, 67%	S, V	fair		
040	UJK	Unnamed tributary	SE Bluff Rd	1	Round	PCC	92	0.48			16.3	2.8%	1.9					1.8	Partial, 33%	S, V	good		
040A	UJK	Unnamed tributary	**PRIVATE** driveway at 30830 SE Bluff Rd	1	Round														No survey		unknown		
041	UJK	Johnson Creek	SE Short Road	2	Round	CST	154	0.99			15.4	1.6%	1.2				5.4x5.6x0.99	4.7	Partial, 67%	S	good	8323	11
042	UJK	Unnamed tributary	SE Stone Rd	1	Round	PVC	92	0.23			17.8	1.1%	0.3	0.22				1.3	Partial, 67%	S	good	1069	13
043	UJK	Unnamed tributary	SE 282nd Ave	1	Round	PVC	92	0.1			22	0.0%	0.5	0.22				1.3	No barrier		good		
044	UJK	NF Johnson Creek	SE 282nd Ave	1	Round	PCC	105	0.04	0.25	outlet	19	0.8%	2.3				9x5.1x1.2	3.4	Partial, 67%	HD, V	poor		
045	FSA	Blue Lake outlet	NE Blue Lake Rd	1	Round	PCC	122	0.31	0.65	outlet	81	0.0%	3.3		outlet				Full barrier	HD	poor		
046	FSA	Blue Lake outlet	NE 223rd Ave	1	Round	SST	155	0.12			40.6	0.4%	3					5.9	Partial, 67%	D	good		
047	FSA	Arata Creek	NE Marine Drive	2	Round	SST	172	1.2			104.6	0.1%	9.6					19.3	No barrier		good		
048	FSA	Salmon Creek	NE Sundial Rd	1	Box	CPC													No survey		bridge		
049	FSA	Arata Creek	NE 244th Ave	1	Round														No survey		unknown		
050	FSA	Arata Creek	NE Columbia River Hwy	1	Round	CST	122												No survey		unknown		
051	FSA	Salmon Creek	NE Marine Drive	1	Round	CST	122	0.16	0.33	outlet	49.6	0.7%	3.7				6.1x3.8x0.63	3.8	Partial, 67%	HD, V	good		
052	LSR	Pounder Creek	SE Pounder Road	1	Round	PCC	106	0.07	0.05	outlet	14.1	7.1%	1.4				12.1x4.7x0.51	2.2	Full barrier	S	good	1040	3

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
053	LSR	Pounder Creek	SE Pounder Road	1	Round	CST	92	0.35			20.4	1.0%	2.1				2.8x2x0.68	1.5	Partial, 33%	S	poor	319	11
054	LSR	EB Pounder Creek	SE Pounder Road	1	Round	PCC	62	0.02	0.75	outlet	17.5	4.3%	1.8				2.1x2.2x0.28	1.1	Full barrier	S, HD	poor		
055	LSR	WB Pounder Creek	SE Pounder Road	1	Round	PCC	92	0.09			18.9	1.5%	1.1					1.2	Full barrier	S	fair		
056	LSR	Unnamed tributary	**PRIVATE** driveway off NE Knieriem Rd	1	Round														No survey		unknown		
057	LSR	Unnamed tributary	NE Knieriem Rd	1	Round														No survey		unknown		
058	LSR	Unnamed tributary	SE Knierem Road	1	Round	PCC	76	0.11			24	2.9%	4				6.3x3.6x0.39	2.8	Full barrier	S	poor		
059	LSR	NF Big Creek	SE Howard Road	1	Round	PCC	122	0.41			14.2	0.2%	0.8				4.3x2.6x0.6	1.8	No barrier		good	3952	
060	LSR	SF Big Creek	SE Howard Road	1	Round	SST	186	0.36			19.3	1.7%	0.4				12.8x9x1.02	3.6	Partial, 33%	S	fair	6022	7
061	LSR	SF Big Creek	SE Howard Road	1	Round	CST	122	0.54			15.3	2.8%	2.1				8.2x6.8x0.96	2.8	Partial, 33%	S, V	fair	5550	8
062	LSR	Buck Creek	SE Gordon Creek Road	1	Round	SST	272	0.32	0.43	outlet	41.5	5.5%	10			weirs	2x4.1x0.52	6.1	Full barrier	S, V	good	12335	1
063	GT	Trout Creek	SE Gordon Creek Road	1	Round	SST	252	0.3	0.7	outlet	34.9	4.8%	6.4				14.2x8.3x1.8	6.6	Full barrier	S, HD, V	poor	16999	1
064	GT	Trout Creek	SE Trout Creek Road	2	Round	SST	212	0.32			14.6	1.0%	2.7		both			7.3	Partial, 67%	S, V	fair	13720	2
065	LSR	Buck Creek	SE Mannthey Road	1	Round	PCC	122	0.28	0.24	outlet	15.2	0.6%	1.2				5.6x6.2x0.94	5	Partial, 67%	HD, V	good	7406	14
066	LSR	Buck Creek	SE Deverell Road	1	Round	CST	122	0.24	0.56	outlet	15.1	3.9%	1.7				5.4x4.3x0.66	4.6	Full barrier	HD, S, V	good	6333	2
067	LSR	Buck Creek	SE Deverell Road	1	Ellipse	SST	185x102	0.23			12.4	2.5%	2.4				4.5x4.3x0.81	4.6	Partial, 33%	S, V	fair	4615	9
068	GOR	Latourell Creek	SE Brower Road	1	Round	SST	96	0.08	0.22	outlet	22.7	2.1%	4				2.1x1.7x0.18	1.9	Full barrier	S, HD	fair	75	3
069	GOR	Young Creek	SE Brower Road	1	Ellipse	SST	179x112	0.14	0.62	outlet	23.8	2.3%	3.4				6.3x5.4x1.09	3.8	Full barrier	S, HD	poor	1646	2
070	GOR	Young Creek	SE Toll Road	2	Round	SST	145, 92	0.24	0.28	outlet	18.4	4.1%	1.5				5.6x5.8x0.96	3.8	Full barrier	S, HD, V	good	2260	1
071	GOR	Young Creek	**PRIVATE** driveway	1	Round														No survey		unknown	2660	?
072	GOR	Latourell Creek	SE Thompson Mill Road	1	Round	CST	122	0.19			12.9	2.0%	1.9	0.18				2.9	Partial, 33%	S, V	good	776	5
073A	GOR	Unnamed tributary	E Haines Road	1	Round	CST	47	0.04	1.38	outlet	25	9.1%	3.6	0.18				1.6	Full barrier	HD, S	good		
073B	GOR	Unnamed tributary	E Haines Road	1	Round	CST	47	0.4	1.53	outlet	36.9	10.6%	7					1.7	Full barrier	HD, S, V	good		
074	BEAV	Beaver Creek	S Troutdale Rd	3	Box, Round	2 CPC 1 SST	214x154, 214x156, 185	0.29	0.24	outlet	39.3	0.1%	7.2		outlet	baffles, weirs	2.4x2.1x0.7	8.5	Partial, 67%	HD, V	fair	29893	10
075	BEAV	Beaver Creek	SE Stark St	1	Box	CPC	321x370	0.5	1.15	weir	31.5	1.6%	4.9			baffles, weirs		8.6	Full barrier	HD, S	poor	1	29317
076	BEAV	Beaver Creek	SE Cochran Road	2	Box	CPC	215x125	0.15	0.14	outlet	25.1	1.6%	2.5		both		35.2x15.8x0.79	5.4	Partial, 33%	S	fair	16640	6
077	UJK	Hogan Creek	SE Butler Road **CITY OF GRESHAM**	1	Round	PCC	139	0.03	0.36	outlet	67.1	3.4%	3.5				4.4x4.7x0.43	2.1	Full barrier	S, HD	good	1407	3
078	SIMC	Dairy Creek	NW Reeder Rd	2	Round	SST	358	0			35.1	1.9%						13	Unk, likely partial	O	poor		
079	SIMC	Dairy Creek	NW Gillihan Rd	0															No survey				
080	SIMC	Gilbert River	NW Reeder Road	1	Round	SST	405	0.54			33.8	0.2%	0.4					15	No barrier		good	12157	
081	SIMC	Unnamed tributary	NW St Helens Road	1	Round	CST	46	0.06			23.4	5.9%	2					1.5	Full barrier	S	poor		
082	SIMC	Jones Creek	NW St Helens Rd	1	Round													3	No survey		unknown	2294	?

