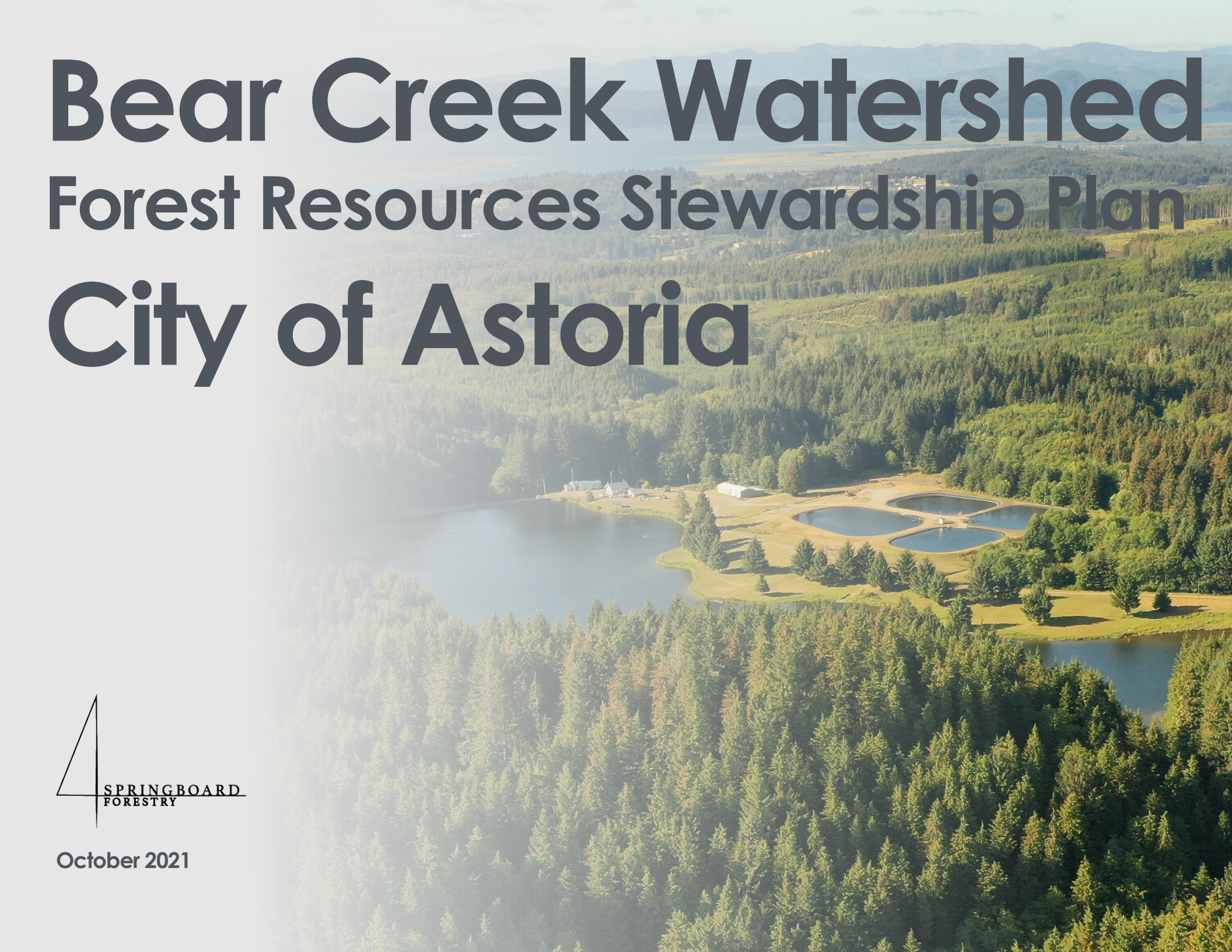
Bear Creek Watershed

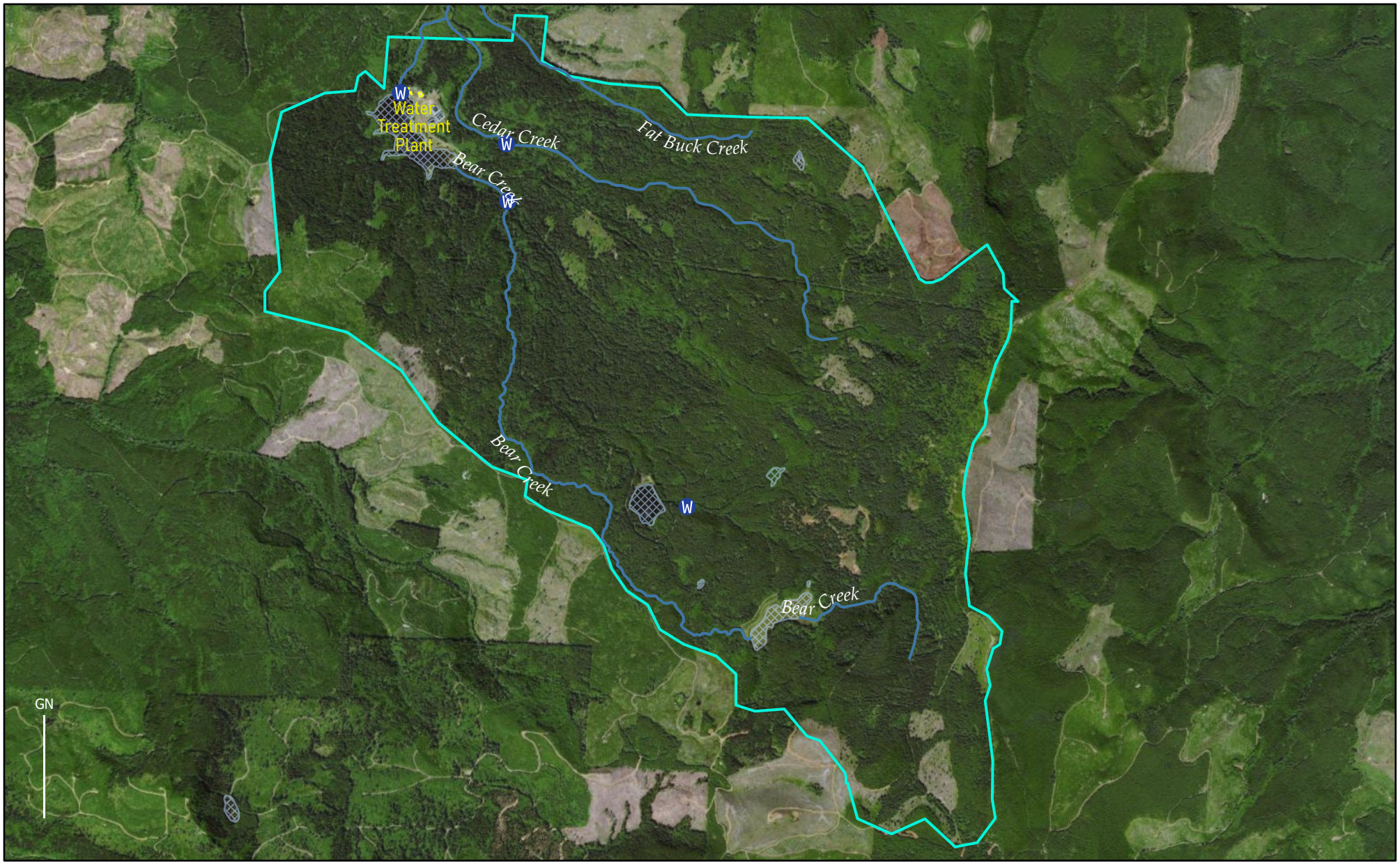
Forest Resources Stewardship Plan

City of Astoria



SPRINGBOARD FORESTRY

October 2021



PROPERTY MAP

Miles
0 ¼ ½ ¾ 1

Bear Creek Watershed
Water Treatment Plant
Source Water Diversions
Water

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ACKNOWLEDGMENTS

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ABOUT THIS FOREST RESOURCES STEWARDSHIP PLAN

The Forest Resources Stewardship Plan reflects the vision, goals and objectives for the City of Astoria's Bear Creek Watershed. In addition, this plan has been structured to satisfy the requirements of the State of Oregon's Forest Management Planning standards, and the standards for Forest Stewardship Council Certification.

Watershed and forest management research continues to expand and evolve at a rapid pace. When combined with advancing equipment technology and techniques for management, an adaptive approach to management planning seems prudent when compared to one that is rigid. Such an approach can be facilitated with regularly scheduled management plan reviews, as well as reexamining plans when new impactful knowledge or experience emerge.

This plan is drafted in this spirit. Past management plans have been conducted in the watershed (Schrager, CH2MHill, etc.) and have become dated with respect to the range and depth of resource considerations to meet the fundamental management objective of maintaining, currently observed, high levels of water quality and quantity through a climate resilience lens. Thus, this plan discusses watershed features, functions, commitments, and values with a focus on locally unique conditions and actions that have potential implications for future water quality and quantity in a modern context, taking into consideration climate resiliency, carbon sequestration and other important factors and opportunities for long and short-term objectives.

