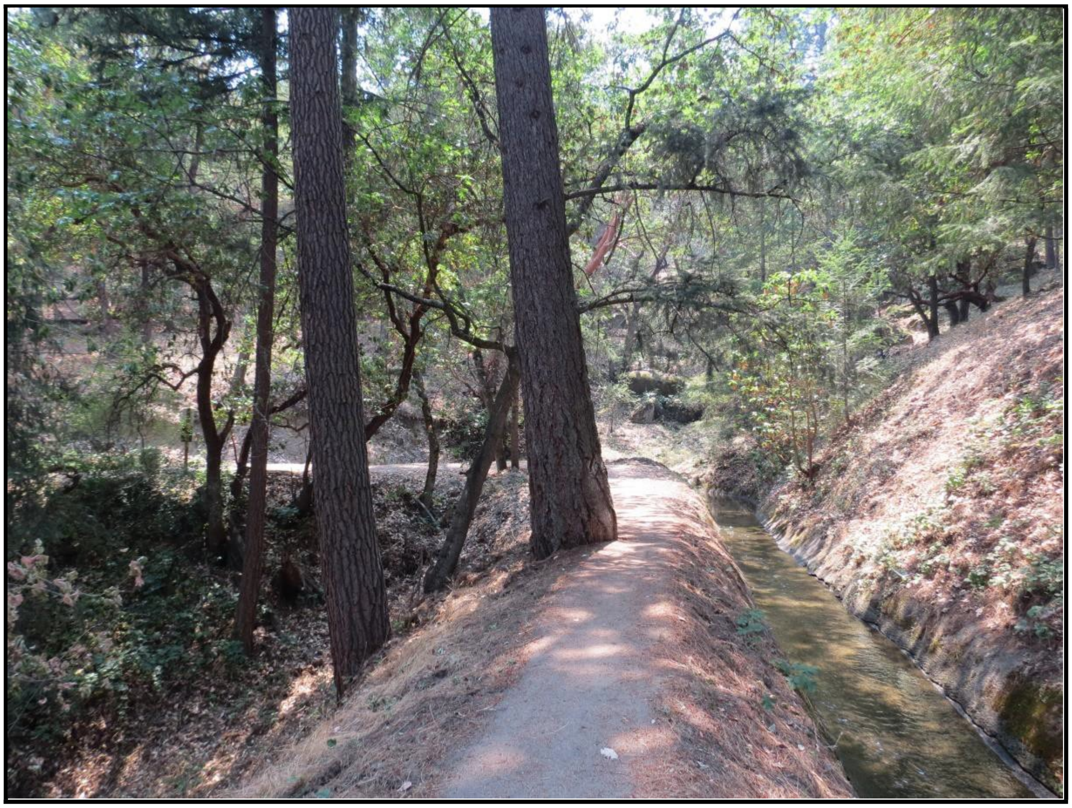
Minimizing Ecological Risks Associated with the City of Ashland Piping of T.I.D Water between Starlight Station and Terrace Street Pumping Station



Ecological Analysis by Siskiyou BioSurvey, LLC; July 2018

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I. Introduction

A. Scope of Work

Siskiyou BioSurvey, LLC (SBS) was hired by the City of Ashland (City) to conduct a vegetation survey along a roughly 2 mile stretch of the Ashland TID canal between the Starlight and Terrace Street Stations to identify potential conflicts and impacts with existing vegetation in regards to converting the irrigation canal into a piped route, both during the construction process and the years following. Trees and other vegetation that may be adversely impacted will be identified and mapped. Wildlife uses and benefits of the studied canal segment will be described and evaluated. Design features that help integrate the proposed road where the current canal bed runs are provided.

The City wants to maintain the shady environment that exists along the canal corridor by preserving mature trees and maintaining habitat. To do this, SBS was tasked with summarizing anticipated impacts to different tree species within a larger ecological context and to provide recommendations where appropriate for mitigating adverse effects, including recommending plant restoration opportunities.

B. Layout of this Document

We have arranged this document to be readily used in its 3 main parts:

1. The introduction and body of the document

The document is meant to be read by those interested in an ecological overview of the planned piping of the Ashland Canal and an exploration of the potential impacts.

2. Ecological descriptions of each tenth mile segment

Segment descriptions were recorded along the length of the project. They provide site references as well as a larger context for the study area and broadly characterize the nature of each area including special features we noted during our field analyses. They identify significant landscape aspects we expect to be impacted by piping the irrigation channel and include photos of our observations. The segment profile summaries are provided in Appendix A with maps that reference each tenth mile segment location.

3. Identified areas of concern (AOC) are listed as a summary table in Appendix B.

The table is a catalog of the significant AOC listing potential negative impacts to important features grouped by segment and delineated on the provided maps. The City and landowners can use our recommendations within the detailed descriptions of each AOC, reverenced in the segment profile summaries in Appendix A to develop a practical plan of action to address potential impacts for the best long term outcome.

C. Limits for Implementation

The City maintains a "right of way" (ROW) across the length of the canal that is roughly 10 feet to either side of the canal centerline. The scope of the assessment and recommendations made by SBS extends well beyond this corridor and is presented as an ecological context to help mitigate impacts from piping construction. Beyond the range of the City's ROW, landowners will decide what is appropriate for their landscapes according to their unique circumstances. The City may provide landowners with cautions of certain risks at potential tree loses due to piping the canal as outlined in this document as well as pointing out where noxious weeds pose risks of advancement following construction activities; however, landowners are ultimately responsible for the decision whether to proceed with the outlined mitigation methods or not, and hence, the long-term impacts to their landscapes of construction activities.

II. Methods: Identifying Potential Impacts

Our team surveyed the entire project area in July, 2018, by walking the path along the open canal and the general route above the buried pipe sections throughout its length. The project was divided into one-tenth mile segments to better organize our analysis into distinct sections, and to more clearly discuss and present individual issues and impacts. Our process was to observe and describe the overall composition and ecological character of the forest mosaic in each segment, and to identify and map areas of concern where the construction process could significantly impact the landscape, either by harming mature specimen trees, affecting the quality of the forest, or by altering the hydrology of an area and rendering it unsuitable for the current suite of species on site. We also evaluated and analyzed the existing use of the project area by wildlife, relative to the forested habitat outside of the project canal corridor. And finally, we mapped noxious weed sites along the corridor. Where practical, we made recommendations to address the related risks identified with the project.

We focused our attention on the construction corridor surrounding the present irrigation canal and buried pipeline (see Figures 1A and 1B for a visual of the current irrigation sleeve across the project length). For construction related effects, we consulted with Dan Scalas of Adkins Engineering for an overview of the construction process. We evaluated landscape wide impacts downslope to 60’ from the centerline of the current canal for considerations from changing hydrology due to piping.

Following the on-site evaluation, we provided the City with summary documents including segment profile summaries (Appendix A); a summary table of AOC’s that lists areas of concerns, including potential risks relating to the construction process, and areas identified at risk due to these hydrologic changes (Appendix B), and a summary table of noxious weed sites (Appendix C).

III. Ecological Overview

Southern Oregon is one of the most diverse ecosystems in the country, with a complex relationship between interacting influences that varies considerably over relatively short distances. There have been ecological studies of the wildland/ urban interface and greater Ashland Creek watershed to support the various projects and master planning the City has used to guide its stewardship efforts including Ashland Forest Resiliency Stewardship Project (AFRSP) studies and City of Ashland studies (City of Ashland, (AFRSP). SBS has provided a generalized background of ecological influences worth considering during the piping process. Our goal is to provide enough information to address the expected impacts from this piping project. Because this project occurs along the urban- wildland interface, it includes both native landscapes and residential plantings. Our ecological overview aims at addressing the wildland portions because they depend on a cohesive relationship within the larger environment. The residential landscapes interact with the wild landscapes and will certainly be impacted by the construction activities of installing a buried pipeline.