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
083	SIMC	Jackson Creek	NW Gilkison Road	1	Round	CST	62	0.05	0.33	outlet	54.6	7.8%	15				2.4x2.9x0.54	1.8	Full barrier	S, HD, V	fair		
084	TUAL	Unnamed tributary	NW Beck Road	1	Round	PCC	122	0.02	0.25	outlet	29.1	3.5%	4.1				3.7x3.9x0.29	2.2	Full barrier	S, HD	poor	670	3
085	TUAL	Unnamed tributary	NW Rock Creek Road	1	Round	CST	62	0.03	0.18	outlet	38.3	2.6%	9.4				3x2.2x0.26	1.7	Full barrier	S, O	very poor	68	6
086	TUAL	Rock Creek	NW Rock Creek Road	1	Round	SST	192	0.19			18.7	1.9%	4.6				13.2x8.3x1.1	2.7	Partial, 33%	S	fair	6121	8
087	TUAL	Rock Creek	NW Rock Creek Road	1	Round	PCC	154	0.07	0.27	outlet	16.8	2.6%	0.6				6.7x4.7x0.81	2.7	Partial, 33%	S, HD	fair	6223	7
088	TUAL	Rock Creek	NW 220th Ave	1	Round	CST	142x162	0.22			7.1	2.9%	0.7				16.2x9.6x0.56	3	Partial, 67%	S	fair	6446	9
089	TUAL	Abbey Creek	NW Rock Creek Road	1	Round	PCC	92	0.03	0.19	outlet	11.3	5.0%	0.8					2.5	Full barrier	S	poor	2115	1
090	SIMC	Unnamed tributary	NW Cornelius Pass Road	1	Round	CST	46	0.03	1.2	outlet	22	4.0%	3.8				4x2.8x0.46	1.5	Full barrier	HD, S	poor	178	5
091	SIMC	Unnamed tributary	NW Cornelius Pass Road	1	Round	PCC	76	0.03			30.3	5.1%	1.3		outlet			1.6	Full barrier	S	good	579	3
092	SIMC	Unnamed tributary	NW Cornelius Pass Road	1	Round	CST	62	0.01	0.8	outlet	16.8	7.2%	2.6					1.2	Full barrier	S, HD	poor	296	4
093	SIMC	Unnamed tributary	NW Cornelius Pass Road	1	Round	CST	122	0.18	0.25	internal	44.7	14.5%	10			baffles		2.5	Full barrier	HD, S	good	1392	2
094	UJK	Kelley Creek	SE 190th Ave	1	Round	CST	122	0.03	0.77	outlet	18.5	4.2%	4.1		both		7.2x4.5x0.5	2.1	Full barrier	S, HD	fair	2550	1
095	UJK	Kelley Creek	SE Richey Road	2	Round	PCC	105	0.95			23.1	1.6%	4.3					3.9	Partial, 33%	S	poor	3401	8
096	UJK	Unnamed tributary	SE 182nd Ave	1	Round	CST	76	0.39			16.5	0.1%	1.4				8x2.3x0.4	1.5	Unk, likely no bar		good		
097	UJK	Mitchell Creek	SE Baxter Road	1	Round	PCC	105				14.1	0.4%	2.5				5.2x5.6x1.47	2.4	Unk, likely no bar		very poor	1490	
098	UJK	Kelley Creek	SE Foster Road	1	Box	CPC	182x125	0.24			16.3	0.7%	2		both		19.3x8.2x1.9	8.2	No barrier		fair	4405	
099	FSA	Fairview Creek	NE Glisan Street	2	Box	CPC	122x94	0.29			12.3	1.1%	0.4	0.29			6.1x3.7x0.31	3.1	Partial, 67%	S	good	3427	4
100	FSA	Unnamed tributary	NE Glisan St	1	Round	PVC	92	0.15			58	0.0%	2.5					1.8	Full barrier	HD, V	good		
101	FSA	Arata Creek	NE Marine Drive	2	Round	PVC	92	0.08	0.05	both	36	3.8%	1.6					3.4	Full barrier	S	poor		
102	FSA	Fairview Creek	NE Fairview/233rd Ave	1															No survey		bridge	5607	?
103	FSA	Fairview Creek	NE Halsey St	1															No survey		bridge	5578	?
104	FSA	Unnamed tributary	NE Arata Road	1	Round	PCC	109	0.24			20	0.1%	0.5				4.6x3x0.23	1.3	No barrier		good		
105	FSA	Unnamed tributary	NE Halsey Road	1	Round	PVC	92	0.36			24.6	0.0%	0.9					1.6	Partial, 67%		good		
106	FSA	Unnamed tributary	NE Sandy Blvd	2	Round	CST	76	0.15					1						No survey		fair		
107	FSA	Salmon Creek	NE Marine Drive	1	Round	SST	150	0.5			140.6	0.1%	4.2				7.5x14.6x0.74	6.1	Partial, 67%		good		
108	FSA	Fairview Creek	NE 223rd Ave	1	Round	SST	274	0.2			34.1	2.2%	3		inlet		15.2x7.6x0.52	6.4	Full barrier	S	good	7095	1
110	UJK	NF Johnson Creek	SE Telford Road	1	Round	PCC	122	0.44			14	0.8%	0.6				8.2x2.4x0.64	2.1	Unk, likely no bar		fair	1554	
111	UJK	Johnson Creek	SE Telford Road	3	Box	CPC	183x137	0.38			13.4	0.1%	0.6				13.7x5.8x0.4	5.9	No barrier		good	11487	
112	UJK	NF Johnson Creek	SE 267th Ave	1	Round	SST	152	0.4			42.7	2.1%	0.4				5.1x2.8x0.4	2.2	Full barrier	S	poor	991	5
113	UJK	Unnamed tributary	SE Foster Road	1	Round	CST	76	0.28			13.4	2.1%	1.7				5x2.8x0.28	1.8	Partial, 33%	S	poor		
114	LW	Unnamed tributary	SW Hedlund Ave	1															No survey		unknown	13	?
115	TUAL	Unnamed tributary	SW Thomas Street	1	Round	CST	91	0.03	0.22	outlet	31.6	2.3%	5.4					1.5	Full barrier	S	fair	1118	2
116	TUAL	Unnamed tributary	SW Patton Rd	1	Round	CST	62												No survey		poor	649	?
117	TUAL	Unnamed tributary	SW Patton Rd	1	Round	CST	62												No survey		fair		
118	TUAL	Unnamed tributary	SW Patton Rd	1	Round	CST	62												No survey		unknown		