Over the past decade, the City of Astoria began conceptualizing its commitment to climate resilient land management actions. In 2014, the City formalized steps to maintain existing forest cover and substantially grow more biomass volume to increase carbon stocks. At that time, the City approved and implemented a revised Bear Creek Watershed Forest Resource Plan that focused on carbon sequestration above and beyond all legal and regulatory requirements, in accordance with the American Carbon Registry carbon project that was completed in 2015.

This plan provides a watershed overview, clear management objectives, and adaptive recommendations to meet the needs and concerns at this time.

MANAGEMENT OBJECTIVES

Primary Objectives

The City of Astoria owns and operates the Bear Creek Watershed for the primary objective of protecting source water. These management objectives steer all subsequent management decisions.

1. The watershed will be managed to provide the very best quality and quantity of potable water for the customers it serves for the foreseeable future.
2. The watershed (forest) will contain a diversity of native tree and plant species and forest structural compositions, in order to develop greater ecological resilience.
3. Unique areas of High Conservation Value Forest will be identified, managed and protected.
4. The watershed (forest) will contribute to the economic and social vitality of the communities and industries it serves though its primary resource, water, and secondary resources of merchantable timber and carbon sequestration.
5. The production of forest products or the sale of carbon offsets will contribute to forest health, fire safety and diversity and will be completed in a manner that minimizes any near or long-term impacts to source water quality or quantity.
6. The watershed will support and enhance habitat for native wildlife, consistent with water quality objectives.
7. The watershed will maintain an ecosystem that has the capacity across the watershed for renewal, recovery from disturbance, and retention of ecological diversity.