Figure 1: Map of west half of the Ashland Canal

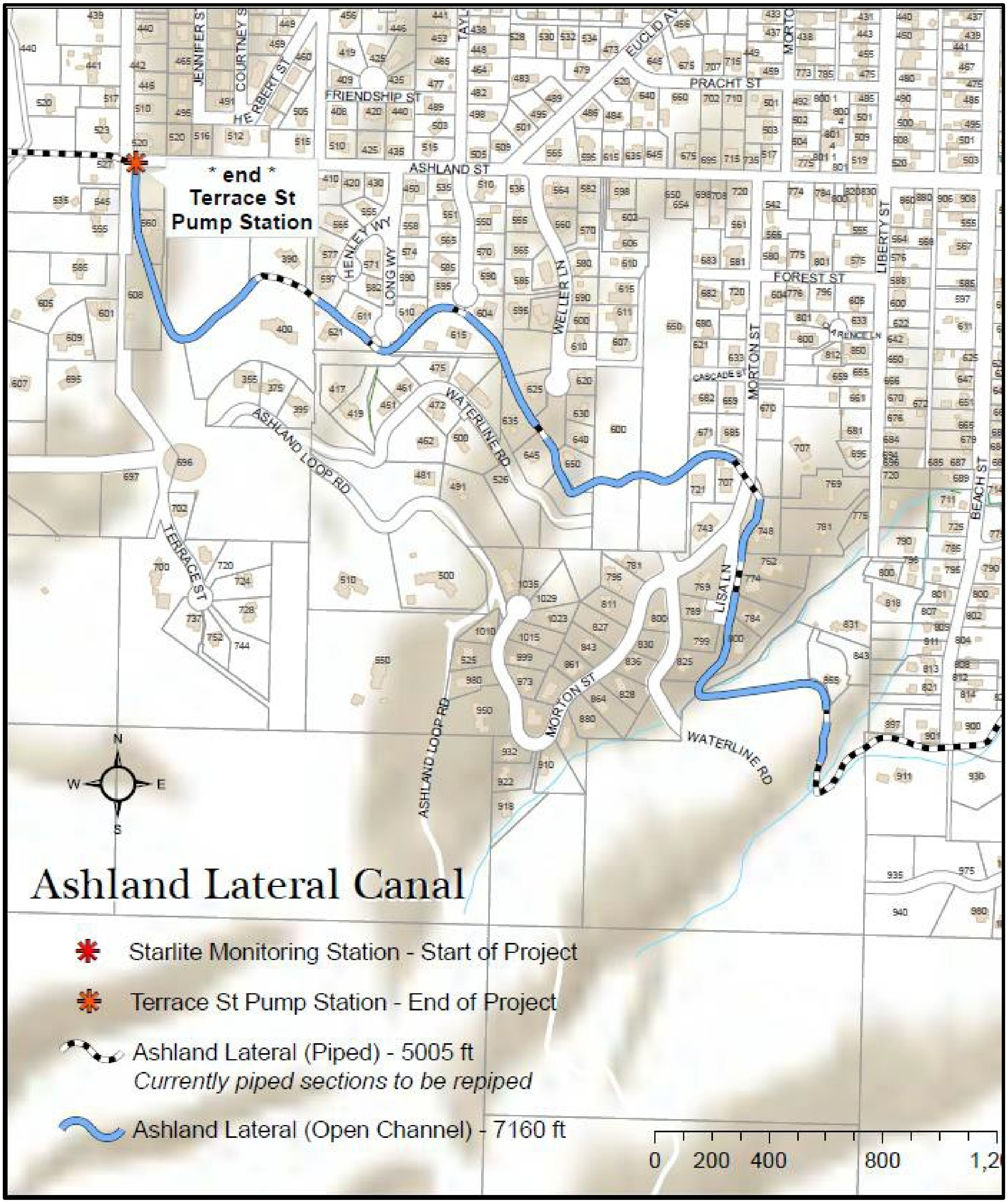
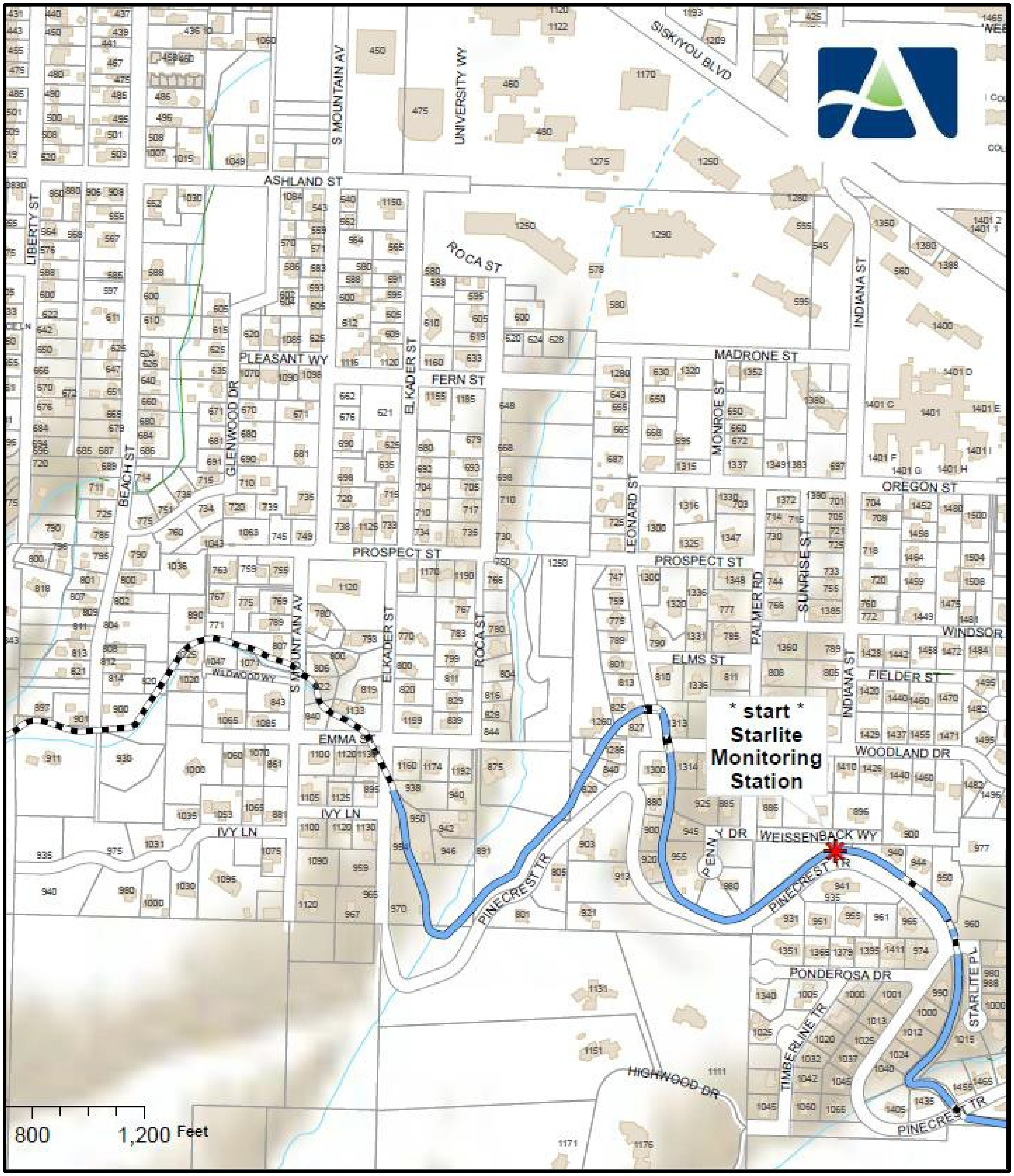


Figure 2: Map of east half of the Ashland Canal



A. Forest Ecosystem Implications of Water Inputs from the Canal

Ecologists attempt to quantify inputs into a system; however, the water inputs from the canal are difficult to track and measure. In some ways, the canal functions like a riparian corridor running through a dry, mixed conifer/ hardwood grassland. The added water has pushed the balance in a narrow band surrounding the canal towards a more coastal complexion characteristic of forests to the west such as Grants Pass, Williams, and the Illinois Valley. However, those areas also have milder winters conducive to some species not found in the Ashland area so the influences from the Ashland Canal are more subtle to observe and describe. The more obvious influences of water inputs include the foliage lushness of the larger Douglas firs and their much larger sizes compared with upland sites. Generally, the wildland slopes above Ashland are able to support younger Douglas firs to about 16” diameter at breast height (DBH) before the extensive foliage needs of summer water cause weakening and decline (Atzet, 1999; Main, 2018). There are many large Douglas firs adjacent to the canal approaching 3 foot DBH, and looking healthy. These trees are receiving augmentation from the canal to perform so well, and will certainly be impacted when the water becomes piped without an alternate source of water, or strategies to mitigate water loss.

What is notably absent along and below the canal are typical riparian species such as rushes, sedges, horsetails, and willows. We catalogued four willows on the entire stretch of the canal. This indicates that seepage moves quickly below the top 12”-24” of soil and remains below that surface layer across the extent of the canal corridor we surveyed.

The added surface water allows land creatures to stay on site through the summer without having to travel great distances each day to replenish water. It also attracts animals that would normally avoid close proximity to people, especially predators, seeking abundant food and water.

B. Forest Setting

The canal occurs along contour, on middle to lower north facing slopes, with aspects ranging from east to west. The north and northeast slopes are typically the coolest due to reduced solar exposure, while the more westerly aspects are generally hottest from increased solar absorption. In addition, the terrain is hilly, with a succession of convex ridges and concave draws across the project. Those slope undulations influence the available ground moisture during the rainy runoff period. As water moves downslope, it aggregates and saturates in draws while moving away from ridges. This seasonal hydrologic pattern extends available groundwater in draws, helping to maintain a denser plant community of more riparian species with a longer growing season. Convex slopes tend to be drier and are inhabited by species better adapted to xeric conditions with less available ground water and shorter growing seasons.

In a very broad depiction, the classified forest type through this area is a Douglas fir-mixed pine forest (sugar and ponderosa pine) with native fescue bunchgrass ground cover (USDA, Soil Conservation Service, 1993). That means under circumstances without dramatic impacts such as catastrophic fires or major landscape altering human activities, this is the type of forest that would be most prevalent through the area. Mixed oaks (Oregon white oak and California black oak) and pacific madrones form a common hardwood component intermingled with conifers. A mix of shrub species are members of this plant community including: snowberry, tall Oregon grape, poison oak, and baldhip rose to name the most common. Several species of native bunchgrasses are common, with a diverse mix of wildflower species and annuals intermingled.

