

Draft Strategic Operations Plan For Addressing Beaver Activity Within the City of Salem



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1.0 INTRODUCTION AND PURPOSE

American Beaver (*Castor Canadensis*) provide important watershed health and ecological benefits but can also cause damage to property and infrastructure in the City of Salem (City). The City has nearly 90 miles of streams, as well as six miles of the Willamette River and several sloughs and back channels. Urban development confines many of these stream channels and limits the natural floodplains. Striking a balance between beaver and human habitat can be challenging in an urban environment. The purpose of this plan is to provide guidance for living in an urban environment with this native species, establish best management practices (BMPs) for utilizing tools for beaver coexistence, and provide a clear and objective decision-making process for managing beaver in Salem.

The BMPs were developed with the City's NPDES MS4 permit and FEMA Community Rating System requirements in mind, as well as the need to protect water quantity and quality, maintain public safety and infrastructure, and enhance biological communities. These BMPs are intended to comply with Oregon Department of Fish and Wildlife (ODFW) regulations and its *Relocation Requirements for Beaver in Oregon* (ODFW 2017), Federal Endangered Species Act (ESA) regulations for sensitive aquatic species, and Oregon Department of State Lands (DSL) removal/fill regulations.

The techniques recommended in this plan have proven track records for mitigating the negative impacts to property and infrastructure that can occur when coexisting with beaver. All BMPs used within the City must follow current regulations and adapt to specific circumstances. These implementation BMPs have been selected from a variety of sources, including the Beaver Restoration Guidebook (<https://www.beavercoalition.org/guidebook>), ODFW website (https://www.dfw.state.or.us/wildlife/living_with/beaver.asp), City of Portland (City of Portland BES 2020), the Oregon beaver coexistence expertise of Beaver State Wildlife Solutions LLC, and personal communication with practitioners in the field, including The Beaver Advocacy Committee of the South Umpqua Rural Community Partnership, Beaver Solutions LLC, Beavers Northwest, Sierra Wildlife Coalition, Methow Beaver Project, Montana Beaver Working Group, King County WA, Beaver Deceivers LLC, and the Miistakis Institute.

The Beaver Restoration Guidebook is a particularly useful resource. It is an adaptive, living document developed by authors from the US Fish and Wildlife Service (USFWS), the National Oceanic and Atmospheric Administration (NOAA), the University of Saskatchewan and the US Forest Service (USFS) to be a compendium of the best available science and technical guidance for beaver coexistence and restoration techniques. While this plan's toolkit of BMPs represents current best practices, beaver coexistence techniques will continue to evolve, and the guidebook will be updated regularly by The Beaver Coalition, in partnership with federal and state agencies and experts in the field. The updated guidebook should be consulted by the City annually to ensure that the best available standards for coexistence solutions continue to be followed. ODFW should also be consulted annually for updates regarding beaver regulations, as these may change over time.

The purpose of this plan is to:

- 1) Unify and clarify the City's decision-making process for management actions related to beaver activity within the City.
- 2) Document applicable regulatory requirements and consultations for various management actions.
- 3) Establish standards for when, where, and what BMPs for mitigating negative impacts of beaver activity should be used by the City.
- 4) Provide guidance for City staff as they consult with citizens concerned about beaver on or near their property.

2.0 NATURAL HISTORY OF THE BEAVER

Historically, beaver dams created braided stream systems with deep water and floodplain wetlands, dominated by emergent vegetation and shrubs. These ecosystems changed drastically in the 1800s, due to the reduction of beaver caused by unregulated trapping. The removal of beaver significantly altered the dynamics of watersheds and contributed to the decline of stream health. However, with better management, beaver are becoming re-established and are now common throughout their historical range in Oregon (ODFW 2012).

2.1 Beaver Ecology

Beaver live in rivers, lakes, ponds, marshes, and streams, where their preferred foods are in ample supply. They currently inhabit most of Oregon's waterways, although at far fewer numbers than before the fur trapping of the 1800s. Within the Willamette Basin, beaver live throughout wooded and partly wooded habitats, with the highest densities in the Coast Range. They typically inhabit rivers, second- to fourth-order streams, lakes, and sloughs, although they can be found almost anywhere with enough water and forage.

A beaver colony, or family unit, will often include 2-12 individuals, including a breeding pair (beaver will often mate for life), as well as their kits from the year and kits from the previous year. These family units are highly territorial, and the size of that territory seems to be primarily dependent on forage availability. Beaver breed between January and March, and litters of one to eight kits (averaging four) are born between April and June. Beaver are vegetarians, eating primarily the cambium (layer just below bark), leaves and twigs from trees and shrubs. Native species like willow (*Salix spp.*), black cottonwood (*Populus balsamifera*) and Oregon ash (*Fraxinus latifolia*) have co-evolved with this activity and can resprout after repeated browsing by beaver. In addition to trees and shrubs, beaver also eat aquatic vegetation, grasses, rushes, sedges and forbs. Like most herbivores, beaver forage from a broad range of plants, and they will select different species during different times of the year. In addition to native vegetation, beaver will also forage on planted ornamental, fruit and nut trees, berry bushes, and other crops like corn and sugar beets.

Beaver are known for building dams across streams and other watercourses to impound water. This activity creates deep water for protection from predators, for access to food supplies, and to provide safe underwater entrances to dens. To maintain the depth of water around the entrance to their den, beaver will often dam downstream in what can be considered their primary dam. Since

this dam is responsible for setting the water level around these beaver's den or lodge, they are most attentive to any leaks or potential damage to this dam—often repairing any breach within the next night. Beaver will also build dams to facilitate safe movement throughout their territory. These dams can be thought of as secondary, or auxiliary dams. Beaver are often less invested in these structures, and are frequently slower to repair these dams when they are breached or removed. The sound and feel of flowing water seems to stimulate beaver to build or patch dams, and they will maintain dams to sustain water levels. Beaver typically build their dams during months when rainfall and stream flows are lowest. They will also build and maintain channels across the floodplain to access additional habitat and food sources

Not all beaver colonies build dams. Beaver that live in areas with plenty of available deep water (i.e. Willamette River) adjacent to adequate forage opportunities will dig a den in a high bank and inhabit the area without much more labor. In areas where deep, calm water is unavailable, beaver will create ponds by building dams across streams. They prefer to build dams on small- to medium-sized, low-gradient streams (<6% slope), with a canopy cover of 25 to 50 percent, and a bank-full width of 13 to 20 feet (ODFW 2012). Beaver usually avoid areas with rock, bedrock, or manmade hard-surfaced banks. Because streams in western Oregon are generally degraded and incised into deep ditches (rather than the historical braided systems across the floodplain) beaver construct very few lodges here; instead, they are more likely to tunnel into stream banks to dig a den for resting, staying warm, overwintering, giving birth, and raising young—much as they would on a river. Beaver will build a freestanding lodge only when the floodplain is reconnected, and the stream banks are too saturated to dig into and create a den.

2.2 Benefits of Beaver Activity

Beaver and their actions can provide many valuable benefits to the natural environment by creating diverse habitat structure that improves water quality and quantity and enhances fish and wildlife habitat. Because of these benefits, dissuasion, or removal of beaver from a system should be weighed carefully.

Water quality benefits arise from water storage behind dams that can decrease the potential for flooding downstream of dams, attenuate peak flow volumes and velocities, and reduce channel incision and bank erosion. Dams also help moderate water temperature and remove excess nutrients and toxic chemicals by trapping fine sediment.

Beaver dams can improve stream flows (e.g., water quantity) through the drier portions of the year by elevating water levels behind dams and facilitating groundwater recharge. This is evident when beaver recolonize streams, their impoundments increase base flows, as well as recharge and elevate the water table (Pollock et al 2018). Water storage from beaver impoundments could be an effective tool to help mitigate the expected reductions in water resources due to climate change.