Climate Change Adaptation

Climate change is rapidly becoming the greatest risk to source water for municipal systems drawing from surface water sources. The scale of ecological disturbance is anticipated to increase with climate change, while the predictability of these events will decrease. Examples of disturbances that are likely to affect the Bear Creek Watershed include extreme weather events with wind and/or rain, pathogen outbreaks such as Spruce budworm or Hemlock looper, and wildfire.

Similar to how a financial investor selects a wide range of different investments in order to create portfolio diversity, a forest manager focused on resilience will manage towards a more diverse and complex forest. Pests and pathogens typically only attack certain species, various tree species and ages have differing susceptibility to windthrow, and a diverse forest stands will respond differently to the large stand-replacing fire historically present in the Oregon Coast Range. For the financial investor, some investments will continue to yield whether or not others fail. For a forest manager, some species of trees and stand types will continue to provide high quality water filtration when others are unable to do so. This resilience is key to managing for long-term water quality in a drinking watershed.

The present stands on the Bear Creek Watershed display relatively low levels of spatial heterogeneity and relatively low species diversity or structural complexity on a stand level. Over time, active management can select for increased species diversity and complexity. An example of this management is pre-commercial thinning that selects trees to increase diversity. In older stands, variable retention harvests can increase spatial complexity while creating a multi-strata stand. This type of stand displays the characteristics of resilience. Over time, management interventions will create a forest more capable of providing high quality drinking water despite the challenges of climate change and pre-existing ecological disturbance risk.

Carbon Mitigation

While forests will change and adapt to climate change, they also play a critical role in mitigating carbon emissions. Approximately 50% of the dry weight of a tree is carbon, which can be converted into carbon dioxide through a ratio of atomic weights (44 /12). Both during a trees life, and following harvest or natural mortality, carbon is stored in the bole, branches, needles, roots, and soils surrounding the tree. These different components have different resonance times, with carbon in roots and the bole stable for many years, and needles breaking down relatively quickly. The processes of decomposition and burning both emit carbon dioxide, however decomposition within a mature forest occurs at a relatively slow rate.

Due to low harvest levels following the City of Astoria's acquisition of the Bear Creek Watershed, the property accumulated higher than average standing timber volume for the region. The regional baseline condition for a property like the Bear Creek Watershed would be approximately 120 metric tons of carbon dioxide equivalent (Co2E) per acre. The common silvicultural practice for Northwest Oregon forests includes short rotations (34-45 years) with full overstory removal (clearcuts) at harvest. The average rotation age has decreased with a regional transition to institutional ownership of forestland as a financial investment, which began in the early 1980s. This trend has been further driven by re-tooling of regional sawmills to process small logs, with premium prices for logs 5"-11" and significant price penalties for logs over 28".

The result of Astoria's relatively moderate management of the Bear Creek Watershed is that the property exceeds the average stocking in the region. Over the period of 2015-2034, this is estimated to result in the property storing 478,203 metric tons of Co2E more than a property managed under business-as-usual practices. In 2014, the City of Astoria initiated a carbon project in order to sell carbon credits. This project resulted in 20-year initial crediting period during which harvest will be minimized, followed by a minimum 20-year monitoring period. This project guarantees that management activities will maintain the existing standing inventory and create a pathway for the sale of additional carbon credits resulting from harvesting less than growth.

MANAGEMENT OBJECTIVES

Beyond the financial implications of a carbon project, the management of the Bear Creek Watershed in a manner that stores carbon has positive implications for the citizens of Astoria. Both the City of Astoria's multi-jurisdictional natural hazards mitigation plan addendum and the Clatsop County Multi-jurisdictional Natural Hazards Mitigation Plans identify a number of natural hazards that are driven by climate change. These include sea level rise, extreme weather events, and associated hazards including floods, landslides, wildfire, and drought. While the storing of carbon in the Bear Creek forest is a minor step towards mitigating climate change, it presents a tangible example of the positive impacts of sustainable forest management.

Beyond the financial implications of a carbon project, the management of the Bear Creek Watershed in a manner that stores carbon has positive implications for the citizens of Astoria. Both the City of Astoria's multi-jurisdictional natural hazards mitigation plan addendum and the Clatsop County Multi-jurisdictional Natural Hazards Mitigation Plans identify a number of natural hazards that are driven by climate change. These include sea level rise, extreme weather events, and associated hazards including floods, landslides, wildfire, and drought. While the storing of carbon in the Bear Creek forest is a minor step towards mitigating climate change, it presents a tangible example of the positive impacts of sustainable forest management.

PROPERTY DESCRIPTION

The Bear Creek Watershed is located about 10 miles southeast of Astoria and contains approximately 3,700 acres. Primary access is via Svensen Market Road and Headworks Road from Highway 30 near Svensen. All access routes into the watershed are gated and public access is not allowed.

The terrain is dominated by Wickiup Mountain (elevation 2700 feet) and Wickiup Ridge which form the southern boundary of the watershed. The terrain slopes west and north from the ridge toward the Columbia River. Bear Creek and Cedar Creek (also referred to as Waterworks Creek) and Fat Buck Creek are the dominant drainages that provide water resources.

Historically, the watershed's use as a domestic water supply dates back to the end of the 19th century, circa 1880). Through the years the city has increased its ownership and control to its present state. Crown Zellerbach Corporation owned most of the forest within the watershed prior to city ownership. Under their management and harvest program the majority of the land was logged from approximately 1936 to 1954.

The reforestation efforts that followed harvest were mixed in rough equal thirds between planted regeneration, seeding and natural regeneration. The current forest is the result of the early management and logging process and has resulted in a forest with a mixture of species, density and age classes.