C. Residential Landscapes

Because this area occurs along the urban interface, residential plantings form a significant portion of the landscape. These vary from drought tolerant native plantings altered very little from the existing vegetation that blend well with adjacent wildlands to lush, exotic plantings forming dramatic landscape textures that make residential landscapes so unique. Generally speaking, non-native residential landscapes that rely on irrigation water for surviving through the summers are less susceptible to long term affects from piping the canal. Construction impacts can have a significant role on larger trees near the canal if their extensive root systems get compromised during excavation.

D. Ecological Background of the resident tree species

There is a moderate diversity of native conifer and hardwood species in the wildlands and a broad mix of non-native species within the private ownership landscapes. For the purposes here, we only address native species on non-irrigated landscapes.

1. Conifers

The large sizes of the conifers are an indication there is subsurface water reaching most of them. This can be inferred by looking upslope 50 feet or more above the canal for a comparison of what would occur naturally on the landscape without the canal. Although there are moderately sized conifers upslope of the canal, and most of these ponderosa pines, few reach even close to the large sizes common along the canal.

Douglas fir (*Pseudotsuga menziesii*) is a primary species along the canal corridor with many specimens attaining diameters at breast height[1] (DBH) sizes around 3 feet across. Although trees that large are common throughout their range, those tree sizes are exceptional within the drier southern Oregon landscapes. More common are Douglas firs reaching DBH sizes of 1-2 feet; at which time they begin to decline. Not only do Douglas firs have water requirements during the spring when new growth is happening, they also have summer water requirements when rainfall is low. The younger, smaller trees with modest sized crowns have water requirements that can more easily be met by the seasonal water absorbed from the soil around their driplines. Trees adjacent to creeks, positioned in a draw that accumulates water late into the season, or in areas of a high water table from other sources can continue thriving even as it becomes mature. Larger Douglas firs show drought stress by weakened or dead tops and the ends of branches as well as generalized thinning of foliage and poor seasonal growth. If lack of adequate summer water continues for several years, the weakened tree becomes susceptible to insects and pathogens and eventually dies. Douglas firs require canopy openings to thrive and space around them without substantial competition for resources, so although young trees will grow as stands, few trees reach maturity without room above and around them due to competition pressures for limited resources. Heavy seed crops occur about every 7 years on average and provide nutritious food for many small mammals and birds as well as generating seedlings to fill in areas opened up by disturbance.

Ponderosa pine (*Pinus* ponderosa) is another primary conifer. It is represented by specimens of considerable size across this study area with many 3 foot DBH trees. It is well adapted to Southern Oregon dry summers having low water requirements following spring growth by going dormant for extended dry

[1] We use the standard forestry tree measurement of DBH.

periods during the summer. It can also capitalize on abundant water, putting on impressive growth. There are large specimen trees a short distance above the canal; however, their greatest abundance is observed below the canal, often at significant distances. Although the scope of our analysis stopped at about 60 feet below the canal for practical purposes, we observed great specimens beyond this range and imagine water seepage from the canal is reaching many of them.

Sugar pine (*Pinus lambertiana*) is a minor component of the forests occurring along the canal. It is more noteworthy within the watershed and further upslope. The trees observed are of all below 24 inch DBH indicating their more recent occurrence within this corridor, possibly because they were the first trees targeted for harvesting by woodworkers and are only recently regenerating where so accessible. They are an adaptable species capable of growing within a fairly shaded canopy, albeit rather slowly, until disturbance creates enough opening to trigger more substantial growth. They typically prefer deeper, moderately rich soil on upper slope aspects, and can tolerate limited moisture similar to a ponderosa pine. They also can thrive on more exposed rocky promontories with little competition.

Incense cedar (*Calocedrus decurrens*) is another minor component of the forest; although it is highly adaptable once established. Incense cedars can withstand very dry sites, occasionally being confused for a western juniper, and can grow with its root system in a creek tolerating inundation throughout the year. Once established, cedars do well increasing their numbers, and are tenacious survivors.

A practical question then is which of these trees are most susceptible to impacts. We make suggestions in the subsequent chapter on Recommendations. All of the older trees with sizes above 30 inches DBH can be expected to exhibit stress responses if they have been receiving summer water that gets cut off, regardless of how far below the ditch they are. We observed large trees 20 feet above the canal with roots penetrating the canal liner that will also exhibit water stress following piping.

2. Hardwoods

The hardwoods form a significant component of the landscape and are often the oldest trees on a site, although not the largest. This area has a particularly healthy composition of specimen hardwoods well distributed across the project area. Each species contribute unique qualities to an incredibly strong ecological web across the forest structure by increasing biodiversity and interdependence.

Pacific madrone (*Arbutus menziesii*) is a versatile species able to grow in substantial shade or the open, so is most consistent across the landscape. Some trees occur as multi-trunked groups where earlier fires caused the “parent” trunk to die and root sprouts have formed into new trees. Although madrones are very common in the Ashland woods, they become less common north, south, and east of our area.

California black oaks (*Quercus* kelloggii) form a co dominant species with many specimen trees of great age common over much of the project. They attain their greatest size on moderate slopes with open canopies above them and do poorly when crowded by encroaching conifers.

Oregon white oaks (*Quercus* garryana) are also common, becoming prominent on convex slopes, being more adapted to dry conditions. They are more common across the valley on the exposed slopes of Grizzly Peak. The wildlife value of both oak species includes their nutrient rich acorns and habitat they provide for a whole host of animal life. Oaks are recognized as keystone species throughout temperate

North America as biodiversity increases with increasing presence and age of oaks (Fralish, 2004).

Bigleaf maples (*Acer macrophyllum*) are common within the draws and moist concave slopes, forming groves with occasional specimen trees. They provide dense shade maintaining cool and moist conditions so essential for species that thrive in riparian areas. Bigleaf maples are also well adapted to Southern Oregon's dry summers.

Pacific dogwoods (*Cornus nuttallii*) occur as scattered understory trees in the shady and cool, mature forest sections. They also produce a nutritious fruit sought after by wildlife in the fall. **Whiteleaf alders** (*Alnus rhombifolia*) and **black cottonwoods** (*Populus trichocarpa*) are found where perennial groundwater is continuously available such as along Roca Creek. Several native and non-native fruit seedlings occur in the area including: elderberry, cherry, apple, plum, hawthorn, and pear. These originate from animal droppings and develop into understory trees throughout the project area, primarily in shady forested areas. They provide additional wildlife food.

3. Shrubs and herbs

The shrub layer is highly diverse and contributes significantly to wildlife habitat through forage and shelter. It varies significantly across the landscape, attaining its greatest biomass and diversity in moist areas, and becoming largely replaced by grasses in drier areas. The forb layer is composed of generally three types of herbs with composition percentages that can be a metric for assessing forest health:

- ***Deep rooted perennial bunchgrasses-*** These are well adapted to southern Oregon ecosystems that include fire, long periods without rain, symbiotic fungal relationships with native oaks, and which provide multiple benefits to wildlife and the ecosystem. They are considered a sign of a healthy oak savanna within the larger ecosystem because overgrazing can eliminate them.
- ***Perennial rhizomatous or bulbous herbs-*** They contain starchy roots adapted to fire, months without water, and significant animal browse. They provide much of the nectar for a healthy pollinator component. These plants occupy much of the space between clumps of bunchgrasses.
- ***Native and nonnative annual grasses and herbs-*** They adapt to variable weather patterns and high disturbance through short reproductive cycles that synchronize with available water and optimal growing temperatures. These tend to be weedy opportunists that capitalize on disturbance to quickly become established across the available area. They have short growing seasons compared with perennials due to their shallow roots and orientation to reproduction rather than longevity. They can help prevent soil erosion and provide diversity and productivity to a site when prevented from taking over by a healthy perennial layer.

E. Soils:

The US Department of Agriculture, Soil Conservation Service's soil survey of Jackson County lists the dominant soil across the project area as Shefflein loam (USDA, Soil Conservation Service, 1993). It is described as deep and well drained, derived from granite, with an effective rooting depth of up to around 5 feet. The permeability is moderately slow with a medium to high hazard of erosion, especially during excessive runoff periods. Caution is advised when excavating to revegetate as quickly as possible to prevent erosion. Activities should be quickly followed by both seeding and mulching to further minimize erosion potential.

One challenge with Shefflein loam during landscape restoration involves the rapid drying out of the soil surface layers as well as their increased temperatures due to exposure. Maintaining an overstory of trees to shade the surface and mulching around new plantings to preserve moisture during summer can dramatically increase their survival. The presence of undesirable plants can also limit revegetation efforts without adequate site preparation to remove competing vegetation.

F. Wildfire Resilience

Fire plays a significant role in our ecosystem, having contributed to the selection of appropriate species for each ecosystem in the West through millennia. Fortunately for this community, the City has taken a very proactive approach in facing wildfire risks of the wildlands surrounding the community, having dramatically reduced the risks to the watershed through phased fuel treatments. With fires slightly more prone to occur on private lands through human causes and lightning caused fires significant in wildlands, this project on the wildland/ urban interface is a priority for fire risk reduction.