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
119	LW	Balch Creek	NW Cornell Road	1	Round	CST	122	0.04	0.31	outlet	31.2	1.5%	3.9				4.1x3x0.63	1.9	Partial, 33%	S, HD	fair	1392	1
120	LW	Balch Creek	NW Thompson Road	2	Round	CST	92, 62	0.19	0.25	inlet	17.4	2.9%	1.7				2.6x2.5x0.19	2.5	Partial, 33%	HD, S	poor	1068	2
121	TUAL	Ward Creek	NW Laidlaw Rd	1	Round	CST	92	0.03	2.3	both	22.1	0.0%	4				3.4x2.9x0.46	3	Full barrier	HD	poor	618	4
122	TUAL	Unnamed tributary	NW Laidlaw Rd	1	Round														No survey		poor		
122A	TUAL	Unnamed tributary	NW Laidlaw Rd	1	Round														No survey		poor		
123	TUAL	Abbey Creek	NW Germantown Road	2	Round	PCC	105	1.05			20	0.0%	2				9.3x5.7x1	3.2	Unk, likely no bar		poor	3269	
124	TUAL	Abbey Creek	NW Kaiser Road	1	Box	CPC	244x155	0.42			12	0.3%	1.7				30x3.8x0.94	3.5	No barrier		good	3304	
125	TUAL	NF Abbey Creek	NW Germantown Road	1	Round	PCC	92	0.03	0.36	outlet	26.1	9.0%	5.3					3.5	Full barrier	S, HD	poor	118	5
126	SIMC	Ennis Creek	NW Riverview Road	1	Box	CPC	245x185	0.2	0.66	apron	56	6.0%	3.1		outlet			3.1	Full barrier	S, HD	good	2498	1
127	UJK	Clatsop Creek	SE Barbara Welch Road	1	Round	PCC	60	0.07			29.2	6.9%	7.3				2.8x2.4x0.3	1.6	Full barrier	S, V	fair	928	6
128	UJK	Jenne Creek	SE McKinley Road	1	Round	CST	120	0.15			35.2	3.6%	3.9					2.4	Full barrier	S	fair	1009	4
129	UJK	Sunshine Creek	SE Kane Road/257th Ave	1	Squash	SST	376x236	0.17	0.2	internal	17.5	0.0%	0.5				22x6.2x0.55	5.8	No barrier[14]		poor	6248	
130	FSA	Osborn Creek	NE Sandy Blvd	1	Box	CPC	125x65	0.2			31.6	1.2%	7				1.5x2x0.3	2.6	Partial, 33%	S	good	691	3
131	UJK	Brigman Creek	SE McNutt Road	1	Round	CST	65	0.1	0.5	inlet	16.6	3.7%	3.8					1.6	Partial, 33%	S, HD	poor	111	9
132	UJK	McNutt Creek	SE McNutt Road	1	Round	CST	92	0.01	0.5	outlet	16.7	1.9%	0.4					1.7	Full barrier	HD, S	poor	260	7
206	GOR	Latourell Creek	NE Haines Road	1	Round	SST	272	0.31	0.11	outlet	8	2.1%	1.2				3.9x4.5x0.54	3.7	Partial, 33%	S	good	7578	4
207	FSA	Fairview Creek	NE Sandy Blvd	1	Box	CPC	183x189	0.09	0.21	outlet	11.1	4.1%	1.8		both		6.4x7.5x0.8	4.9	Full barrier	S	fair	6748	2
208	FSA	Arata Creek	NE Halsey St	1	Round														No survey		fair		
209	FSA	Arata Creek	NE Sundial Road	2	Round	CST	122	0.08	0.08	outlet	31	0.0%	0.9	0.22				2.9	Partial, 67%	D, V	good		
210	UJK	NF Johnson Creek	SE 262nd Ave	1	Round	PCC	122	0.28			16.3	1.7%	1.2				16.3x6x0.78	3.1	Partial, 67%	S, V	fair	1386	12
211	LSR	Unnamed tributary	SE Stark St	1	Round	PCC	92	0.03	0.65	outlet	29.7	8.0%	5.7				4.3x2.6x0.46	2.1	Full barrier	S, HD, V	fair		
212	LSR	Unnamed tributary	SE Kerslake Rd	1	Round	PCC	92	0.04	0.02	outlet	35.5	5.1%	9.1				5.3x6.5x0.6	1.9	Full barrier	S, V	fair		
213	LSR	Unnamed tributary	SE Wilson Road	1	Round	PCC	74	0.03	0.84	outlet	19.1	5.2%	4.4				4.4x2.5x0.69	3	Full barrier	S, HD	poor		
214	LSR	Unnamed tributary	SE Stark St	1	Round	PCC	92												No survey		poor		
215	LSR	Unnamed tributary	SE Stark St	1	Round	PCC	105												No survey		good		
216	LSR	Unnamed tributary	SE Kerslake Rd	2	Round	CST	74	0.05	0.25	outlet	45	1.4%	12					2.6	Partial, 33%	S, HD	poor		
217	BEAV	Beaver Creek	SE Division St	1	Box	CPC	184x154	0.06	0.07	outlet	22.3	2.1%	1.7				20x5.8x0.66	3.1	Full barrier	S, HD, D	good	5405	2
218	BEAV	Beaver Creek	SE 302nd Ave	2	Round	CST	124	0.23			15.5	2.5%	2.6				8.3x5.6x0.57	3.6	Partial, 67%	S	poor	5303	12
219	BEAV	Beaver Creek	SE Division St	1	Box	CPC	187x184	0.58			24.7	1.1%	1.3					2.8	Partial, 33%	S	fair	5992	7
220	UJK	Johnson Creek	SE 267th Ave	3	Round	PVC	91	0.2			11	0.3%	0.9				10.7x7.9x0.81	4	Partial, 67%	V	poor	11061	10
221	UJK	Unnamed tributary	SE Foster Road	1	Box	CPC	152x223	0.17			22	0.0%			both		8.2x4.3x0.37	1.9	No barrier		good		
222	SIMC	Unnamed tributary	NW Gilkison Road																No survey				
223	TUAL	Unnamed tributary	NW Rock Creek Road																No survey				