The watershed is currently bordered by private lands; Hampton Tree Farms, Greenwood Resources, Teevin Resources, and a number of non-industrial ownerships surround the watershed.

In addition to understanding the previous watershed ownership and land management, a foundational understanding of the ecological history of the area is critical. Disturbances, including fire, wind events, landslides, flooding, disease and pests, are a part of the rich history of the Bear Creek watershed. Historically, fire and wind have been shown to have been the most prevalent large-scale disturbances in the region. With regard to climate modeling, other disturbance types may play a larger and more impactful role in watershed health moving forward (i.e. pests, fire, disease, recreation).

Regional Context

The City of Astoria is located in Clatsop County, at the mouth of the Columbia River and the Northwest corner of Oregon. Astoria and the surrounding forests, including bear creek, exist in a moderate temperate maritime climate. The month temperatures fluctuate very little, with summertime highs around 69 degrees, wintertime highs around 48 degrees, and respective lows of 60 degrees and 36 degrees. Both the City of Astoria and the Bear Creek Watershed report 66 inches of rain per year, although the Bear Creek Watershed receives significant moisture due to the dew and moisture generated through fog drip. Annual rainfall has ranged as high as 88 inches per year. These additional sources of moisture are not measured but contribute both to forest health, overall forest composition, and wildfire risk. Heavy dew is a common occurrence even during dry summer weather.

Astoria is the oldest American settlement west of the Rockies, with John Jacob Astor's expedition setting up a fur trading post in 1811. From 1813 until 1818 the settlement was known as Fort George. In 1818 a treaty with England led to join occupation of the Oregon Country, setting the international boundary at the 49th parallel. The population of Astoria has stayed relatively stable since approximately 1920, with a current population of approximately 10,000.

Astoria has existed for the past two centuries primarily as a fishing, fish processing, trading and lumber town. Both fisheries and lumber processing have declined since the early 1990s, while tourism, development and government services have provided additional economic activity. As a result of the water required for fish processing and possible military development during the last century, the present water system has oversized mains and more transmission capacity than is currently utilized.

The City of Astoria is land-locked by City and County owned forestland and water, with a relatively constrained urban growth boundary. Revitalization of the downtown core has occurred over the past 15 years with the advent of large breweries, restaurants, and galleries. The continued growth of breweries relying on water from the Bear Creek Watershed has led to increased interest in source water quality and forestry practices.


Astoria, OR
Seaside, OR
Astoria-Megler Brg
Warrenton-Astoria Hwy
Columbia River Hwy
Nehalem Hwy
Oregon Coast Hwy
Hwy 30
Nehalem Hwy
Miles
0
2½
5
7½
10
Bear Creek Watershed
Major Roads
Urban Areas

REGION

Present Forest Conditions

A diverse forest structure is essential to maintaining and/or improving a healthy forest ecosystem. The Bear Creek Watershed contains a wide range of forest stand types, from very young forest to stands with trees upwards of 300 years old. The below stand successional descriptions provide broad categories for understanding the Bear Creek watershed.

EARLY SERAL- 5% OF THE MANAGED FOREST AREA.

These sites are occupied primarily by tree seedlings or saplings, herbs or shrubs. The trees can be conifers or hardwoods. Herbs, shrubs, and/or grasses are widespread and vigorous, covering 20 to 80 percent of the ground. This type includes first-year regenerated stands and continues to the stage when trees approach crown closure. These stands develop through a stand initiation process, which begins when a disturbance such as timber harvest, fire or wind has killed or removed most, or all of the larger trees, or when vegetation has been cleared for panting. Herbs, shrubs, and some live trees will remain from the previous stand, as well as snags and down wood. New plants (trees, shrubs, and herbs) begin growing from seed, artificial regeneration. After years of these conditions, increasing crown closure shades the ground and herbs, shrubs, and grasses begin to die out or lose vigor.

CLOSED CANOPY- APPROXIMATELY 70% OF THE WATERSHED.

Trees fully occupy the site and form a single, main canopy layer. There is little or no understory development. Where understory vegetation exists, there is low shrub and herb diversity. The shrub or herb layers may be completely absent or may be short and dominated by one or two shade - tolerant species, such as sword fern, Oregon grape, Salal, or other species. These stands may include sapling stands, un- thinned stands, or thinned stands where the overstory still occupies most of the stand.

The stem exclusion process begins when new trees, shrubs, herbs no longer appear and existing ones begin to die, due to competition. Later in the stage shrubs and herbs may essentially die out of the stand altogether. The trees begin show decreasing limb sizes, diameter growth rate, and crown length. Later, less competitive trees die. As some trees die, snags and down wood begin to appear in the stand. Near the end of stage, enough trees have died and living trees have enough variation that small gaps form the understory trees, shrubs, and herbs begin to appear.

OLD FOREST STRUCTURE- APPROXIMATELY 10% OF THE WATERSHED.