Although young conifers are susceptible to fires, older trees with thick bark are much more resilient. Periodic low intensity fires naturally thin younger conifers away from the big trees and can help maintain a more open, parklike setting. Healthy trees are much less combustible that standing dead or dying trees so maintaining healthy forests can be part of a fire safe strategy. Common to hardwoods is the ability to regrow following fires. Although the crown may be completely killed from a more intense fire, root sprouts emerge the following season and can send up large stalks from their generally intact root systems. This process can allow a wildfire to thin out competing smaller trees, preserving the larger ones and still maintain a hardwood component within the understory that provides food for wildlife (i.e. madrone berries and acorns). Following a wildfire, the lower canopy layers are typically charred to the ground including shrubs and herbs. This provides a fresh seed bed for regeneration of many forest species, some that won't germinate without fires, and maintains a healthy forest in many ways.

G. Wildlife Use Considerations

Many Ashland residents are familiar with and appreciate the many animals that live in our local forests and are associated with the irrigation canal. A detailed list of species that occur in the forests and along the canal is beyond the scope of this analysis. Groups of species clearly use the irrigation canal and/or surrounding forest; these include song birds, owls and other raptors, small and large mammals, reptiles, amphibians, terrestrial invertebrates, fish and aquatic invertebrates. Wildlife may use the open canal and surrounding forest environment for shade, shelter, water, food, cover, foraging or hunting and reproduction. At first glance, the canal and immediate environment appear as a riparian zone: an open canal of water moving through a forested environment. Forested riparian areas, however, provide a unique and complex web of ecological features and functions distinct from the surrounding forest environment. The irrigation canal does not function as a riparian corridor; it lacks critical riparian features, and does not provide unique riparian functions.

1. Wildlife Use Evaluation for the Irrigation Canal

The irrigation canal corridor provides limited beneficial use to wildlife beyond what the adjacent non-riparian (i.e. non-canal) habitat provides. The flowing fresh water is currently used by larger mammals and birds during the spring-summer seasons. Beyond access to spring-summer water, however, the corridor provides minimal riparian function. Although riparian areas differ considerably in their structure and function from site to site, there are features common to riparian areas which are missing in the canal corridor. These include:

- ***Critical riparian edge habitat*** (i.e. the transitional habitat typically present at a stream/upland interface). Riparian edge habitats include a range of specialized vegetation adapted to growing within moist soil that provides habitats for a host of animal species. In contrast, the canal is steep-sided and concrete lined to provide undeterred water flow and is maintained free of obstructions. Aquatic vegetation is notably lacking, with soil and debris accumulation regularly removed. In addition, the water flow is consistent and relatively fast for its grade. Access to the water for small mammals and birds, amphibians and reptiles is limited and potentially perilous to some. The canal edge has a distinct boundary with dry grasses and annual species present instead of riparian ones.

- ***Foundational aquatic macroinvertebrates and their habitat***. Aquatic macroinvertebrates play an important role in stream ecology, including decomposition of debris by "shredders, collectors, and filter feeders." These creatures are in turn a food source for small invertebrates and form the basis of stream system food webs. The waters of the canal corridor are missing the carbon source (leaves and debris) that feed these creatures and the edge habitat that provides a home. Clearly the canal lacks basic foundational aquatic food, typical in riparian ecosystems.

- ***Unique riparian vegetation***. Vegetation at riparian zones typically includes a unique suite of plants, shrubs and trees distinct from the surrounding upland forest which provides shade and cover adjacent to water. Common riparian plants shrubs and trees in our local forest include horsetail, sedges, rushes, willows, dogwoods, alders, and maples. The streamside of forested creeks often includes dense herbaceous plants and a distinct litter layer; all missing along the canal. The vegetation along the canal is instead dominated by upland tree species that occur well outside the canal corridor including: pines, Douglas-fir, white and black oak, and madrone, as well as dry upland grasses and forbs.

- ***A distinct humid environment***. Riparian corridors often provide a moist, micro climate distinct from the surrounding forest based on humidity and reduced temperatures in the summer and less temperature extremes in winter months. The humid environment extends as a gradient of soil moisture decreasingly outward from the source (e.g. a creek). The riparian humid environment includes the presence of water (and evapo-transpiration), shade from associated vegetation, and an interface between the waterway and the geologic/biologic components (i.e. soil). The canal corridor does provide a more humid environment than the surrounding forest. The area directly along the corridor is likely to see relatively reduced air temperature and increased relative humidity during summer months. Missing, however, is an increase in the creek-side (i.e. canal side) soil moisture that benefits small mammals, reptiles, amphibians, and terrestrial invertebrates. The concrete lined canal limits the ecological interface between the water flow and surrounding soil. Subsurface movement of water from the channel into the groundwater aquifer beneath is only determined by breaches in the concrete-lined waterway rather than evenly distributed along the canal.

- ***Heterogeneity of habitat***. Riparian areas are characterized by a range of habitats that vary along a stream corridor. The range of habitats is often a function of aspect, slope, sediment, vegetation, and water depth, to name a few. The typically heterogeneous nature of riparian zones offers a variety of habitats for differing wildlife species and wildlife use. The canal corridor, in contrast, is characterized by a relatively homogenous habitat along a linear horizontal zone that is designed to be uniform to allow for better irrigation management.

The canal corridor lacks many characteristics and functions of a riparian zone. Our assumption is that wildlife species use the corridor *and* the forest habitat nearby in a similar fashion. If the corridor functioned more like a riparian area, we would expect to see a suite of riparian associated bird species. Instead, the same bird species are seen in the irrigation canal corridor as use the surrounding forest environments (robins, thrushes, dark-eyed juncos, chickadees, nuthatches, downy and hairy woodpeckers). Riparian-associated birds are infrequent along the canal primarily because insect rich sources and riparian cover, both critical riparian habitat features, are missing or underrepresented along the canal.

Large mammals and forest birds living in the areas adjacent to the canal use the canal opportunistically as a spring-summer water source. Since the canal doesn't run water from October through the end of March, the loss of the open water canal is expected to have a minimal effect on wildlife beyond a spring-summer water source. Furthermore, since project construction is designed to be completed during the "off season" when water is not running in the canal, wildlife will continue to orient towards natural runoff sources, despite the greater distances they will need to travel during the summer.

2. Canal Corridor and Wildlife Movement

A final question relating to wildlife use considers the function of wildlife movement along the canal channel and trail. Natural riparian areas are well known to serve as critical corridors for wildlife movement. Besides serving as dwelling habitat or a location for scarce drinking water, does the irrigation canal, like a natural riparian corridor, provide a connectivity function; one that allows resident wildlife species to move across the landscape, albeit horizontally in the case of the canal? Does the irrigation canal actually provide habitat connectivity through a larger geographic area or even within the corridor?

To tease out the role of the irrigation canal for wildlife movement, is to compare wildlife movement along the canal corridor with the surrounding forested habitat. Wildlife movement along riparian zones can be a critical piece of a species' ability to maintain healthy populations. A study of the wildlife movement along the canal and greater environment is beyond the scope of this analysis. However, because the canal corridor lacks authentic riparian features, it is reasonable to assume that it also does not function as a unique *riparian* corridor for wildlife movement. Wildlife is likely to use the trail to travel through the forest, and that trail corridor will continue to exist after project construction.

H. Noxious Weed Considerations

1. Overview

Noxious weed and invasive plant control and management along the Ashland canal is an important concern to address within the scope of this project. As opportunists, weeds proliferate in areas of disturbance. Their dispersal in response to construction and earth movement can occur through different modalities such as; seed transference on boots, clothing, tools and vehicles or vegetative reproduction through root disturbance caused by machinery. Plans need to be in place in advance of construction to decrease the likelihood of their spread.

Noxious weeds are currently an integrated part of the canal landscapes on both native and cultivated lands. Our team mapped the occurrence of noxious weeds along the project based on the Oregon list of noxious weed species and noted that the primary weeds of concern are **scotch broom** (*Cytisus scoparius*), **English ivy** (*Hedera helix*), and **Himalayan blackberry** (*Rubus armeniacus*). All three species are present in substantial quantities and are adept at fully occupying a site to the exclusion of native plants.

Yellow Starthistle (*Centaurea solstitialis*) is also a weed species of concern, but was only located as two small patches in one small segment of the canal corridor. Since it prefers open, hot and dry habitat where it has an adaptive advantage, it is not considered a species of special concern within this well forested habitat.

Secondary weeds that were mapped include broad-leaved sweet pea (*Lathyrus latifolius*), Periwinkle or vinca, (*Vinca minor*), one-seeded hawthorne trees (*Crataegus monogyna*), and English holly (*Ilex aquifolium*). The last three species are often intentionally planted for their landscape value. Our team however focused on those sites of secondary weeds that have naturalized outside of homeowners' property onto or near the canal landscapes. A complete list of our findings is included in Appendix C.