Beaver activities enhance fish and wildlife habitat. Water storage is particularly important for many aquatic and terrestrial species during low-flow periods, when direct hydrologic inputs are limited. Slack water provides habitat for juvenile salmon to feed and grow; fallen trees and brush provide cover for fish to hide from predators and refuge during high flows. Beaver ponds can provide for increased native insect production, which benefits insectivorous fish, amphibians,

birds, and bats. Ponds also provide nesting and brood-rearing areas for waterfowl. Trees that die as a result of higher water levels can become snags, which attract insects that in turn provide forage for a number of insectivorous species and habitat for bats and cavity-nesting birds. Fallen trees provide locations for bird roosting or nesting, turtle basking, and small mammal cover (COP 2010). Riparian and wetland communities also thrive with beaver activity, increasing in size and habitat diversity to support greater species richness (Pollock, et al 2018).

Because beaver are becoming increasingly common in urban areas, they also play an educational role in engaging the public with their natural environment. Education increases awareness of the benefits of beaver activities as well as fosters curiosity about the natural world we live in.

3.0 DISTRIBUTION AND ABUNDANCE WITHIN THE CITY

The historic range of beaver likely included every waterbody in the greater Salem area, and although many of these streams have been heavily modified by urban development, the majority are still potential habitat for beaver. While some reaches may not be currently occupied and others might not provide the most ideal habitat at present, this could change over time as beaver populations expand and shift in response to changes in the watersheds.

The City's Public Works Department makes note of beaver activity occurring in City streams as part of the summer stream cleaning program. GIS data collected by the 2019 and 2020 summer stream cleaning interns identified dams and beaver chewing activity in seven streams including the Willamette River and its associated sloughs, Battle Creek, Glenn Creek, Pringle Creek, Waln Creek, Croisan Creek, and Pettijohn Creek (Figure 1, Appendix B). No beaver dams were recorded in Mill Creek, Shelton Ditch or smaller tributary streams, however, beaver chew on trees is often noted higher up on banks and beaver have been observed in both Shelton Ditch and Mill Creek.

4.0 BEAVER MANAGEMENT TOOLKIT

Beaver are a native species with profound benefits to the environment, including water quality, flow attenuation, wildfire risk reduction, and fish and wildlife habitat. As such, it would benefit the City of Salem and its residents to coexist with beaver to the maximum extent possible. Consequently, when beaver activity is occurring on City-owned property and not threatening harm to infrastructure or safety, the City should take a hands-off approach. However, beaver activities like damming can cause damage to public infrastructure by blocking culverts, plugging storm drains, flooding roads, paths, and parking lots, and causing washouts. Their activities can lead to extensive tree and landscape damage as well, with indirect mortality resulting from flooding due to beaver dams and direct mortality caused by girdling, chewing, and falling of vegetation. Where beaver activity is putting public infrastructure or public safety at risk, the City can work to address this conflict using the decision tree in Appendix A, and in accordance with the BMPs listed below:

- No action
- Monitor habitat change
- Tree protection (e.g. wire or sand and paint)

- Preemptive Planning (e.g., infrastructure, planting, education)
- Habitat Modification (e.g. dam notching, pond levelers, culvert exclosures)
- Beaver Removal

The City should consider all options for resolving beaver conflict within City properties. Techniques will range from monitoring habitat change to actively engaging in habitat or infrastructure modifications. The recommended BMPs for engaging with each of these techniques are described below. The decision-making chart in Appendix A summarizes when each of these techniques may be an appropriate approach. In some cases, multiple methods may be required. As mentioned previously, the science behind managing beaver is evolving, and as new techniques emerge the BMPs to be used by the City should be updated to reflect current information.

4.1 No Action

In areas where no adverse effects to infrastructure, safety, or vegetation are currently observed or anticipated (e.g., within large natural area parks like Minto-Brown Island Park), no action may be necessary.

4.2 Monitor Habitat Change

In areas where no adverse effects to infrastructure, safety, or vegetation are currently observed, but where there is potential for adverse effects to occur if the activity expands, beaver activities should be documented and monitored. Dam locations, descriptions, and photographs should be entered in the City's GIS monitoring app and monitored annually.

4.3 Preemptive Planning

Planning ahead can alleviate future beaver management problems. This can be accomplished by updating infrastructure, planting plants that are unpalatable to beaver to encourage them to forage elsewhere or planting a "beaver buffer" of preferred forage species near the stream to focus beaver activity away from other vegetation, and educating the public regarding living with beaver.

4.3.1 Modification of Affected Infrastructure

Sometimes it is possible to modify infrastructure rather than interfere with beaver activity. A trail that is regularly flooded could be rerouted or elevated to avoid inundation. Portable facilities could be moved to higher ground (e.g., picnic tables, park benches, signs, etc.). When installing new trails and park facilities or updating or replacing bridges, culverts, or stormwater infrastructure, beaver presence should be anticipated, and infrastructure should be designed in such a way as to minimize future conflict. Such modifications to infrastructure are the most robust long-term beaver coexistence solutions and should be preferentially considered before habitat modifications such as pond levelers and culvert protection systems.

4.3.2 Planting Unpalatable Plants and “Beaver Buffers”

In areas where beaver would likely create a negative impact on infrastructure, the planting of unpalatable plants can achieve some overall habitat improvements while deterring foraging by beaver. Some native riparian plants that grow in the Salem area that are less palatable to beaver include Pacific ninebark (*Physocarpus capitatus*), red elderberry (*Sambucus racemosa*), cascara (*Rhamnus purshiana*), osoberry (*Oemleria cerasiformis*), and twinberry (City of Portland, 2011). The list might also be used for vegetation maintenance and replacement in facilities with beaver presence.

Alternatively, native plants that beaver prefer, such as willow, red-osier dogwood (*Cornus stolonifera*), Oregon ash, bigleaf maple (*Acer macrophyllum*), and black cottonwood (*Populus trichocarpa*) can be planted along the waterline in dense “beaver buffer” plantings, to focus beaver foraging attention away from other vegetation. These species have coevolved with beaver, and will continue to re-sprout, even after repeated cutting. However, young plantings will need to be protected until they are established.

4.3.3 Public Education

Where beaver activity is occurring in public parks, interpretive signs can educate the public on beaver ecology and the benefits of living with beaver. When a private landowner seeks assistance from the City for alleviating beaver conflicts, we recommend that the City provide them with information related to managing beaver activity on private property. This information would need to be developed by the City, and could include fact sheets, fliers, web-links, and contact lists to assist landowners in finding a long-term beaver coexistence solution.

4.4 Tree Protection

Losing canopy is undesirable in the urban context for a number of reasons, including threats to public safety and adjacent structures from falling trees, temporary reduction of stream shade given the Willamette River Basin Temperature TMDL, damage to valuable ornamental landscaping, and challenges with establishing new vegetation on streambanks or floodplains associated with mitigation or restoration projects. Beaver can cause mortality to trees and other vegetation in two ways—flooding and foraging.

In the case of flooding, the situation should be carefully evaluated to determine if intervention solely for the purpose of saving the trees or vegetation is warranted. There may be situations where losing vegetation to flooding is unacceptable, and action is needed. However, given the many positive benefits of beaver dams, in some situations there may be more benefit in allowing the area to remain flooded and convert to a natural wetland community than in saving the existing vegetation. In the latter situation, the site should be monitored and, if necessary, replanted with native wetland trees and shrubs. Dead trees should be left as snags for wildlife habitat unless they present a safety hazard. If vegetation loss due to flooding is determined to be unacceptable at a given location, section 4.5 should be consulted to determine what type of intervention will best meet the site’s objectives. The habitat modification BMP selected for this purpose will depend largely on whether short or long-term pond reduction is needed.