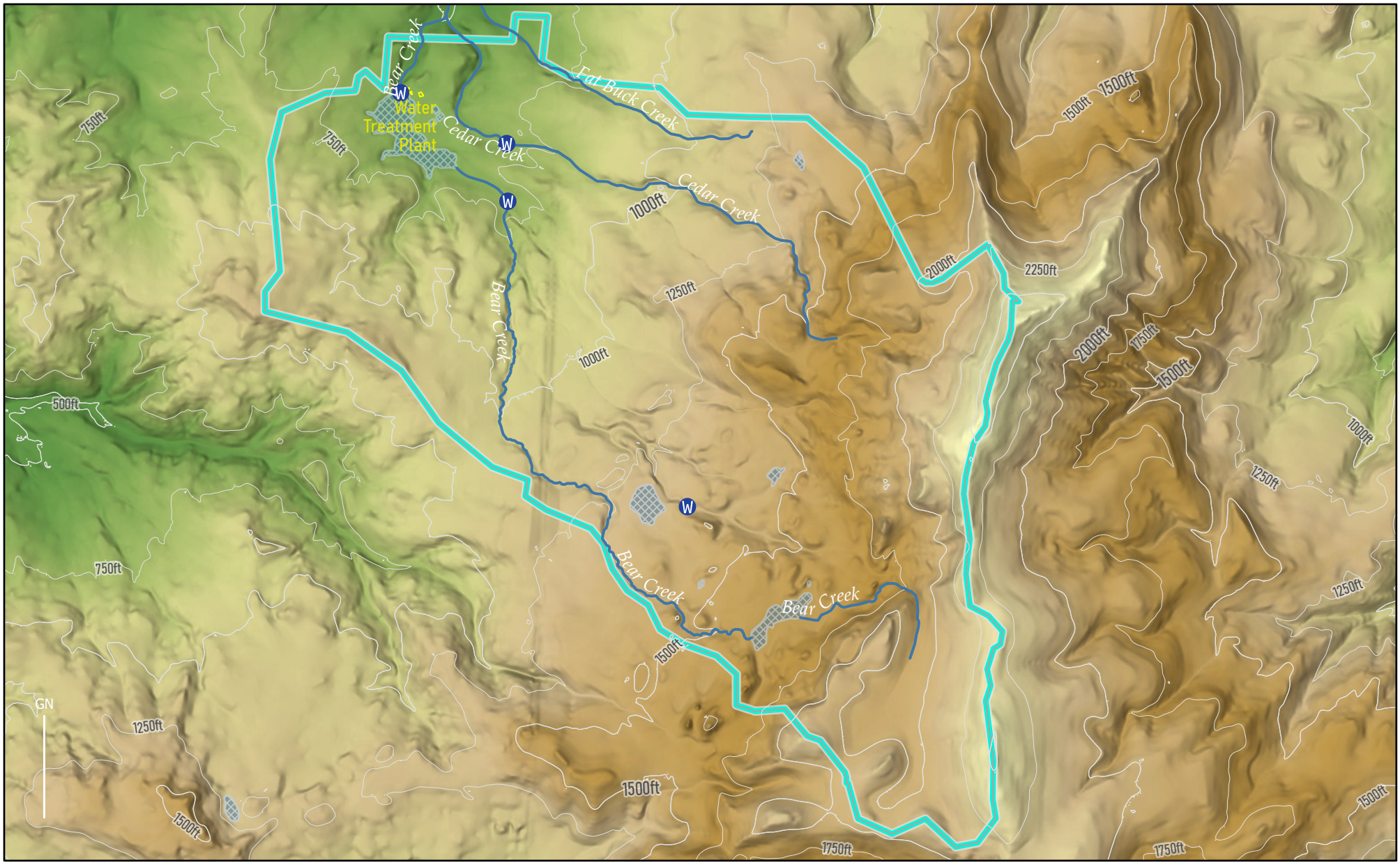
These stands occur when stands develop a variety of structural characteristics which are linked to older forests or old growth. These forests have at least 8 or more live trees per acre that are at least 32 inches in diameter at breast height. Two or more canopy layers are present, often with one layer of shade tolerant species. Snags are present at 3- 6 per acre, 2 of which are at least 24 inches in diameter. A substantial amount of down wood (600 to 900 cubic feet) per acre. At least one large remnant tree per 5 acres is present over 32 inches in diameter. These trees exhibit deeply fissured bark, large limbs or platforms, broken tops, evidence of decay, or other evidence of decadence. Multiple tree species (at least 2) are present at least one of which is a shade tolerant species. A diverse understory layer is present to include shrubs, herbs and regeneration of tree species.

RIPARIAN ZONES- 15% OF WATERSHED.