2. A generalized noxious weed control plan

The City should formalize a noxious weed strategy prior to beginning construction on this project and designate a construction steward[2] to oversee its implementation through each phase of the project (i.e. rather than expecting equipment operators to self-police the cleaning and certifying of weed free equipment, for example). Following are standard practices implemented to control the spread of noxious weeds during landscape construction adjusted to fit the scope of the City's project.

a) Pre-Construction

- Treat invasive plants throughout the project area following the City's noxious weed protocols.
- Intensify treatments at staging areas and entrance areas of the project to mitigate initial spreading of noxious weeds.
- Provide educational material on identifying noxious weeds and native plant landscaping alternatives to land owners in conjunction with the other informational material provided on this project.

b) Construction

- Require all heavy equipment and the trucks/ trailers they are hauled in on to be thoroughly pressure cleaned of soil and debris prior to being brought onto site. This ensures that noxious weed seed and rhizomes will not be inadvertently spread to the City's project area.
- Ensure all soil brought in is weed free[3].

c) Post Construction

- Use weed free straw and material[4] for mulching areas covering as much of the exposed soil as practical.
- Provide vegetative restoration plantings using native species, especially grass and forb seeds.
- Include noxious weed monitoring as part of the follow up strategy, mapping occurrences so they can be quickly eradicated.

2 See reference in Chapter VII: Recommendations; B: Assigning Construction Stewards for the purpose of a construction steward.

3 This is important to certify that all material used to backfill around the pipe is weed free.

4 Important to used certified weed free straw if used during restoration activities for mulching a seedbed.

- Following construction and monitoring, return with hand crews to target areas of occurrence, repeating as often as necessary to achieve satisfactory results.

IV. Construction Related Concerns

We conferred with Dan Scalas of Adkins Engineering about the construction process to get an overview of how construction activities might impact the landscape surrounding the canal during piping and learned that the procedures will be determined by the construction contractor according to what is necessary to accomplish the goals. The task is to remove the current concrete liner using heavy equipment, run the piping along the canal bed, and backfill around the pipe to a final grade approximately where the current trail surface sits along the lower slope of the canal. With that process in mind, we categorized the primary impacts we imagined according to this process and made suggestions how to minimize those impacts. The suggestions that follow are standard implementation procedures used to avoid ecological damage.

A. Staging equipment and material on site during construction

In preparation for removal of the liner, setting pipe on the canal bed along the route, and backfilling to meet the final road grade level, equipment and material will need to be staged along the canal. Proper planning can make these operations run smoothly and minimize impacts to the landscape. We observed trees overhanging the canal that will impede this process and will get broken or destroyed during staging and should be removed. This job requires thorough planning of where to locate staging areas distributed strategically across the project area. They need to be wide enough to store material or equipment but far enough from resources to avoid damaging valuable landscape features and trees during periods of repeated use. Planning of staging areas should involve the construction steward to consult on safe and appropriate locations.

B. Soil compaction

The hazards of soil compaction within Shefflein loam are described in Chapter III: Ecological Overview, Section E, Soils. Prior to construction, the City should develop a plan that addresses this risk and the strategies to avoid it. Soil compaction is heightened during the wetter seasons when soil moisture is high, reducing soil permeability, and causing water to run off, rather than to percolate into the soil. There is substantial documentation on the hazards and undesirable effects of soil compaction as well as good resources listing strategies to avoid this issue.

C. Removal of the concrete canal liner

This operation has the greatest potential to harm a large number of specimen trees by destroying major roots. We observed exposed roots traversing alongside the liner at risk of injury during liner removal. We recommend using an adaptive approach that proceeds as planned where the liner can be removed with little damage to roots, but where the approach is adjusted if the threat of root damage becomes significant. Some portions of the liner may be left in place in areas with significant root presence, since the ecosystem has already reached a balance with it there. In areas with large cracks over much of the liner, it may actually provide additional protection to the roots of mature trees surrounding the canal. In other areas, the liner may be largely intact, with few breaches; hence, root systems will be less motivated to encircle the liner so removing it with an excavator/ thumb combination might produce minimal damage.

D. Construction related damage to trees or landscape features

Many specimen trees occur near enough to the canal that the construction work poses direct risks from mechanical damage. A certain amount of incidental contact to trees by machines is acceptable, but always undesirable. We suggest coordination between the construction steward and construction contractor to prevent excessive mechanical damage to trunks, branches, and roots. Erecting construction barriers that limit where equipment may drive is a useful practice to avoid damaging important trees and their roots. Using thick sheets of plywood and chipboard to prevent direct contact between metal excavation teeth and tree bark is another means to protect trees when an operation requires working very close to important landscape trees. An onsite construction steward will be able to assess the risks and provide practical and effective methods to protect the valuable landscape resources through the construction process. During surveys, our team identified "at risk" features which are described on the appropriate segment report where they occur and made suggestions how best to mitigate for them.

V. Anticipated Long Term Tree Risks associated with Reduced Soil Moisture and Microsite Humidity due to Piping of TID Water

We did not conduct any soil studies to determine natural hydrologic migration on these slopes. It is important to note that granitic soil percolates water very well, when not compacted or otherwise altered to become hydrophobic. We saw no evidence of direct canal leakage downslope despite the obvious and innumerable breaches in the canal liner through its length. We concluded the leaking water moves quickly into lower soil strata, in fact so quickly that it didn't produce an abundance of riparian species normally associated with wet areas. We only observed a handful of willows growing along the whole project length. This canal zone is not a typical riparian area. We don't actually know how deeply the leaking water penetrates and to what extent it migrates downslope along the 5 foot deep rooting layer, if at all.
The water may quickly penetrate straight through the rooting zone, only providing summer water to trees that encircle the canal liner. The water may continue downward until it reaches a less porous layer of non-decomposed granite 20 feet deep and then follow that less permeable layer horizontally. If the leaking canal water does move quickly through the soil horizons, impacts to the forest stand from piping may be minor.

A. Generalized overview of how trees fair with sudden environmental changes

Trees have life phases that correspond with age and size. Although there is incredible variation between species, they tend to be most vulnerable both early and later in their lives, while the middle period is characterized by fairly sustained vigor. A tree is in its prime from roughly 15 years through 80, varying greatly between species and site conditions. While younger trees can tolerate a substantial amount of excavating near their driplines, older trees often weaken or die with smaller amounts. The same is true for changes in the water table, available sunlight, nutrients, competition, disease, and mechanical damage. The upper crown of a tree corresponds with its root system, so what happens below will affect what grows above.

There is no sure way to predict how much deficit a tree can endure before it succumbs, especially with gradual change, but sudden and dramatic change like the piping of the canal will produce both sudden and drawn out effects. Older trees may live for decades in a state of decline, while younger trees often die suddenly without showing obvious signs of stress.

B. Expected Impacts to the Tree Canopy from Construction and

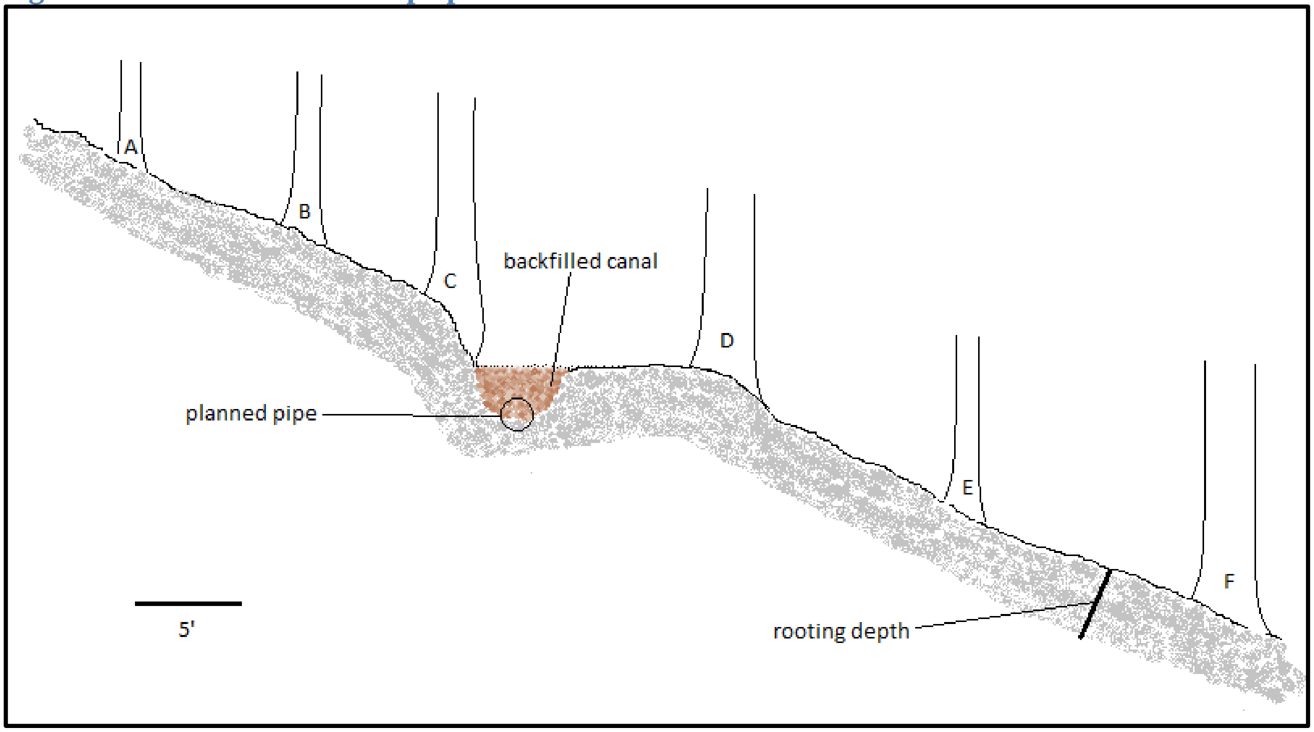
Changes in the Water Regime

The canal has been in place so long that tree roots from the adjacent forest have completely permeated the moist zone surrounding the canal. Larger trees roots have contributed to the failing of the liner and probably surround the liner in most areas. Water is the greatest limiting factor for most trees living in southern Oregon, so access to a reliable summer water source has been maximized by the forest trees, extending their growth and size over decades. The larger trees won't be able to adjust to a sudden change of water, particularly because their crowns are so much larger than they would be on a comparable dry site and their root systems won't have access to enough water to keep all that foliage green and healthy through summer. Even without construction related root damage, the larger trees tapped into summer ground water will experience a form of moisture crisis the first summer season following piping, as soon as ground water gets used up. Smaller trees will also experience a less dramatic moisture crisis, but with reduced demands, they may adapt easier.