With regard to foraging, beaver prefer to eat certain native riparian species, such as willow, cottonwood, ash, red osier dogwood and maple, however these taste preferences differ by region and beaver family group. Because native vegetation has co-evolved with beaver foraging, most native species will regrow from the stumps. Planted trees that didn't coevolve with beaver, such as landscaping and fruit trees, will die if beaver cut them down.

Trees and other vegetation are best protected from beaver foraging in two ways—exclusionary fencing or a sand and paint mixture applied to the bark. These techniques are effective but come with both an initial implementation and maintenance cost. At the time this plan was written, no permitting was required for the methods of tree protection below. Check for updated guidance and regulations annually.

4.4.1 Wire Mesh Cages

In locations where trees or shrubs should be protected from gnawing or felling by beaver, wire mesh cages can be installed around the trunk of a single tree or wire fencing around multiple trees/shrubs. This method requires material, labor, and periodic monitoring, maintenance, and reinstallation as trees grow. A typical tree cage consists of 2x4 welded wire, 4 feet in height with 2-3 steel T posts holding it in place. An effective mesh cage consists of the following (Pollack, et al 2018):

- The gauge should be reasonably heavy (e.g., 6 gauge) to prevent beaver from chewing through it and be flexible enough for this application.
- Mesh size should be 6x6 inches or smaller (2x4 inches is ideal).
- The cage should be 1 to 2 feet in diameter larger than the tree trunk.
- Cages should extend 3 to 4 feet above the ground.
- Wire fencing can be used to encircle multiple trees.

Things to consider:

- Beaver can be heavy, so build your tree cage from a material that can withstand a 60-pound animal putting its front legs up on it (i.e. not chicken-wire).
- Leave adequate room between fencing and tree bark for trees to grow.
- Check on any caged trees on a regular yearly schedule to adjust cages as needed.

4.4.2 Sand/Paint Mixture

In areas where trees should be protected from gnawing or felling, but where investment in the higher costs for material and labor is not worth the effort, abrasive paint may be used. This method requires minimal material and labor and annual monitoring and repainting. This method might be useful for volunteer events where skill in manual labor is not critical to success. This method does not work on saplings. Use only on stems approximately 6-inches in diameter or larger. Abrasive paint should consist of a mixture of:

- 8 ounces of fine dry sand (30-mil, 70-mil, or masonry sand)

- 1 quart of latex paint, matched to the color of the tree trunk (Pollack, et al 2018)

Once combined, the mixture is painted on the tree to 4 feet above the ground.

Things to consider:

- This method is not recommended for any tree with a stem less than 6-inches in diameter.
- Check latex paint for environmental safety. Some exterior latex paints have heavy metals to protect color from fading, and for this reason sometimes interior paint is better for this application near streams.
- As the protected tree grows in diameter, areas of un-protected bark will emerge. Check on painted trees on a regular yearly schedule to add additional paint as needed.

4.5 Habitat Modification

Beaver build dams to create more habitat for themselves, and at the same time they create a functional riparian and wetland habitat ecosystem. However, in urban stream systems with low gradients and/or inadequate riparian buffers, beaver habitat creation can directly conflict with the habitat needs of humans—our infrastructure, houses and landscaping. Habitat modification allows us to coexist with beaver by altering their structures to artificially restrict the habitat footprint by modifying the ability for beaver to dam at constriction points (such as under-sized culverts) or flood adjacent infrastructure; the City benefits from beaver activities while reducing risks to adjacent infrastructure.

These coexistence techniques for habitat modification include rapid breaching or removal of dams and installing pond levelers and culvert protection systems. When correctly implemented, these strategies can offer long-term, cost-effective coexistence solutions.

When using any of these methods in streams with native migratory fish (NMF), it is important that regulatory guidelines for migratory fish passage are followed; currently, direct communication with an ODFW fish biologist is required on a case-by-case basis. Additional regulations regarding removal or fill of material within regulated waters are discussed below.

4.5.1 Rapid Response Dam Reduction or Removal

Dam breaching should be considered if there is acute flooding risk as a result of the dam. Because beaver will often rapidly repair a breached dam, breaching should be considered a short-term, emergency approach for safety purposes and to relieve dangers to infrastructure. Dams may be reduced to the extent that they might still provide benefits associated with beaver dams, while still protecting infrastructure.

Full dam removal is a more significant effort and will typically drain the entire beaver pond. This often exposes submerged den and burrow entrances, allowing access by terrestrial predators. If beaver are present, it is best to avoid dam removal during the kit season from April to June to protect beaver kits that may not be fully mobile and more vulnerable to predation.

It's important to remember that breaching or dam removal may trigger beaver to re-build, leading to additional vegetation removal by beaver for dam building materials, sometimes pushing them further from the site or toward ornamental vegetation if sufficient native vegetation does not remain at the site.

There are two recommended ways to breach or remove a beaver dam depending on the size of the dam. These are described below:

- Breaching or removing a dam by hand: Remove material from the dam slowly by hand and/or using hand tools such as four-pronged pitch forks, long-handled cultivator rakes (potato hooks), shovels and chain saws to dislodge and remove material.
- Power excavating: Remove material slowly using a backhoe or excavator to breach or remove large dams. The machinery should be stationed at the top of the bank, road, or bridge where practicable. Remove the dam from top down in layers, scraping off six inches to one foot of material to reduce the potential for flooding or stream scouring. Wait for the water levels to stabilize and flow to clear before removing the next layer. Remove material to the desired depth or substrate or to the natural substrate level if needed. To maintain compliance with the Oregon DSL large wood exemption, ponds should only be lowered to the level necessary to eliminate risk and no further (https://www.oregon.gov/dsl/WW/Documents/Removal_Fill_Guide.pdf).

For all breaching activities, staff should follow the procedures identified in Appendix B, "Standard Operating Procedure (SOP) for Beaver Dam Assessment and Breaching" to ensure that the proper analysis is conducted so that the release of impounded water behind the dam does not endanger downstream structures and or property. As part of the SOP, the City should document and maintain records of any beaver dam reduction or removal activities in order to be able to respond to any complaints that may be brought to the attention of regulating agencies. The specific reason for dam breaching or full removal should be documented to demonstrate compliance with DSL removal and fill regulations and exemptions.

Things to consider:

- Reduce the dam height to only the minimum needed. The more the beaver dam and pond are reduced, the more likely you are to destabilize the situation. The amount of water over the beaver's underwater den entrance will determine how far down you can bring the beaver impoundment before destabilizing the situation and causing the beaver to build a new dam.
- Breaching or removal of dams could result in increased tree/shrub damage as beaver seek new vegetation to patch or rebuild dam.
- Use appropriate best practices for controlling sediment plumes as needed.
- Timing must be in accordance with the ODFW in-water work periods (June 15 - October 15) or coordinated with the regional fish biologist if outside this period.
- DSL Removal-Fill Permit required if removing >50 cu yds of material under standard DSL rules or if removing more material than necessary to eliminate risk under large wood exemption (see section 5.1 for details).

4.5.2 Pond Levelers

In areas where freestanding dams are not located at a culvert, but still present a threat to infrastructure if the upstream pond level should rise above a certain elevation, pond levelers have been proven highly effective (Pollock et al. 2018). The goal of a pond leveler is to minimize disruption to the beaver colony, while creating a maximum dam height and impoundment footprint. In these situations, the City can ensure that the upstream water depth and extent does not increase beyond an acceptable threshold. This is accomplished by using a pond leveler flow device to create a non-repairable leak in the top of a beaver dam. These devices generally consist of a large-diameter flexible pipe installed over the dam, in combination with an upstream cylindrical wire cage to protect the intake from being dammed by beaver (Figure 2, Appendix B).