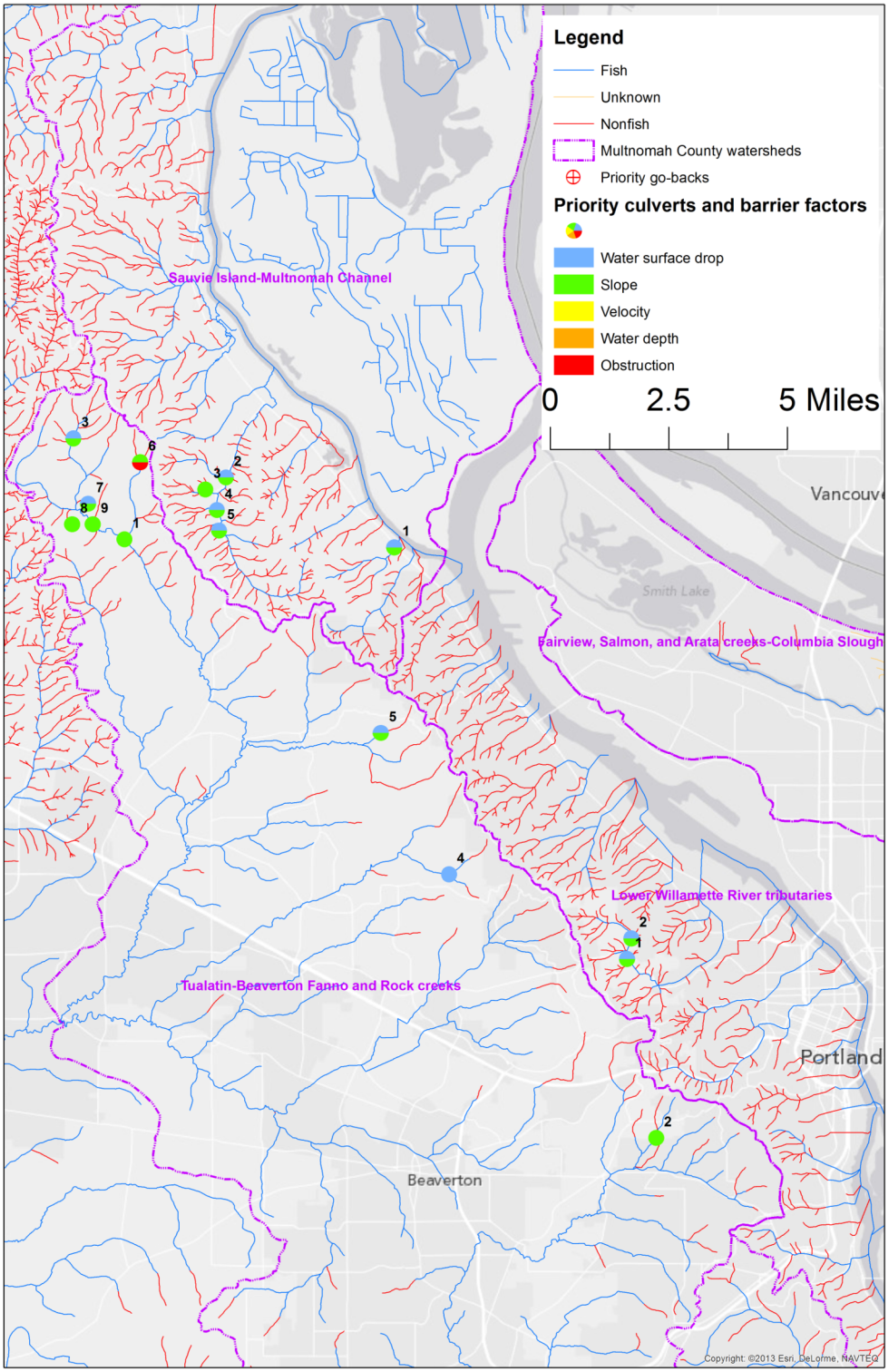
[14] Although listed here as a non-barrier, the SE Kane Rd/257th Ave crossing on Sunshine Creek qualifies as a partial barrier for fish according to Oregon fish passage standards due to an internal break causing a hydraulic drop.