The largest trees, close to and just below the canal will probably experience this moisture crisis severely because most of their root systems are tapped into this augmented water, but large trees perched just above the canal with most of their roots enveloping the canal will undergo similar crises. Further downslope, the larger trees will also experience moisture stress, but additional variables may influence the impacts. For instance, when a dense system of roots from several trees occupies the effective rooting area upslope and towards the canal from a tree in question, less water will be available to migrate all the way down to our tree in question, being drawn up and utilized upslope by the other trees. This means the lower sloped tree should actually be better adjusted to water being cut off than the trees upslope of it. The least affected trees will be those above the canal beyond rooting access to canal water. See Figure 2 below for a visual representation of the landscape profile surrounding the canal and Table 1 for a scale of expected impacts to trees based on various slope positions. This representation is meant as a conceptual aid to provide a means of anticipating outcomes and for planning remediation. Substantial variation will occur based on individual tree resilience, actual rooting profiles, extent of long term canal leakage in any given site, future weather patterns, construction activities, if the slope in question is near a draw or a ridge[5], and other environmental influences.

5 which influences seasonal water accumulation or loss based on hydrologic patterns of runoff on slopes

Figure 3: Trees on various slope positions relative to canal



Explanation of Figure 2:
For practical reasons, only Douglas fir and Ponderosa pine are evaluated among the conifers despite incense cedars and sugar pines also being present. The two later species should be preserved where practical, to maintain biodiversity unless they appear weak or diseased. In addition, black oaks, white oaks, and madrones are considered interchangeably regarding slope location impacts and are all grouped under the heading of "oaks". Bigleaf maples, cottonwoods, alders, dogwoods, and wild fruit tree seedlings are not included, though they are all present within the wildland portion of the landscape. They occur in small numbers, adding to biodiversity including providing wildlife food. Many occur as shorter lived transients within the project area with some only reaching mature stature along Roca Creek and similar riparian areas.

Table 1: Piping impact severities for tree locations on slope (related to Figure 3 above)

Slope Position	Distance (feet)	Upslope/ Downslope	Species	DBH (inches)	Piping RISK	Constr. Risk
A	20+	Upslope	D. fir	<18	0	0
				18+	1	0
			pine	<18	0	0
				18 +	1	0
			oaks	all	0	0
			D. fir	<12	0	0
				12 to <18	3	0
				18 to 30	4	1
				30+	4	1
				<12	0-1	0

B	10-20	Upslope	pine	12 to <18	2	0
				18 to 30	3	1
				30+	4	1
			oaks	<10	0	0
				10 to <18	1	0
				18+	2	1
C	<10	Upslope	D. fir	<12	1-2	0
				12 to <18	3	0
				18 to 30	4	1
				30+	4	1
			pine	<12	0-1	0
				12 to <18	2	0
				18 to 30	3	1
				30+	4	1
			oaks	<10	0	0
				10 to <18	1	0
				18+	2	1
D	<20	Downslope	D. fir	<12	1-3	1-5
				12 to <18	3-5	3-5
				18 to 30	4	3-5
				30+	4	3-5
			pine	<12	0-2	1-5
				12 to <18	1-3	3-5
				18 to 30	3-4	3-5
				30+	3-4	3-5
			oaks	<10	0-2	1-5
				10 to <18	1-3	3-5
				18+	3-4	3-5
E	20-35	Downslope	D. fir	<12	1	0
				12 to <18	2	0
				18 to 30	3	0
				30+	3	0
			pine	<12	0	0
				12 to <18	1	0
				18 to 30	2	0
				30+	3	0
			oaks	<10	0	0
				10 to <18	1	0
				18+	2	0
			D. fir	<12	0	0
				12 to <18	1	0
				18 to 30	2	0

F	>35	Downslope		30+	3	0
			pine	<12	0	0
				12 to <18	0-1	0
				18 to 30	2	0
				30+	2	0
			oaks	<10	0	0
				10 to <18	0	0
				18+	1	0

Table 1 Legend: Impact Severity Scale for Piping and Construction Risks

Impact Severity Scale Descriptions	Value
Expect no long term impact from piping	0
May show minor impacts but should recover	1
Expect impacts; may require mitigation treatments to sustain health	2
Expect impacts; may or may not die. Employ mitigation	3
Will probably decline and die over time, even with mitigation	4
Will probably die within first season	5

Position “A” trees 20 feet upslope from the canal centerline and beyond:

Most trees of all species and DBH’s should fare well through construction and piping in this position upslope of the canal. These trees became established without canal water influences and should be far enough upslope to have limited access to canal water, except where a few long reaching roots may have entered the canal moisture zone over time. The overall affects due to piping should be nominal and these trees are beyond the range that construction impacts will affect them. Impact severity ratings should be 0 for most species except the larger conifers where it is 1 (See Table 2 above for severity descriptions).

Position “B” trees 10-20 feet upslope from the canal:

Trees represented in position “B” are between 10 and 20 feet upslope from the canal centerline. Generally, the oaks and madrones of all sizes, pines up to 18” DBH, and Douglas firs below 12” DBH should tolerate piping with an impact severity rating of 0-2. Some roots may be impacted from construction at this location. Pines above 18”-30” DBH and Douglas firs between 12”-18” DBH will be impacted at a level of 3. Both groups will be impacted at level 4 above these sizes, especially close to 10 feet above the canal.

Position “C” trees 5-10 feet upslope from the canal centerline:

Trees represented in position “C” are perched on the cutslope above the canal and generally have substantial rooting within the canal footprint. As such we expect they will be impacted both by construction and the change in hydrology from piping. Generally, the younger hardwoods may tolerate this disruption without substantial stress with severity impact ranging from 1-3. Large hardwoods above 18” and conifers between 12”-18” are expected to be impacted with a severity ranging from 3-5. Larger conifers above this size, perched on the upper lip of the canal are likely to die fairly quickly and are good candidates for pre-construction removal. Exceptions should be made when evaluating each tree in this position since microsite conditions bear heavily in outcome, as do other aspects like tree vigor and species.

Position "D" trees below the canal to 20':

Trees represented in position "D" are typically below the trail and may extend downslope to 20 feet from the canal centerline. This is a particularly complex situation to evaluate because substantial leakage is probably occurring over most of the project length through this zone. If leakage was the only variable to evaluate, impact severity determination would be based strictly on tree species (D. fir, pine, and oak groups). We are treating trees in this position as if they were receiving supplemental water from the ditch because they are close enough that given enough time, their roots would seek out summer moisture and orient to the moisture more over time. Even if the liner has limited leakage, the specimen trees in this position will have found those leaks and are tapping into it. Direct construction impacts will vary greatly with site conditions and proximity but indirect impacts should be severe due primarily to root damage associated with the liner. Generally, the younger to medium aged hardwoods may tolerate this disruption without substantial stress. All large trees of each tree-type group are expected to be seriously impacted in this position to similar severities; however, the long term potential for recovery is best in the hardwoods and pines because ultimately they are the best suited trees for most locations across the project area. Larger Douglas firs are likely to die fairly quickly and are good candidates for pre-construction removal. Exceptions should be made when evaluating each tree in this position since microsite conditions bear heavily in outcome, as do other aspects like tree vigor and species.

Position "E" trees below the canal from 20'-35':

All trees in this position may recover from piping of the canal. They are also likely to be receiving supplemental groundwater during the summer. To what extent that may be happening can best be inferred based on foliage density and yearly growth indications (this is easy to evaluate with many conifers due to their yearly whorl arrangement of branches and terminal leader growth which can be visually estimated if the top of the tree is clearly visible). Trees that are showing exceptional growth, especially large Douglas firs that in normal circumstance should be mostly in a holding pattern due to their maximized crown sizes need to be evaluated as at more risk. The large pines, madrones, and oaks in this position are ideally suited for preservation by the landowners, compared with any excessively vigorous specimen Douglas firs sharing the same sites. All the trees in this position have low risk to construction damage. Generally, this is a favorable position for the healthiest specimen trees to be located along the canal for this project. They are far enough from the canal to be safe from construction impacts, near enough to provide valuable shade covering for trail users and aesthetic benefits of large trees, and have the greatest likelihood of surviving piping impacts.

Position "F" trees below the canal beyond 35':

Groundwater may be leaking well into this zone and can potentially be inferred as described above; through excessively vigorous growth. Where it does permeate this zone, it could impact the larger trees, especially the larger Douglas firs and ponderosa pines, since mature trees don't readily adjust to abrupt environmental changes. Through most of this zone, impacts will be mitigated by the large distance from the canal.