BMPs for pond leveler construction, installation and maintenance are evolving, and future revisions of the Beaver Restoration Guidebook should be referenced for project design specifics. Each pond leveler will need to be field fit for specific site conditions.

Essential design components of this system as of the date of this plan include:

- **An upstream intake:** While beaver will quickly fix any leak in the upstream surface of their dam, hiding the intake of the pond leveler 20 feet to 60 feet upstream removes it from the proximity of the dam where beaver tend to search for the leak.
- **A caged intake:** Use of an intake cage will prevent beaver from swimming close enough to the overflow pipe to feel or hear running water. If the exclusionary fence is too small and beaver sense the leak, they will rapidly mobilize enough mud to encapsulate the entire intake cage. The cage should be constructed with 6-gauge wire (or heavier) and have a maximum of 6-inch by 6-inch openings (beaver can swim through anything bigger). The size of the cage should correspond with the size of the pipe used; for a 12-inch overflow pipe installed into the center of the round intake cage, the radius of the cage should be at least 3-feet and typically include a domed top and flat bottom.
- **Minimize “trickling” sound:** Beaver detect leaks by hearing or feeling them. It is essential to minimize the sound and sensation of flowing water within the pond leveling system upstream of the crest of the beaver dam (beaver are used to cascading water on the downstream side of their dam). Use double-wall plastic culvert pipe at the intake cage (the smooth interior minimizes noise) and wherever pipe flexibility is not essential. Use single-wall plastic culvert pipe where flexibility is needed (for example where the pipe curves up the face and over the crest of the beaver dam).
- **Intake flow dispersion:** The uniform circular lip of the intake pipe should be disrupted to prevent the intake flow coupling with the pond surface. One effective method is to cut a half-circle of pipe material out of the bottom lip of this opening.
- **Stabilize flow-device in place:** It is critical to stabilize the intake cage and pipe to keep beaver from moving it and to minimize the need for major readjustment after high-flow events. The pipe can be held in place at the dam crest with steel posts and the intake cage and pipe can be held in place with either steel posts or weights.
- **Vented pipe:** Small vent holes or slits should be cut in the submerged pipe to release gas trapped in the pipe or within the pipe wall. In addition to anchoring with weights or steel

posts, these holes are essential to keep the pipe from floating. The holes should be kept to a minimum to avoid attracting the attention of the beaver. Cut holes only through the outer wall of the double wall pipe.

This method requires an investment of time and materials, plus monitoring and maintenance to ensure the intake cage and pipe remain in good condition. Quarterly/seasonal cleaning, such as February, May, August, and November, is necessary to clear the cage of obstructions (i.e., woody debris).

Things to consider:

- Reduce the dam height only the minimum needed. The more the beaver dam and pond are reduced, the more likely you are to destabilize the situation. The amount of water over the beaver's underwater den entrance will determine how far down you can bring the beaver impoundment before destabilizing the situation and causing the beaver to build a new dam.
- Install the pond leveler over the dam's crest, not through it.
- If a dam is built directly downstream of a pond leveler, it is possible to extend the pipe to the second dam.
- Pond levelers should have a maintenance plan and be checked quarterly (e.g. February, May, August, and November). These flow devices should be removed from the stream as soon as they are not needed.
- Consult with ODFW fish passage biologist regarding potential fish passage issues.

4.5.3 Culvert Protection Systems

Culvert protection systems keep beaver from plugging a culvert or spillway by either excluding the animal from the culvert and providing an alternative location for the beaver dam just upstream, or by directing the beaver's damming activity away from the trickling water cue at the culvert's mouth.

The first tactic directly protects the culvert's mouth with a semi-circle of wire mesh fencing, such that the beaver's damming activity is allowed at the culvert mouth, but the location is controlled with the enclosure. This approach is called a *diversion fence*. If beaver are building on the diversion fence and the extent of the impoundment is a concern, the City can maintain the maximum water surface elevation behind the diversion fence by installing a pond leveler through the dam/fence. This hybrid structure is called a *pipe and fence* culvert protector (Figure 2, Appendix B).

The second tactic protects the culvert mouth by excluding beaver dam building from the culvert and separating the beaver from the physical and aural cues. By excluding beaver from the area around the culvert mouth with wire fencing and directing their damming activity into still water upstream of the culvert they lose the cues to dam at the site. Even if beaver attempt to construct a dam along the enclosure, the majority of the fence remains un-impacted, allowing unobstructed flow to the culvert. This culvert protector is often called a *trapezoidal culvert fence* (Figure 2, Appendix B).

The BMPs for culvert protection systems construction, installation and maintenance are evolving, and future revisions of the Beaver Restoration Guidebook should be referenced for project design specifics. Each flow device should be field fit for specific site conditions.

Things to consider:

- Checking in with the Engineering Division prior to installing a culvert protection system is recommended to determine if there are any plans for replacing or upgrading the infrastructure in the problem area. In some cases, if a culvert is old and undersized, it may already be on the radar for replacement and the problem could be resolved through preemptive planning (see Section 4.3).
- Fish and wildlife passage considerations are essential in designing a site-appropriate culvert protection system.
- Avoid galvanized metal to limit leaching of zinc into the environment.
- Culvert protection systems should have a maintenance plan and be checked quarterly, such as February, May, August, and November. These flow devices should be removed from the stream as soon as they are not needed.
- Consult with ODFW fish passage biologist regarding potential fish passage issues.

4.6 Beaver Removal

Aquatic systems with beaver activity in the City are areas that beaver have determined to be suitable habitat. Given that beaver are highly territorial, trapping (either for relocation or lethally) alone is not often a long-term solution for addressing beaver concerns, as this action will open this territory for another beaver colony to inhabit if modifications to the site are not made. Trapping and removing beaver often becomes a costly treadmill of reactionary management (Hood et al 2017). As such, the City should only use beaver removal as a last resort when all other options for coexistence have been exhausted.

When infrastructure modifications are not possible, and habitat modifications and infrastructure protection methods are not fully effective at managing detrimental beaver activity, removal of a beaver or beaver group might be necessary. Removal could be by lethal trapping or relocation. Given the benefits that beaver can provide, non-lethal means of removal is preferable to lethal means, however relocating beaver is a complicated process and must be done in coordination with ODFW.

4.6.1 Relocation

ODFW directs the trapping and relocation of beaver in Oregon (https://www.dfw.state.or.us/wildlife/living_with/docs/Oregon_Beaver_Relocation_Requirements_Forms.pdf). Relocating beaver entails cooperation between multiple partnering agencies and can be a long process. At this time, beaver seem to be utilizing all suitable habitat within the City of Salem, therefore, relocating beaver within the City is not an option because ODFW requirements prohibit releases into areas already occupied by beaver.

In order to relocate beaver, an appropriate, unoccupied location would need to be identified, approved by ODFW, and supported by the majority of property owners within a 4-mile radius of the new relocation site. Relocations are best conducted between August 1 and October 31 (ODFW 2017). Every attempt should be made to trap all members of the family (this could be anywhere between a recently dispersed pair to a family of 12). They should be held until all members of the family can be relocated together (within reasonable timeframes). Follow-up monitoring at release sites by project implementers and reporting to ODFW agency biologists is essential to determine success of reintroduction efforts.

There is quite a bit of work involved in planning and employing a successful beaver relocation. We recommend that the City collaborate with ongoing regional beaver relocation programs rather than attempting to independently plan non-lethal trapping and relocation of beaver.