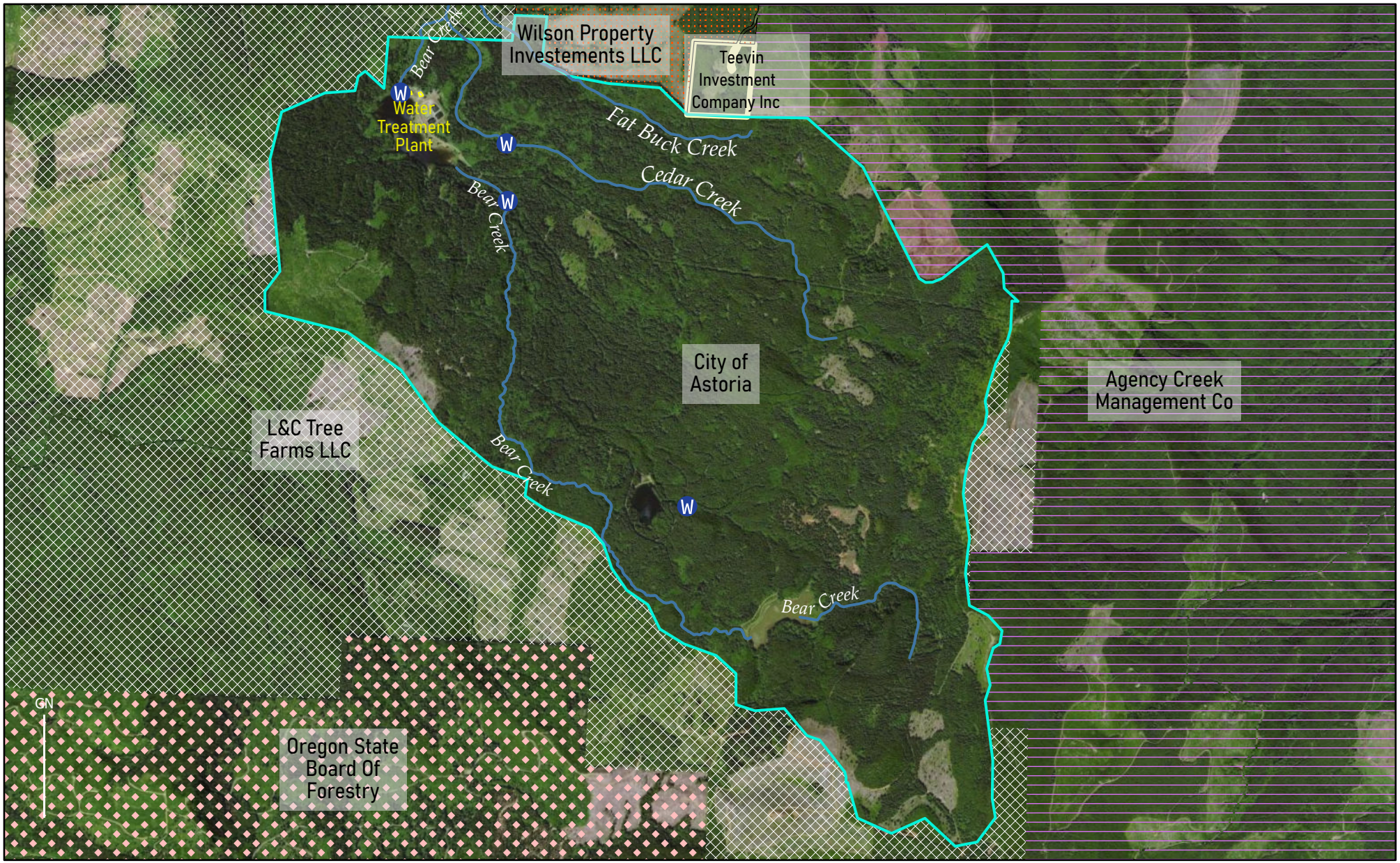
Riparian forests have important influences on water quality, as their shade can help maintain cool water temperatures while limiting the production of algae and aquatic plants in surface water, which generally benefits water quality for domestic use. The high productivity of many riparian areas can promote well-developed duff, soil, and rooting layers, which help reduce runoff and erosion while also contributing to favorable soil water storage and release characteristics.

Riparian zones will be managed to maintain healthy conditions for water quality and associated aquatic species. These areas will be managed or maintained so that over time average conditions become similar to those of mature streamside stands. Conifer stands dominate mature streamside stands over time. Mature stands will provide ample shade over the stream, an abundance of large woody debris in the channel, snags and regular inputs of nutrients through litter fall. These conditions will support the presence of fish.

Streams that are not fish bearing will be managed to support functions and processes that are essential to downstream uses. Such processes include maintenance of cool water temperatures influences on sediment production and bank stability. All streams shall be identified and managed to meet these conditions. The three main reservoirs will be protected to maintain water quality and quantity.


Bear Creek
Water Treatment Plant
Cedar Creek
Fat Buck Creek
Cedar Creek
Bear Creek
Bear Creek
Bear Creek
Bear Creek
750ft
750ft
1000ft
1250ft
1000ft
500ft
750ft
1250ft
1500ft
1500ft
1500ft
1750ft
1750ft
1500ft
1500ft
2000ft
2250ft
2000ft
1750ft
1500ft
1000ft
1250ft
1250ft
1250ft
GN
Miles
0
¼
½
¾
1
Bear Creek Watershed
Water
Source Water Diversions