ID	Watershed[4]	Stream	Road	N Culverts	Shape	Material[5]	Dimensions[6] (cm)	WDIC[7] (m)	Hydraulic Drop (m)	Hydraulic Drop Location	Length (m)	Slope	Fill Depth[8] (m)	Embedded Depth[9] (m)	Apron	Fishway[10]	Plunge Pool Dimensions --- L x W x Max Depth (m)	Bankfull Width (m)	Barrier Status[11]	Barrier Factors[12]	Culvert Condition	Upstream Fish Habitat (m)	Priority Rank[13]
224	TUAL	Unnamed tributary	NW Rock Creek Road																No survey				
225	TUAL	Unnamed tributary	NW Old Germantown Road																No survey				
226	TUAL	Unnamed tributary	NW Old Germantown Road																No survey				
227	LW	Unnamed tributary	SW Radcliffe Road																No survey				
228	LW	Unnamed tributary	SW Radcliffe Road																No survey				
229	BEAV	Unnamed tributary	SE Oxbow Dr																No survey				
230	BEAV	MF Beaver Creek	SE Lusted Road																No survey				
231	GOR	Unnamed tributary	NE Thompson Mill Road																No survey				

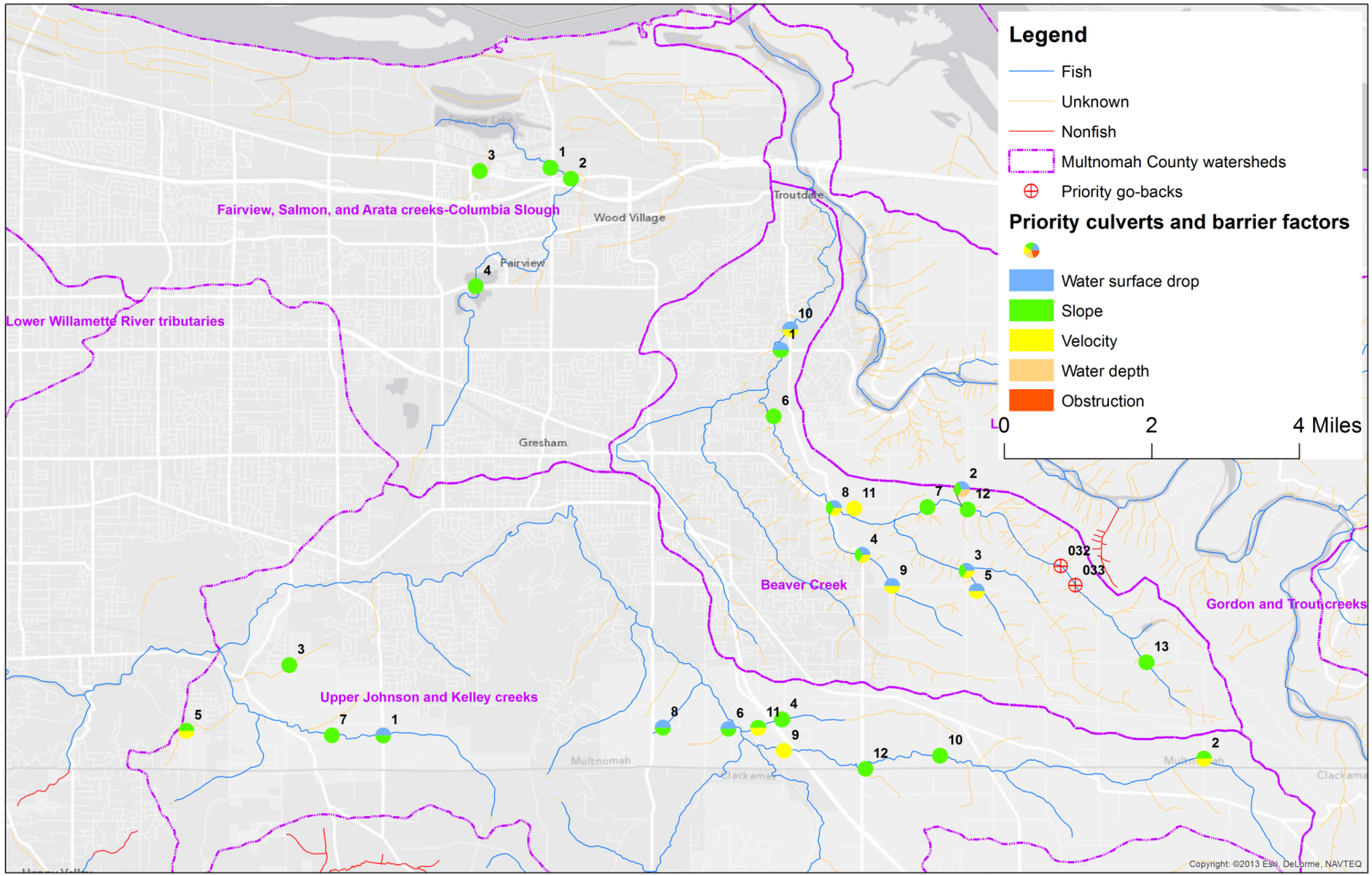