Things to consider:

- Relocation is only a temporary solution with short term benefits until habitat/ infrastructure modifications can be accomplished. Beaver are highly territorial, and if beaver have identified the area as good habitat, a new family will likely move into any territory that is opened up through beaver removal.
- Live capture traps can be dangerous for people, pets, and other wildlife and should be well signed. Any relocation trapping should be conducted by an ODFW licensed wildlife control officer (WCO).
- Relocation requires lengthy coordination with ODFW, landowners and/or land management agencies at release site.

4.6.2 Exclusion and Hazing

Other options exist if beaver need to be moved a short distance from their current location. This situation could arise when beaver are located within infrastructure such as pipes or manholes and need to be moved before placing exclusion devices. Eviction generally involves moving animals very short distances (less than 1,000 feet) within the same property ownership. The intent with eviction is to move animal(s) within their own existing territories by “evicting” them from problematic den sites. By definition, eviction actions are not relocations and therefore not subject to ODFW’s Relocation Requirements. Eviction has not been standard practice, and each situation will likely be unique. Proposed techniques must be coordinated with and authorized by ODFW prior to implementation to ensure that applicable laws and regulations are adhered to. Evictions are likely best conducted between August 1 and October 31. Preventing re-entry is paramount, as the beaver are likely to return. Potential methods could include the use of strobe lights or loud noises to encourage beaver to move out. Any methods used must not overly disturb other residents, either human or wildlife, and would need to be approved by ODFW prior to implementation.

Things to consider:

- Be sure to have a plan for exclusion that incorporates the abilities beaver have for digging and flooding.

- Hazing is not a feasible technique in open waterways but may be effective within stormwater pipe systems and certain stormwater treatment ponds with notification of neighboring property owners.
- Contact ODFW wildlife biologist prior to implementation.

4.6.3 Lethal Trapping

In areas where infrastructure modifications are not possible, and repeated habitat modification techniques and coexistence solutions have not been successful, lethal removal by a licensed WCO might be appropriate. If removed beaver are located in a pipe or other item of infrastructure, measures to prevent re-entry by other beaver should be implemented, if possible.

Things to consider:

- Trapping is only a temporary solution. Beaver are highly territorial, and if beaver have identified the area as good habitat, a new family will likely move into any territory that is opened up through beaver removal.
- Traps can be dangerous for non-target wildlife, people and pets. Be sure to sign the area accordingly and to work with an ODFW licensed WCO.
- Consider contacting Confederated Tribes of Grand Ronde regarding use of beaver pelts or other parts.

5.0 STATE AND FEDERAL PERMIT AND REVIEW REQUIREMENTS

5.1 Dam Breaching and Removal, and Coexistence Devices

Permit regulations can change over time. As this document ages we recommend consulting state and federal agency websites for the most up-to-date permitting guidance. Current permitting and/or consultation requirements for beaver coexistence solutions are:

- Beaver dams and dens are not a regulated resource by ODFW and can be removed or altered without a permit from that agency; however, these activities must be conducted in accordance with the ODFW in-water work period (June 1 through October 15), and instream work outside this window requires consultation with the ODFW's District Fish Biologist. Additionally, dam breaching or removal can require notifications and consultations with ODFW's District Wildlife Biologist and/or Regional Conservation Biologist if state sensitive species could be impacted (e.g. egg masses of red-legged frog). Confirmation of den/lodge abandonment should occur prior to dam alteration or removal activities to limit potential injury or death to a beaver.
- Removal or fill of more than 50 cubic yards of material from waters of the State requires consultation with DSL. In streams identified as Essential Salmon Habitat (ESH), removal or fill of any volume of material below ordinary high water (OHW) requires a DSL permit. Within Salem, waters mapped as ESH by the state include the Willamette River and its associated sloughs, Mill Creek, Shelton Ditch, lower Pringle Creek, Gibson Creek, and Glenn Creek (Figure 3, Appendix B). Since ESH maps are updated as needed, check the following weblink for the most up to date information: <https://maps.dsl.state.or.us/esh/>. Habitat modification tools such as pond levelers and culvert protection systems are considered fill in ESH streams and require a DSL permit.

However, breaching or removing beaver dams, is exempt from DSL permitting if the following criteria are met:

- The dam and its associated wood pose a direct and demonstrable danger to the following:
 - human life or real property, or
 - transportation facilities including culverts, bridges, and roads
- The removal is no more than the amount necessary to reduce or eliminate these threats.

In this situation, beaver dams are considered “large wood” by DSL and removal is allowed under an exemption for danger and risk (OAR 141-085-0530(9)). This exemption applies to both ESH and non-ESH waters, and there is no volume threshold. To be covered under this exemption, the City would only remove the amount of dam material that is necessary to protect property or infrastructure from a direct and demonstrable threat. The City does not need to seek permission from DSL for removal of dam material; however, DSL does recommend that the City maintain documentation of any beaver dam reduction or removal activities undertaken under this exemption in order to be able to respond to any complaints that may be brought to their attention.

- When coexistence devices such as pond levelers or culvert protection systems are proposed in waters of the state that are inhabited or were historically inhabited by native migratory fish (NMF), the City must consult with an ODFW fish passage scientist prior to installation. The species distribution and use of the site by native fish will inform the design specifications of the flow device. Figure 4 (Appendix B) shows NMF streams.
- It may also be necessary to obtain a permit from the U.S. Army Corps of Engineers (USACE) to place fill below the ordinary high water of creeks; however, the USACE does not regulate the types of activities that DSL does. For example, the USACE does not consider pond levelers or culvert exclusion systems, as fill under Section 404 of the Clean Water Act. It is best to discuss the project with the USACE project manager for Marion County to determine whether the proposed activity will require a federal permit. If a federal permit is required, it may also trigger the need to address the Endangered Species Act (ESA). Chinook salmon and steelhead trout are species protected by the federal ESA and managed by the National Marine Fisheries Service (NMFS). The requirement to engage NMFS in the project should also be discussed with the Corps project manager.
- Lowering water levels in beaver ponds may unintentionally strand amphibian egg masses causing mortality. State-sensitive red-legged frogs typically lay their eggs in beaver ponds in February. If lowering pond levels, first determine if sensitive amphibians may be present and consult with ODFW Regional Conservation Biologist for avoidance and minimization measures. These actions can also impact ESA threatened freshwater mussels and strand Pacific Lamprey ammocoetes. Salvage actions require an ODFW permit.

- In general, constructed stormwater treatment facilities, such as sediment retention ponds and bioswales, are not waters of the State /U.S.; therefore, dam breaching, material removal, and placement of pond levelers may occur without agency consultation in constructed stormwater treatment facilities. Some facilities, however, may overlap with regulatory waters and careful consideration should be given on a case-by-case basis. Always consult with agencies if there is any question about regulatory status of a facility.

5.2 Relocation and Hazing Activities

It is illegal for anyone to move a beaver in Oregon without a permit from ODFW (ORS 497.308 and 498.002). The intent of the relocation permit is to maximize the ecological benefits provided by beaver while minimizing potential conflicts (e.g., damage to private property), identify strategies for successful establishment of beaver at release sites, ensure humane treatment of individual animals, and avoid adverse social, disease or genetic impacts on beaver populations where beaver relocation is deemed appropriate and is authorized by ODFW.