TOPOGRAPHY

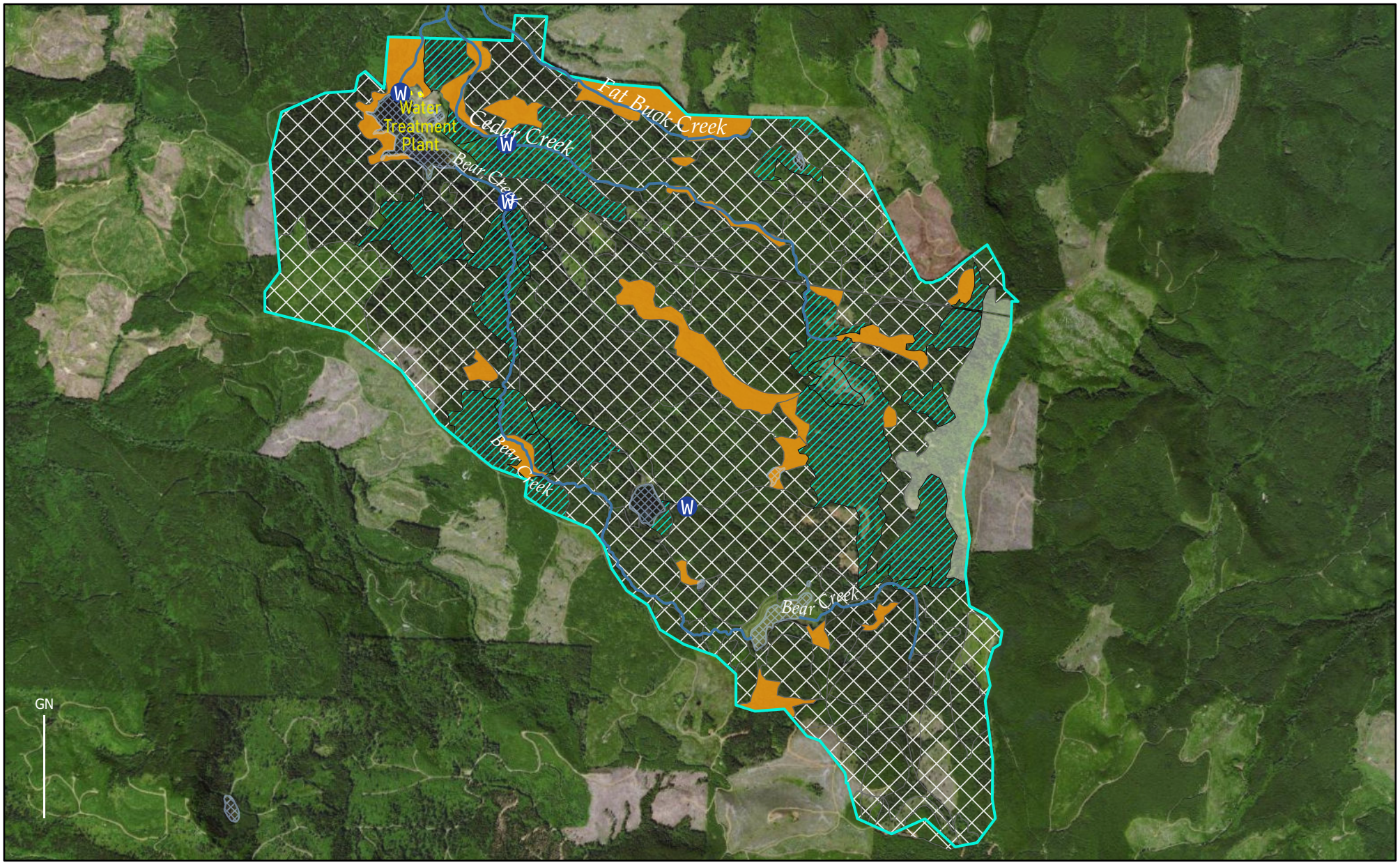


OWNERSHIP

Miles
0 ¼ ½ ¾ 1

Forest Ownership

- Hampton Tree Farms
- L&C Tree Farms LLC
- Oregon State Board Of Forestry
- Teevin Investment Company Inc
- Wilson Property Investements LLC