Appendix Table B. FishXing results for culverts with level B analyses and WDFW hydraulic criteria for velocity, hydraulic drop, and depth.

ID	Stream	Road	Fish Passage Low Flow (cu m/sec)	Fish Passage High Flow (cu m/sec)	Percent of Flows Passable	Max Velocity Criteria (cu m/sec)	Max Drop Criteria (m)	Min Depth Criteria (m)	Low Flow Fish Passage Barrier Factors	High Flow Fish Passage Barrier Factors
019	Big Creek	SE Littlepage Rd	0.014	2.32	0%	1.22	0.24	0.3	Drop; Depth	Velocity
020	Beaver Creek	SE Division St	0.007	2.33	0%	1.22	0.24	0.3	Depth	Velocity
021	Beaver Creek	SE Troutdale Rd	0.007	2.33	99%	1.22	0.24	0.3	Depth	None
098	Kelley Creek	SE Foster Rd	0.002	1.47	76%	1.22	0.24	0.3	Depth	Velocity
107	Salmon Creek	NE Marine Dr	0.004	1.22	16%	0.61	0.24	0.3	Depth	Velocity
209	Arata Creek	NE Sundial Rd	0.001	0.46	0%	0.91	0.24	0.3	Drop; Depth; Pool	Drop; Depth; Velocity

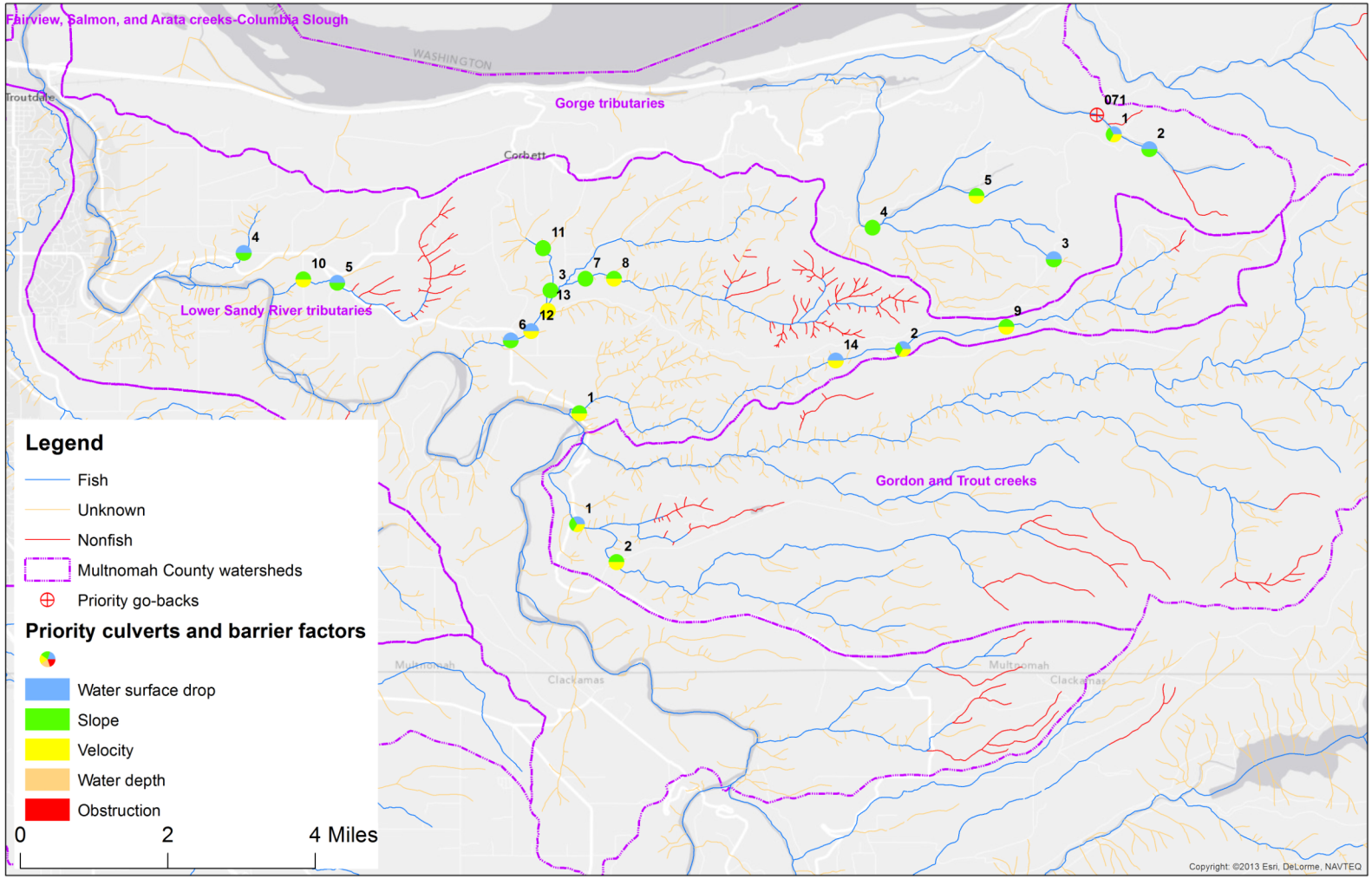
Appendix Figure D. Fish passage barriers prioritized by watershed based on relative importance to fish recovery for the Sauvie Island-Multnomah Channel, Tualatin, and Lower Willamette River watersheds.