C. Areas of Concern (AOC)

We approached the identification of AOC in two ways: the first considered the broader landscape to determine thematic impacts that would occur repeatedly across the landscape during both construction and piping influences. These we identified and described through the body of this report. Because the many convening influences complicate the potential impacts, we endeavored to address them by presenting an appropriate context to consider their occurrence and treatment.

During segment surveys we also pinpointed specific areas at risk and itemized those within each segment profile (see Chapter VI below and Appendix B). Some of these were identified because they represented trees or features prone to impacts common across the landscape and others were identified because of significant or unique considerations. Where meaningful, we include a photo alongside the noted concern in the segment profile and suggested appropriate mitigation measures.

VI. Canal Segment Profile Summaries

Our team divided the approximate 2.4 mile linear canal project into 24 tenth mile segments to organize results in a systematic and practical fashion. A summary for each of the 24 segments is provided in Appendix A. Each segment summary describes the segment location, habitat, areas of concerns, noxious weeds present, and a list of recommendations. Photographs of the start and end each of each segment are included, as are photographs of notable issues and areas of concern along the canal corridor. A map of segment locations is included with Appendix A.

VII. Recommendations: Practical Steps to Minimize Adverse Impacts from the Piping Process

A. Use an adaptive approach

This project involves such a broad set of conditions, difficult to quantify variables (e.g. how much water is actually leaking from the canal and where, or what will the rainfall be in 2020?), and significant uncertainty working with living organisms such that no one technique will work well across the entire project. Instead, the managers should plan to adapt techniques to suit the circumstances from a toolbox of options. SBS recommends using an adaptive approach to meet this complexity effectively. The primary steps with an adaptive approach include: design (planning the approach formula), implementation (customized procedures to fit the design), monitoring (observe the impacts, results, and effects), evaluate (compare the outcomes with expectations and needs, discussing the pros and cons with the team), adjust (modify the procedure to improve the results), assess (keep noticing how the results change with a modified design).

B. Assign a construction steward to oversee the project

From the construction planning through its completion, a construction steward can provide guidance to avoid unnecessary impacts and can help streamline the process by identifying issues and having them remedied as soon as possible. This position may involve one or more people trained as an arborist, in forestry, and in landscape restoration. In addition, they should have a thorough understanding of project implementation and have good communication skills to interface effectively and respectfully with construction workers as well as land owners in construction areas. The construction steward must be able to oversee current construction operations, while also looking ahead at future staging areas efficiently to avoid imposing unnecessary construction slowdowns on the equipment operators, or relations will begin to suffer. For this reason, the construction steward may require an assistant.

Hazardous trees should be identified and removed prior to beginning the construction process. The steward can identify sensitive areas to avoid when staging material, and suggest where equipment can be driven or avoided. The construction steward can also determine when construction conditions are likely to cause excessive damage to the soil, setting up erosion events, increasing incidental damage to tree roots, or compacting overly saturated soil into an impermeable pan that will repel water and destroy its friability.

Maybe most important is to oversee the actual excavation and backfilling process to encourage optimum tree care is taken for all the specimen trees adjacent to the construction corridor. Because so many specimen trees occur within the canal footprint or have substantial roots engaged with the liner, significant root damage is apt to occur during the process so an expert arborist capable of evaluating the impacts to those trees during construction can make the judgement call to remove severely impacted trees, rather than proceed through all the stages of construction, only to have those damaged trees die during the first summer, creating greater hazards to the finished landscape as they are removed.

A construction steward will also oversee the steps taken to prevent noxious weed spread by insuring existing infestations are adequately dealt with prior to beginning construction, verifying only cleaned equipment is brought on site and that adequate steps are taken not to introduce or spread noxious weeds during the grading and restoration steps taken in the final stages of the project.

C. Plan to remove specimen trees currently too close to the construction corridor to practically save

Because most of the large conifers close to the canal won’t survive the construction process or be able to adapt quickly enough to the loss of such a substantial source of summer water, these trees should be removed prior to beginning construction to minimize costs, and to avoid higher potential damage to the recovering landscape if they are removed later as dying or dead trees. The City should consider removing any conifer of 24 inch DBH or greater within 10 feet of the canal centerline, above and below the canal. These dimensions are meant as guidelines and should be refined based on site conditions, the advice of the acting construction steward, other expert advice, and other compelling reasons. Exceptions should be made on a case by case basis to accommodate conditions where a specimen tree has decent potential of surviving long enough to warrant preservation. Black oaks, white oaks and madrones within this zone may also need to be removed to facilitate construction, but should be preserved where practical because they require less summer water, can tolerate greater swings in precipitation, have deeper roots than similar sized Douglas firs, and represent much older trees than conifers of the same girth. These selections should also be decided on a case by case basis.

D. Under exceptional circumstances, some specimen trees might be saved from construction impacts using specialized techniques

Under the supervision of the construction steward or a certified arborist, some valuable specimen trees might be saved from construction impacts by the use of an “air excavator” or pneumatic air spade. These, and tools like them, use compressed air injected into the soil by a specialized nozzle that removes soil without damaging non-porous objects like roots and utilities. The process is slower than using an excavator, but can avoid root damage. The application for this tool will be limited since piping the canal requires installing a pipe into a trench left by the removed canal liner, or by extracting the current pipe and both processes require an open trench, unobstructed by tree roots. Alternative techniques should also be investigated that can save specimen trees from excessive construction damage, particularly the large ponderosa pines, oaks, and madrones near the canal.

E. Avoid soil compaction and minimize equipment damage to the environment during construction

Except where required by the engineering specifications of the project, avoid soil compaction outside of the pipeline corridor, which can impact the health of the forest through soil destruction (Coder, 2000). Timing earth moving activities while the soil is dry is recommended to avoid compacting moist soil into a water impervious pan (USDA, Soil Conservation Service, 1993). Soil that becomes compacted loses natural voids and air spaces that allow gas exchange. It resists water penetration, becoming hydrophobic and diminishes natural microbial activity, becoming essentially "dead." Once soil has lost healthy structure, it is difficult to restore to its former, natural texture (Coder, 2000).

The construction steward should thoroughly plan out staging areas where equipment may drive and areas equipment must avoid, preventing excessive damage to the landscape. The construction steward and construction operations manager must have a clear understanding of construction conditions that constitute a "safety shutdown."

Some suggestions include:

- Construct highly visible barriers to prevent machinery damage to valuable trees and sensitive environments, especially during wet periods.
- Avoid heavy equipment traffic on site during excessively wet periods where soil erosion is unavoidable due to heavy runoff.
- Avoid equipment operations during periods of partially frozen soil on steep grades that create slippery slopes for equipment.
- Use rubber tracked equipment, where possible
- Deposit a thick layer of wood chips over areas that will sustain heavy equipment use to minimize the hazard of soil compaction

F. Following construction, implement forest health monitoring by a professional forester or arborist trained to recognize early signs of disease and stress in trees

Establish a budget and timetable for evaluations over a minimum period of 3 years following the completion of construction. We recommend beginning with 3 evaluations the 1st year (March 1, June 1, and Sept 1), followed by 2 evaluations subsequent years (March 1 and Sept 1) to identify tree and stand health issues. The City could provide this service along the length of the project to identify issues and implement quick responses, where appropriate. The City has well trained staff that can help identify pathogenic issues as they emerge. Because of the difficulty identifying where excessive leakage has been occurring from the ditch, areas undergoing moisture stress from an abrupt lack of summer water will exhibit various aspects of decline discernable by a trained arborist or forester. Based on the severity and extent, the arborist can prescribe remediation or removal as appropriate.

G. Mulch to conserve water and reduce moisture stress

Develop a plan and budget to provide mulch across areas where conserving soil moisture is important. Those areas include places with substantial forest canopies, valuable specimen trees, and areas with potential of erosion from exposed soil. The only areas that may not benefit from a layer of mulch are some of the native white oak-mountain mahogany-savannas above the ditch. Those areas appear stable and apt to be little affected by the piping of the canal so require no more attention than observation during follow up evaluations. Mulch is a proven technique to preserve moisture and may allow many of the trees cut off from canal water an alternate means of maintaining available soil moisture long enough to gradually adapt to the drier conditions of natural rainfall. This requires shifting from sustained crown growth into more of a crown maintenance orientation while the root system gradually expands its underground network to provide for a greater capacity.

We suggest the City use whatever mulch material is most advantageous and cost effective, such as wood chips; one 2”-3” application of chips may last long enough in the environment to be a complete treatment. The application should be applied over most of the lower slope below the canal wherever important landscape trees occur and as far downslope as 30 feet, or further when valuable trees are present. Mulching will provide the greatest benefit when covering an entire area rather than just applying it below the driplines of each tree, with extensive gaps between applications. Mulching is also excellent in reducing soil erosion, especially when applied on coarse granitic soils that become exposed through equipment use.