For exclusionary purposes, ODFW will coordinate with the City on a case-by-case basis to consider live-trapping beaver to move them short distances, within the same property ownership and within the animals' existing home territory. Such a move would be authorized by permit from ODFW. Although ODFW could be willing to coordinate with the City on moving beaver causing damage or posing a public health risk within the animals' existing territory, it is preferable to try to haze those beaver from problem areas first. An annual hazing permit from ODFW is required to implement any method of disturbance intended to move animals out of problem areas. The permit will outline acceptable methods and will be issued in conjunction with an Annual Incidental Take Permit (Kill Permit) in the event that hazing accidentally results in the death of an animal.

Under certain terms, ODFW may also consider future long-distance relocations of beaver, outside their home range. Permit approval by ODFW may include terms such as an approved holding facility, medical screening or other requirements.

5.3 Lethal Trapping on Public Lands

On public lands, beaver are classified as protected furbearers under Oregon Administrative Rule (OAR) 635-050-0050 and Oregon Revised Statute (ORS) 496.004 and 498.158. Normally this designation carries several limitations to trapping by public agencies; however, in the context of nuisance beaver causing infrastructure damage, ODFW has provided guidance that allows for the use of a licensed WCO to trap and remove beaver. Using a WCO for the purpose of removing a nuisance beaver does not require additional permits or reports from ODFW at this time. The WCO will submit any required reports to ODFW.

5.4 Lethal Trapping on Private Lands

On private lands, the beaver's designation as a predatory animal ("herbivorous nuisance") under Oregon Revised Statute (ORS 610.002) supersedes the trapping prohibition due to location (e.g., within a city's boundary). A private landowner may trap and kill a nuisance beaver on their property. There is no approval necessary from ODFW if the landowner performs this task, and

there are no reporting requirements. If the landowner hires a WCO to perform this task, the operator reports its activity to ODFW.

All the above regulatory considerations and requirements for this plan are summarized in Table 1. An agency contact list is included in Appendix D.

Table 1. Summary of Actions and Regulatory Approvals / Permits

| Action | Regulatory Approvals / Permits |
|---|---|
| Tree Protection | No permit required |
| Preemptive planning | No permit required |
| Dam reduction ^{1,2} | No ODFW permit required during the in-water work period (6/1-10/15); notify ODFW District Fish Biologists at other times. Document internally and provide records to DSL if requested. DSL removal/fill permit required in Essential Salmonid Habitat. |
| Dam removal ^{1,2,3,4} | No ODFW permit required during the in-water work period (6/1-10/15); notify ODFW District Fish Biologists at other times. If native migratory fish (NMF) present, consult ODFW District Fish Passage Biologist. Consult ODFW Regional Conservation Biologist if red-legged frogs/egg masses are present in pond (typically Feb/March) or if other protected species are present. Document internally and provide records to DSL if requested. DSL removal/fill permit required in Essential Salmonid Habitat. |
| Pond levelers & Culvert Protection Systems ^{2,5} | Inform ODFW District Wildlife Biologist. Consult ODFW Regional Conservation Biologist if sensitive species present. If NMF present, consult ODFW Fish Passage Biologist. DSL removal/fill permit required in Essential Salmonid Habitat. Pond leveler and culvert protection systems are likely not considered to be fill by the USACE but consult the USACE project manager to confirm. When a Corps permit is required, a NMFS review may also be needed. |
| Eviction/Relocation | ODFW permit required, contact District Wildlife Biologist |
| Lethal trapping on public lands | No permit required if trapped by state licensed Wildlife Control Officer (WCO) |
| Lethal trapping on private land by property owner | No permit required |

Notes:

1. DSL exemption (OAR 141-085-0530(9)) applies to reduction/removal for purpose of protecting human life, real property, or transportation facilities from a direct and demonstrable threat. Dam reduction or removal for all other purposes that involves >50 cubic yards of material (or any amount on ESH-designated streams) requires DSL permit.
2. No agency notification required for dam breaching, dam removal or placement of coexistence devices in constructed stormwater facilities, such as sediment retention ponds or bioswales.
3. Power excavation: remove the dam from the top down in layers, scraping off six inches to one foot of material at a time. Allow flow to clear before continuing with next layer. This reduces the potential for flooding, scour or large sediment plumes downstream. Use site-appropriate sediment control best management practices.
4. Avoid beaver kit season April-June. In cases with breeding frogs or salamanders, amphibian egg mass salvage requires ODFW permit; contact Regional Conservation Biologist.
5. Consult with DSL if an action includes >50 cubic yards of removal-fill, any amount of fill in ESH, or more substantial structures than those described in this plan are proposed in waters of the State.

5.0 REFERENCES

- City of Portland Bureau of Environmental Services. 2020. *Beaver Management Plan*. Version 2.0. Portland, Oregon. 13 pp.
- Glynnis A. Hood, Varghese Manaloor & Brendan Dzioba. 2017. *Mitigating infrastructure loss from beaver flooding: A cost-benefit analysis*. Human Dimensions of Wildlife, DOI: 10.1080/10871209.2017.1402223.
- ODFW (Oregon Department of Fish and Wildlife). 2017. *Requirements for Relocation of Beaver in Oregon – December 21, 2017*. 10 pp.
- ODFW. 2012. *Using Beaver to Restore Streams – The State of the Art and Science*. Portland, OR. <http://epp.esr.pdx.edu/Beaver%20Restoration.html>
- Pollock, M.M., G.M. Lewallen, K. Woodruff, C.E. Jordan and J.M. Castro (Editors). 2018. *The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains*. Version 2.01. United States Fish and Wildlife Service, Portland, Oregon. 218 pp. Online at: <https://www.beavercoalition.org/guidebook>