Appendix Figure E. Fish passage barriers prioritized by watershed based on relative importance to fish recovery in Fairview-Salmon-Arata, Upper Johnson-Kelley, and Beaver Creek watersheds. Private crossings with the potential to block >2 km of upstream habitat that need follow up are also highlighted in red.



Appendix Figure F. Fish passage barriers prioritized by watershed based on relative importance to fish recovery in Lower Sandy River, Gordon-Trout, and Gorge watersheds. Private crossings with the potential to block >2 km of upstream habitat that need follow up are also highlighted in red.



Appendix Table C. Multnomah County culvert crossings prioritized for replacement/repair by watershed. See Appendix Figures A-F for crossing locations. Also listed are several County-owned culverts with >2000 m of upstream fish habitat that were not surveyed due to access or other constraints.

ID	Stream	Road	Watershed [15]	Barrier status	Upstream fish habitat (m)	Priority Rank [16]
075	Beaver Creek	SE Stark St	BEAV	Full barrier, 0% passable	29317	1
217	Beaver Creek	SE Division St, near 302nd Ave	BEAV	Full barrier, 0% passable	5405	2
026	SF Beaver Creek	SE 302nd Ave	BEAV	Full barrier, 0% passable	2459	3
023	Arrow Creek	SE 282nd Ave	BEAV	Full barrier, 0% passable	2085	4
025	SF Beaver Creek	SE Pipeline Rd east of SE 302nd Ave	BEAV	Full barrier, 0% passable	830	5
076	Beaver Creek	SE Cochran Road	BEAV	Partial barrier, 33% passable	16640	6
219	Beaver Creek	SE Division St between 4 Corners and SE 302nd	BEAV	Partial barrier, 33% passable	5992	7
022	Arrow Creek	SE Division St, just W of Troutdale Rd junction	BEAV	Partial barrier, 33% passable	3126	8
024	Arrow Creek	SE Lusted Rd	BEAV	Partial barrier, 33% passable	1404	9
074	Beaver Creek	S Troutdale Rd	BEAV	Partial barrier, 67% passable	29893	10
020	Beaver Creek	SE Division Street	BEAV	Partial barrier, 67% passable	11456	11
218	Beaver Creek	SE 302nd Ave	BEAV	Partial barrier, 67% passable	5303	12
029	Beaver Creek	SE Lusted Rd	BEAV	Partial barrier, 67% passable	936	13
108	Fairview Creek	NE 223rd Ave	FSA	Full barrier, 0% passable	7095	1

[15] Watershed: LSR = Lower Sandy River, BEAV = Beaver, UJK = Upper Johnson/Kelley, FSA = Fairview/Salmon/Arata, GT = Gordon/Trout, GOR = Gorge, SIMC = Sauvie Island/Multnomah Channel, TUAL = Tualatin, LW = Lower Willamette.

[16] Priority rank: culvert replacement/repair ranking by watershed. 1 = top priority, 2 = second priority, etc. ? = culverts with mapped upstream habitat that were not surveyed due to access limitations, but which should be prioritized for outreach and follow up surveys.