H. Thin to reduce competition

Competition is one of many forest dynamics at play, which comes into prominence during periods of reduced resources and disturbance. Mature, stable situations favor mutualism and symbiosis because interdependence creates a more resilient and biodiverse web over time, whereas competition functions best in short term bursts associated with disturbance. Because construction impacts and a sudden change in available water due to the piping project, competition will be favored in many areas and should be planned for. Rather than weakening a whole forest stand following a reduction in available summer water, certain trees and shrubs can be selected to keep or remove for the greatest benefit to the forest. By thinning a stand and reducing competition between trees, those chosen to remain will have greater access to the available water and resources on site, doing better. Stand thinning is an excellent tool for improving stand health where competition is occurring for limited resources and is an ideal choice through much of the forested areas within this project.

I. Provide for wildlife needs on the wildland/ urban interface

Our analysis did not produce evidence of special wildlife use of the project area compared with the surrounding forest habitat, beyond a dependable summer water resource. The canal isn’t accompanied with ponds, seeps or springs and wetland plants and invertebrates surrounding those areas, and therefore does not provide the unique habitat features and functions of a natural riparian environment. It is difficult to quantify how dependent wildlife is on the open canal as a seasonal water source without a comprehensive study. Generally speaking, by completing construction during the dry period of the canal so that drinking patterns are reliant on natural runoff in draws and creeks, the transition should be easier. Beyond the 20 foot ROW, the land is privately owned and therefore requires no special wildlife considerations. However, we have prepared suggestions for wildlife enhancements because wildlife do occur here and will be impacted by the construction process and some landowners may wish to consider their options.

1. Develop a wildlife enhancement plan to use on this project.

To address wildlife concerns related to piping the canal, we recommend that a construction steward or stewardship team develop a wildlife enhancement plan. The steward should review the appropriate pages in the 2016 Ashland Forest Plan and other city documents that address wildlife issues. We include a copy of the City’s **General Management Goals for Wildlife** taken from the 2016 Ashland Forest Plan (See Appendix D). This will provide the City with guidance of how best to comply with its own policies of enhancing wildlife through the construction process. The steward should also consider consulting with a wildlife specialist to discuss impacts from and mitigating for the loss of a 2 mile long open water source available from spring through summer each year. There may be practical methods to provide for temporary water sources strategically along the route for 1 or more years to supplement drinking water for animals, but we expect it would be challenging to do this without creating nuisance issues. Consider how difficult it has been to maintain reasonably clean and healthy pond environments in Lithia Park. Some level of increased wildlife activity within private landscaped properties is to be expected as wildlife respond to the loss of the open water. Communication with landowners about this risk along the project will also be important.

Due to the significant reduction in mature overstory trees this project proposes, as well as the large disturbance footprint involved in the construction process, wildlife impacts are to be expected for resident animals in the project vicinity. Therefore, the construction steward or team, in formalizing a wildlife enhancement plan, might include strategies to enhance wildlife on a limited or short term basis such as:

- Habitat for mammals, including young rearing areas, forage plantings, watering sources, and natural cover.
- Bird nesting habitat, including preserving native hardwoods, development of cavity nest sites, and native shrub plantings for forage and cover.
- Pollinator nectar and larval host sites, through plantings of appropriate native species. Several patches of showy milkweed were observed during surveys near the canal and path, which will be destroyed by construction activities.

2. Consider Creating Wildlife Trees where large trees are too close to the Construction Corridor to Effectively Save

There are an estimated 200-250 trees that will probably require removal prior to construction due to their likely demise following construction and piping. Among these, there may be five to ten good candidates for wildlife tree creation. Though a very minor component of the overall canopy that will get removed, they represent a portion of the wildlife habitat that will be removed or destroyed during the project construction and therefore, wildlife habitat restoration needs to be considered in conjunction with construction. Generating wildlife habitat trees requires a specialist to perform; otherwise, it is apt to not work effectively for wildlife and completely lack any sense of aesthetics. In fact, a poorly executed wildlife tree creation can look like "tree abuse" if not done properly. With this caution in mind, some of the specimen trees too close to the construction corridor to safely save might still qualify for saving as wildlife trees. Older Douglas firs, madrones, and oaks make excellent choices for wildlife trees because their roots are stable for years and the trees may continue to live for decades in a reduced crown state. Pines are generally not good choices for the opposite reason; their roots rot quickly once the tree is dead. The construction steward will take a primary role in selecting good wildlife tree candidates, with some of these criteria in mind:

- Does the tree already appear to be used by wildlife such as: having good branching for perching or nesting, contain obvious cavities, have multiple tops, include massive buildup of debris (nesting), or have broad and lengthy branching?
- Is the tree well positioning within the landscape so it won't create a hazard should it fall?

- Is the tree well-formed for wildlife use or have special character worth saving such that it may live for years with a reduced canopy following construction pruning?
- Can the wildlife tree creation be easily carried out, improving construction conditions for the operator, with minimal danger to the arborist, and pose minimal risk to the public (less risk than a normal healthy tree in the forest would)?
- Would the wildlife tree fit well with the finished landscape?

J. Trail softening techniques

Roads are designed with functionality in mind and require engineering specifications to be safe, functional and enduring. However, roads traversing through the woods can impact the aesthetic qualities of the natural environment for both wildlife and people. We recommend trail softening techniques that help to blend the maintenance road with the natural environment, while still providing for the important functions a road requires. Use road surfacing material that matches the native soil, where possible. Decomposed granite is naturally occurring through this area and provides a fairly ideal traction surface. Consider topdressing the road surface with decomposed granite rather than an offsite bedding material. Because this road follows the contours of multiple small ridges and draws, it will naturally curve and meander in a visually blending manner along the slope of the former canal course and should not require additional grading techniques.

Several low shrub species common along the canal course (e.g. Oregon grape, creeping snowberry) propagate through underground stems and grow as low thickets. They will gradually fill in along the edges of the TID corridor, further blending the maintenance road/ trail with the surrounding landscape. This natural process should be allowed to progress where appropriate.

The use of mulch materials (e.g. wood chips) to prevent erosion and reduce soil compaction in bare areas will further help to blend in the construction effects with the natural environment, while avoiding scarring caused by granular soil eroding during heavy precipitation.

Where practical, some logs can be left on site as occur in natural forest settings, providing habitat for a host of species. They should be anchored on contour, rather than running up and down slope and should make full contact with the ground to the point of even being slightly buried. In this way, they provide for slope stability, encourage walking use on contour rather than up and down slope, and soften the visual construct of the road.

K. Use the piped Ashland canal corridor as an improved fuel break

The maintenance road associated with the piped Ashland Canal is an ideal project to develop as a fuel break. It occurs along the urban/ wildland interface; there will be vehicular access, should fire vehicles be necessary to dispatch along the corridor; and it will provide a 20 foot zone of nonflammable material within the forest. To work effectively, all vegetation should be kept mowed and free from the driving surface of the road during fire hazard periods and yearly fuel treatments should be included in the maintenance plan along the access road.

VIII. Summary Discussion

Transformative environmental projects such as Ashland's proposal to pipe the irrigation canal can provide opportunities to reset patterns better aligned towards resiliency and long term stability because "no action" leaves a system on its present course. With weather patterns shifting, southern Oregon, like most places, is experiencing dramatic extremes, creating pressures that reduce biodiversity and stress the remaining species as ecosystems reduce their carrying capacities (Bellard, 2012). Land stewards look towards what an environment can support and strive to maintain the appropriate balance of species through management practices that encourage the healthiest combinations.

A. Prepare for environmental stresses by supporting resilient ecosystems

This project presents an opportunity to better prepare for the increase of environmental stresses by improving the resilience of the ecosystem within the wildland/ urban interface. The City has made dramatic progress improving the resilience of the watershed through fuel treatment programs. The region surrounding the canal is a particularly dynamic zone for the reasons we've presented throughout this analysis. Eliminating the summer water currently added into the ecosystem across the canal corridor (which is invisibly happening below the surface through extensive breaches in the thin, concrete liner of the canal) will create a much more competitive setting for the plants surrounding the canal and ultimately shift the plant community to one better suited to the natural site conditions. This could happen in the near future if TID is forced to reduce the amount and periods of time the canal carries water due to several years of excessive droughts. Many other areas of the world have already experienced these climatic extremes and it's difficult to predict the climate patterns southern Oregon will experience in the next few decades. The City is choosing to address this shift ahead of time by eliminating the unintended watering of the hillside by piping the canal. This allows a more well thought out process to unfold.

B. Reviewing the key components of this proposal, they are:

- Optimize the appropriate tree and species selection for natural water conditions of the site, creating a resilient wildland/ urban interface for years to come.
- Use mitigation measures to help transition important trees and landscape features through the piping process with as few losses and casualties as possible.
- Maintain the aesthetic qualities of the current shady and mature landscape to the greatest extent possible.
- Eliminate the open contamination of the water used by the City during dry summer periods, as well as for users downstream.
- Eliminate water loss through the City owned portion of the irrigation canal. This action acknowledges the value of water as a limited resource. TID water was set up for use by farms in the valley, producing food for the greater community and beyond. Prioritizing farm use of scarce water resources is an important decision of a resilient community.

C. Improving resilience is an observational, thoughtful, gradual, and collaborative effort.

This happens most effectively with "buy-in", which is based on trust; in this case that the City has the best interests of their community in mind in deciding to move forward with this action, that there is compelling evidence to take this action at this time, and that the planned action meets the values and practices the City has developed with their community over time.

Siskiyou BioSurvey, LLC thanks the City for this opportunity to serve our community through this ecological analysis and hopes this document will support Ashland to take the best possible steps moving forward.

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