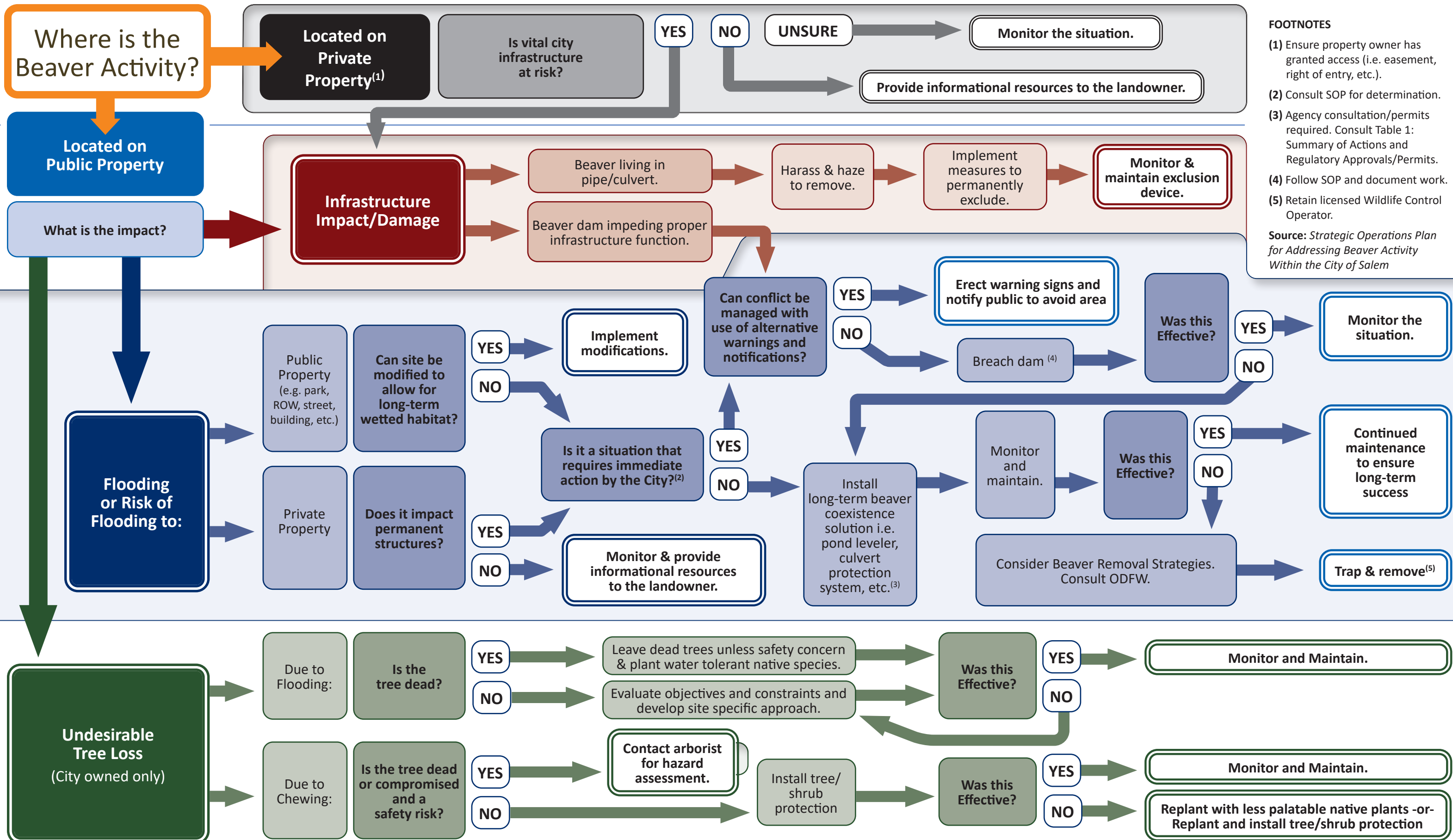
Appendix A

Beaver Management Decisions Flowchart

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The goal of the Strategic Operations Plan is to coexist with beaver to the maximum extent possible; however, where beaver activity is putting public safety and infrastructure at risk, staff should use this decision tree to help make decisions about how to address the conflict.



FOOTNOTES

- (1) Ensure property owner has granted access (i.e. easement, right of entry, etc.).
- (2) Consult SOP for determination.
- (3) Agency consultation/permits required. Consult Table 1: Summary of Actions and Regulatory Approvals/Permits.
- (4) Follow SOP and document work.
- (5) Retain licensed Wildlife Control Operator.

Source: Strategic Operations Plan for Addressing Beaver Activity Within the City of Salem

Appendix B

Figures

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-  Beaver Dam
-  Beaver Lodge
-  Beaver Sign (activity)
-  City Limits
-  Streams

Salem streams with confirmed beaver presence in 2019-2020

Strategic Operations Plan For Addressing Beaver Activity Within the City of Salem, OR. Project # 7192

FIGURE

1

8/27/2021

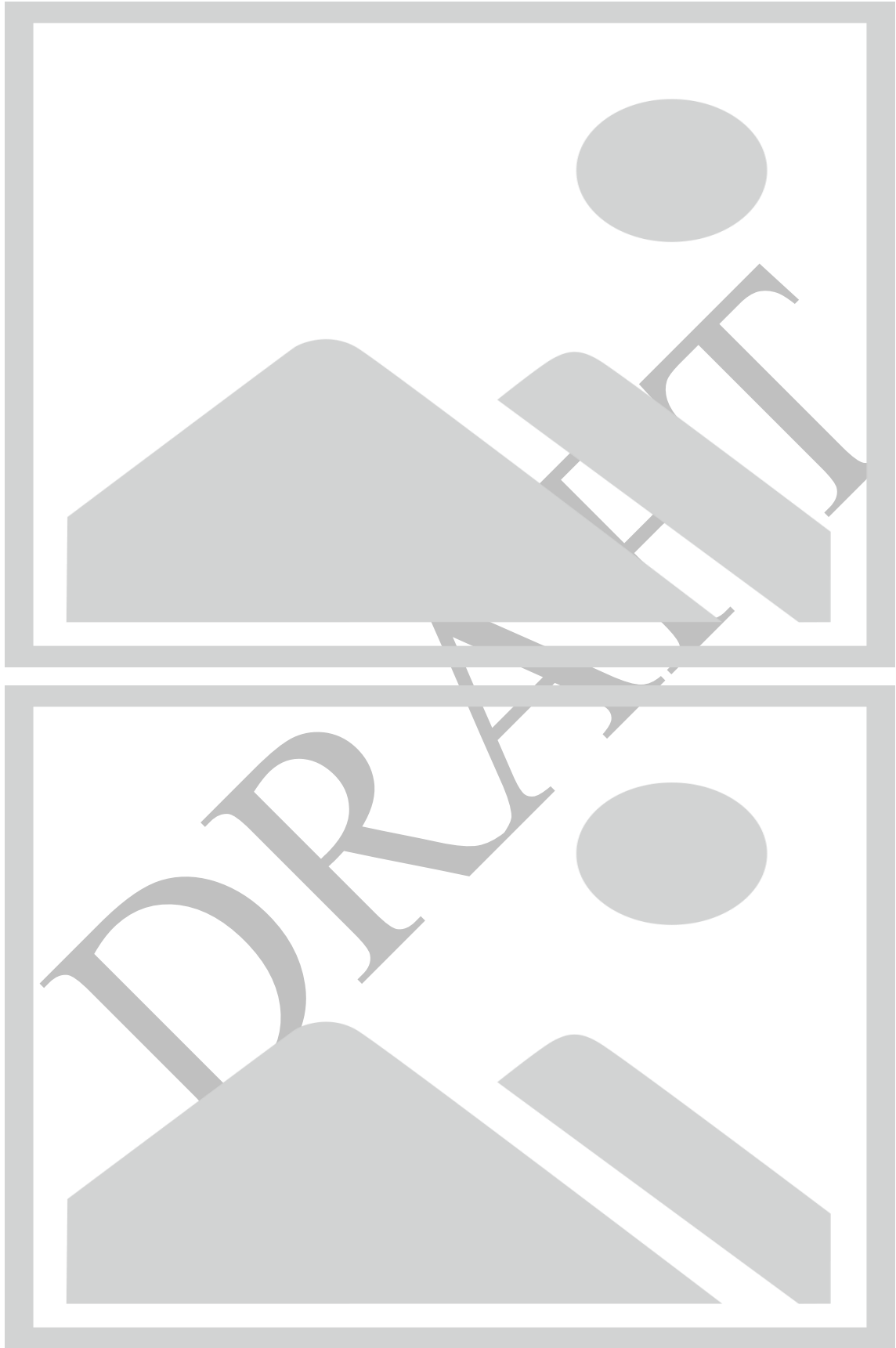
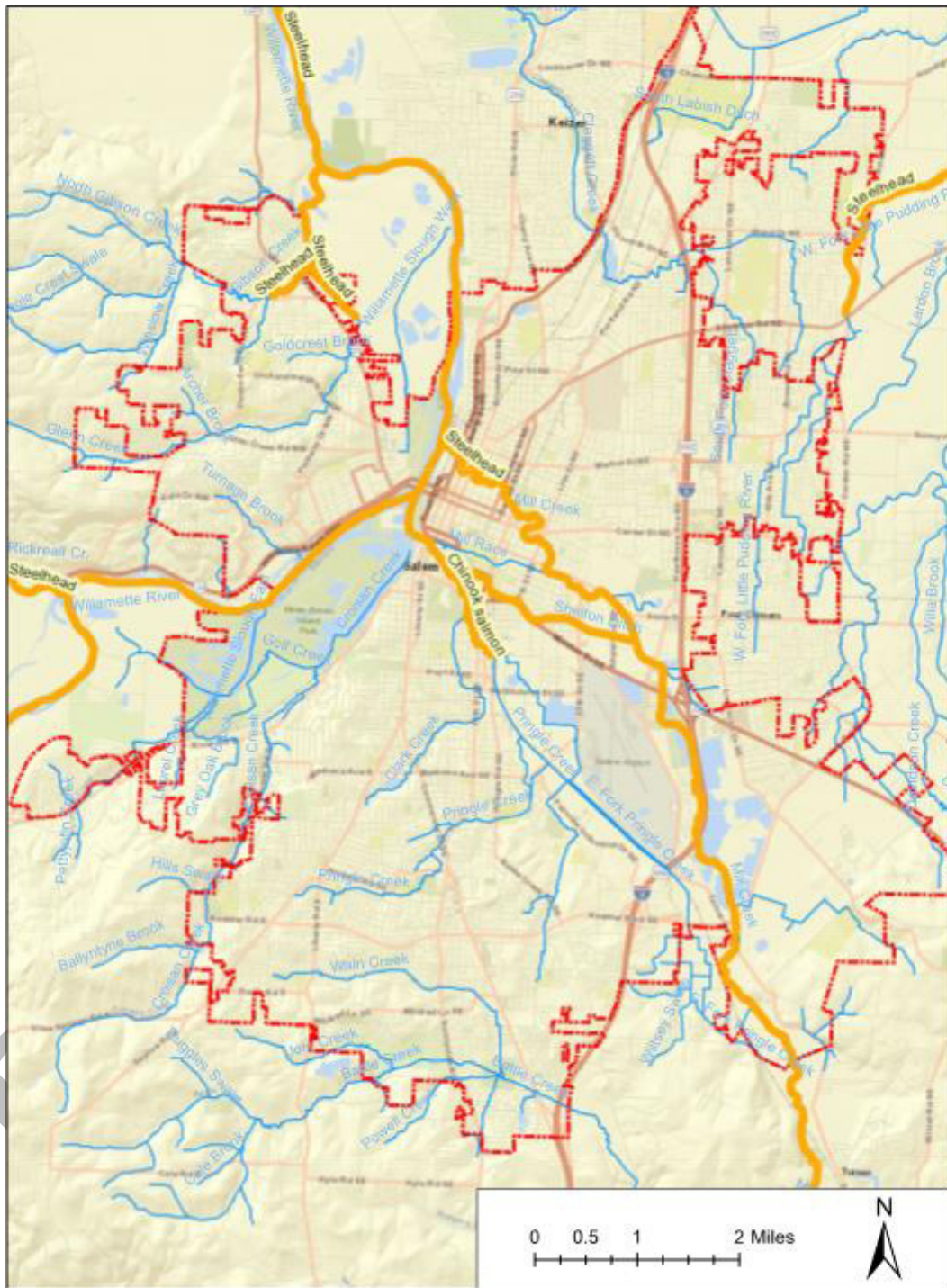