ID	Stream	Road	Watershed [15]	Barrier status	Upstream fish habitat (m)	Priority Rank [16]
207	Fairview Creek	NE Sandy Blvd	FSA	Full barrier, 0% passable	6748	2
130	Osborn Creek	NE Sandy Blvd	FSA	Partial barrier, 33% passable	691	3
099	Fairview Creek	NE Glisan Street	FSA	Partial barrier, 67% passable	3427	4
102	Fairview Creek	NE Fairview/233rd Ave	FSA	No survey	5607	?
103	Fairview Creek	NE Halsey St	FSA	No survey	5578	?
063	Trout Creek	SE Gordon Creek Road	GT	Full barrier, 0% passable	16999	1
064	Trout Creek	SE Trout Creek Road	GT	Partial barrier, 67% passable	13720	2
070	Young Creek	SE Toll Road	GOR	Full barrier, 0% passable	2260	1
069	Young Creek	SE Brower Road	GOR	Full barrier, 0% passable	1646	2
068	Latourell Creek	SE Brower Road	GOR	Full barrier, 0% passable	75	3
206	Latourell Creek	NE Haines Road	GOR	Partial barrier, 33% passable	7578	4
072	Latourell Creek	SE Thompson Mill Road	GOR	Partial barrier, 33% passable	776	5
062	Buck Creek	SE Gordon Creek Road	LSR	Full barrier, 0% passable	12335	1
066	Buck Creek	SE Deverell Road	LSR	Full barrier, 0% passable	6333	2
052	Pounder Creek	SE Pounder Road	LSR	Full barrier, 0% passable	1040	3
002	Bonnie Brook Creek	SE Woodard Rd	LSR	Full barrier, 0% passable	723	4
010	Smith Creek	SE Christenson Rd	LSR	Full barrier, 0% passable	12	5
016	Big Creek	SE Gordon Creek Road	LSR	Partial barrier, 33% passable	12949	6
060	SF Big Creek	SE Howard Road	LSR	Partial barrier, 33% passable	6022	7
061	SF Big Creek	SE Howard Road	LSR	Partial barrier, 33% passable	5550	8
067	Buck Creek	SE Deverell Road	LSR	Partial barrier, 33% passable	4615	9
008	Smith Creek	SE Northway Road	LSR	Partial barrier, 33% passable	596	10
053	Pounder Creek	SE Pounder Road	LSR	Partial barrier, 33% passable	319	11
017	Big Creek	SE Hurlburt Road	LSR	Partial barrier, 67% passable	12616	12
019	Big Creek	SE Littlepage Road	LSR	Partial barrier, 67% passable	10855	13

ID	Stream	Road	Watershed [15]	Barrier status	Upstream fish habitat (m)	Priority Rank [16]
065	Buck Creek	SE Mannthey Road	LSR	Partial barrier, 67% passable	7406	14
119	Balch Creek	NW Cornell Road	LW	Partial barrier, 33% passable	1392	1
120	Balch Creek	NW Thompson Road	LW	Partial barrier, 33% passable	1068	2
126	Ennis Creek	NW Riverview Road	SIMC	Full barrier, 0% passable	2498	1
093	Unnamed trib to McCarthy Creek	NW Cornelius Pass Rd at NW Sheltered Nook Rd intersection	SIMC	Full barrier, 0% passable	1392	2
091	Unnamed trib to McCarthy Creek	NW Cornelius Pass Road	SIMC	Full barrier, 0% passable	579	3
092	Unnamed trib to McCarthy Creek	NW Cornelius Pass Road	SIMC	Full barrier, 0% passable	296	4
090	Unnamed trib to McCarthy Creek	NW Cornelius Pass Road	SIMC	Full barrier, 0% passable	178	5
082	Jones Creek	NW St Helens Rd and SR 30	SIMC	No survey	2294	?
089	Abbey Creek	NW Rock Creek Road	TUAL	Full barrier, 0% passable	2115	1
115	Unnamed trib to Fanno Creek	SW Thomas Street	TUAL	Full barrier, 0% passable	1118	2
084	Unnamed trib to Rock Creek	NW Beck Road	TUAL	Full barrier, 0% passable	670	3
121	Ward Creek	NW Laidlaw Rd	TUAL	Full barrier, 0% passable	618	4
125	NF Abbey Creek	NW Germantown Road	TUAL	Full barrier, 0% passable	118	5
085	Unnamed trib to Rock Creek	NW Rock Creek Road	TUAL	Full barrier, 0% passable	68	6
087	Rock Creek	NW Rock Creek Road - DS crossing	TUAL	Partial barrier, 33% passable	6223	7
086	Rock Creek	NW Rock Creek Road - US crossing	TUAL	Partial barrier, 33% passable	6121	8
088	Rock Creek	NW 220th Ave	TUAL	Partial barrier, 67% passable	6446	9
094	Kelley Creek	SE 190th Ave	UJK	Full barrier, 0% passable	2550	1
036	Johnson Creek	SE Cottrell Road	UJK	Full barrier, 0% passable	2352	2
128	Jenne Creek	SE McKinley Road	UJK	Full barrier, 0% passable	1009	3
112	NF Johnson Creek	SE 267th Ave	UJK	Full barrier, 0% passable	991	4

ID	Stream	Road	Watershed [15]	Barrier status	Upstream fish habitat (m)	Priority Rank [16]
127	Clatsop Creek	SE Barbara Welch Road	UJK	Full barrier, 0% passable	928	5
132	McNutt Creek	SE McNutt Road	UJK	Full barrier, 0% passable	260	6
095	Kelley Creek	SE Richey Road	UJK	Partial barrier, 33% passable	3401	7
131	Brigman Creek	SE McNutt Road	UJK	Partial barrier, 33% passable	111	8
220	Johnson Creek	SE 267th Ave	UJK	Partial barrier, 67% passable	11061	9
041	Johnson Creek	SE Short Road	UJK	Partial barrier, 67% passable	8323	10
210	NF Johnson Creek	SE 262nd Ave	UJK	Partial barrier, 67% passable	1386	11
042	LB trib to Johnson Creek at County line	SE Stone Rd	UJK	Partial barrier, 67% passable	1069	12