Figure 2 - Coexistence techniques for habitat modification



- Essential Salmonid Habitat (ODFW)
- City Limits
- Streams

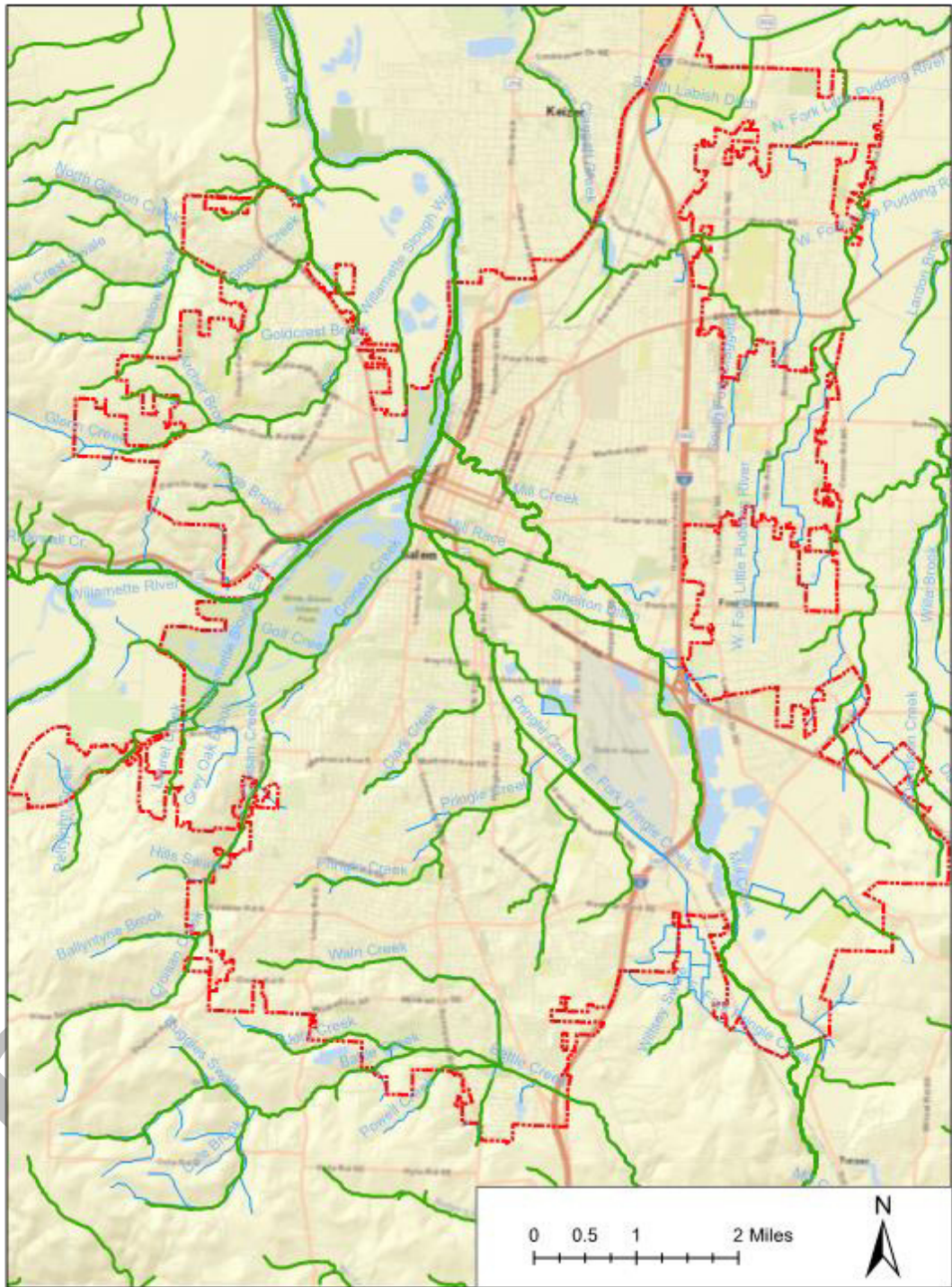
Salem streams identified as Essential Salmonid Habitat

Strategic Operations Plan For Addressing Beaver Activity Within the City of Salem, OR, Project # 7192

FIGURE

3

8/27/2021



- Native Migratory Fish Habitat (ODFW)
- City Limits
- Streams

Salem streams identified as Native Migratory Fish (NMF) Habitat

FIGURE

4

Strategic Operations Plan For Addressing Beaver Activity Within the City of Salem, OR. Project # 7192

8/27/2021

Appendix C

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AGENCY CONTACT LIST (as of August 2021)

Oregon Department of Fish and Wildlife (ODFW)

<https://www.dfw.state.or.us/fish/passage/>

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Appendix D

Standard Operating Procedure for Beaver Dam Assessment and Breaching

This section will be prepared by City of Salem staff based on this Plan and added to the appendices once complete