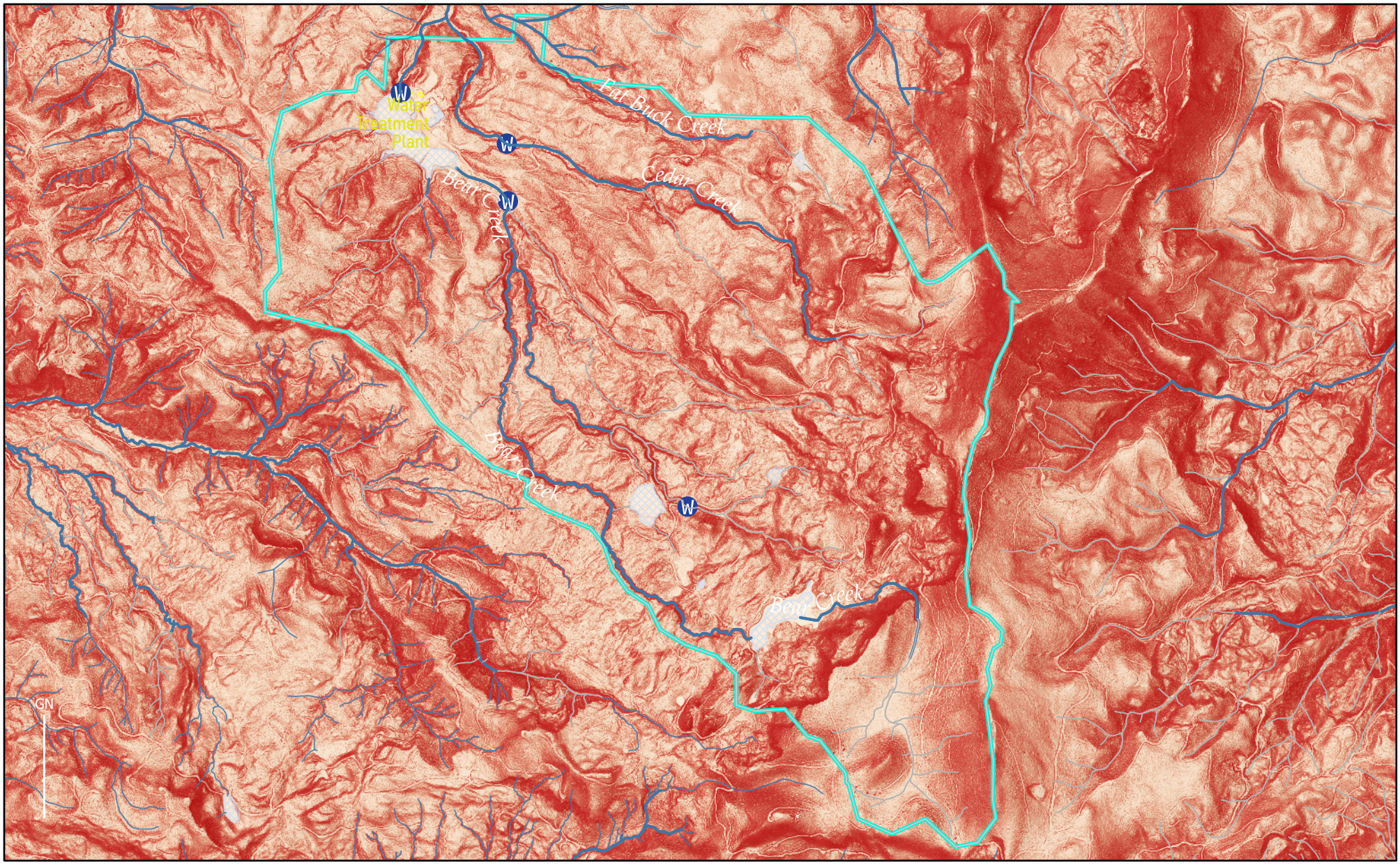


FOREST TYPES

0 ¼ ½ ¾ 1 Miles

Typing

- Conifer (78)
- Hardwood (19)
- Mixed (22)
- Non-Commercial (1)



SLOPE

0 ¼ ½ ¾ 1 Miles

- Bear Creek Watershed
- Water Treatment Plant
- Source Water Diversions
- Water

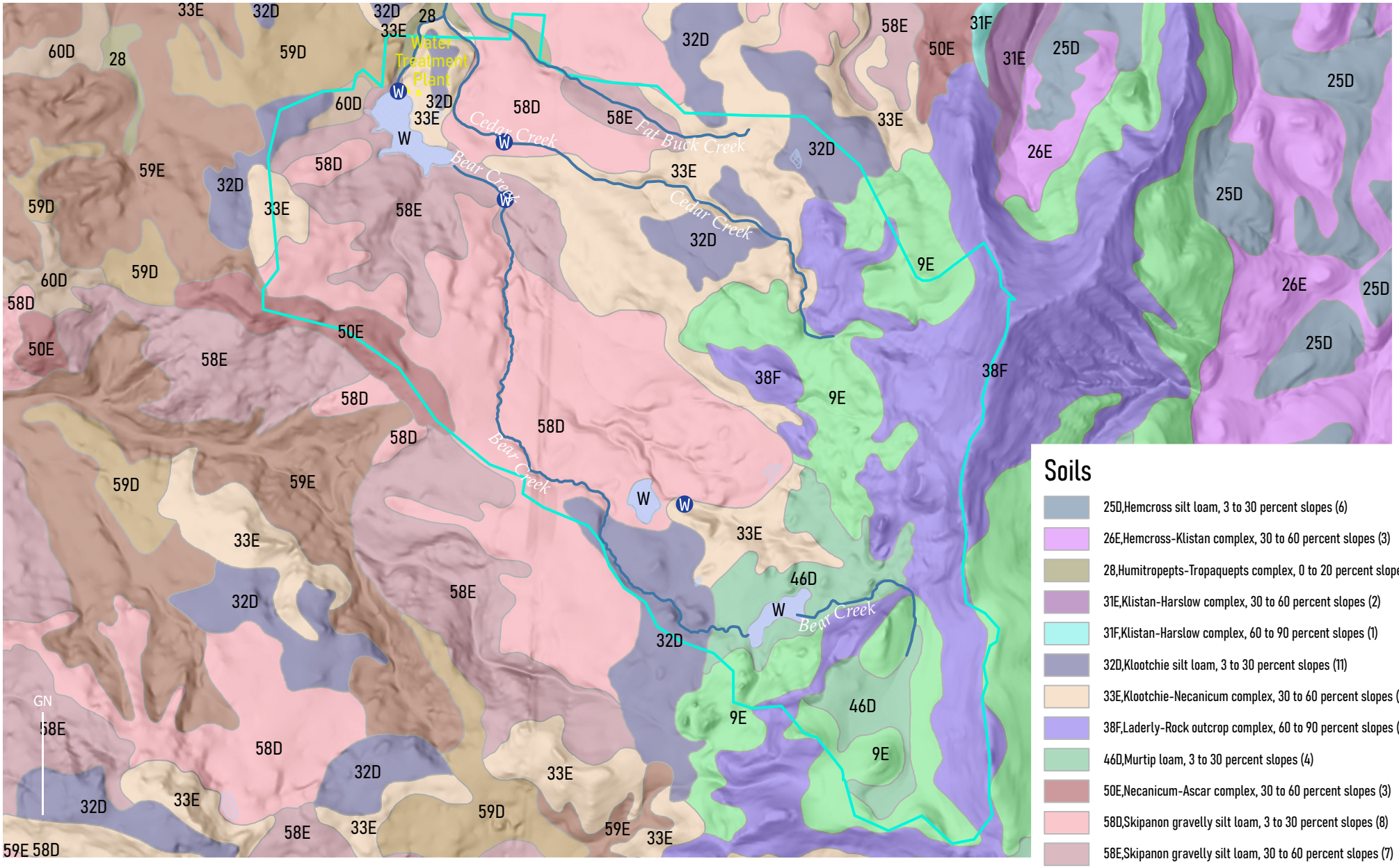
Streams

- Fish Present
- Nonfish
- Unknown

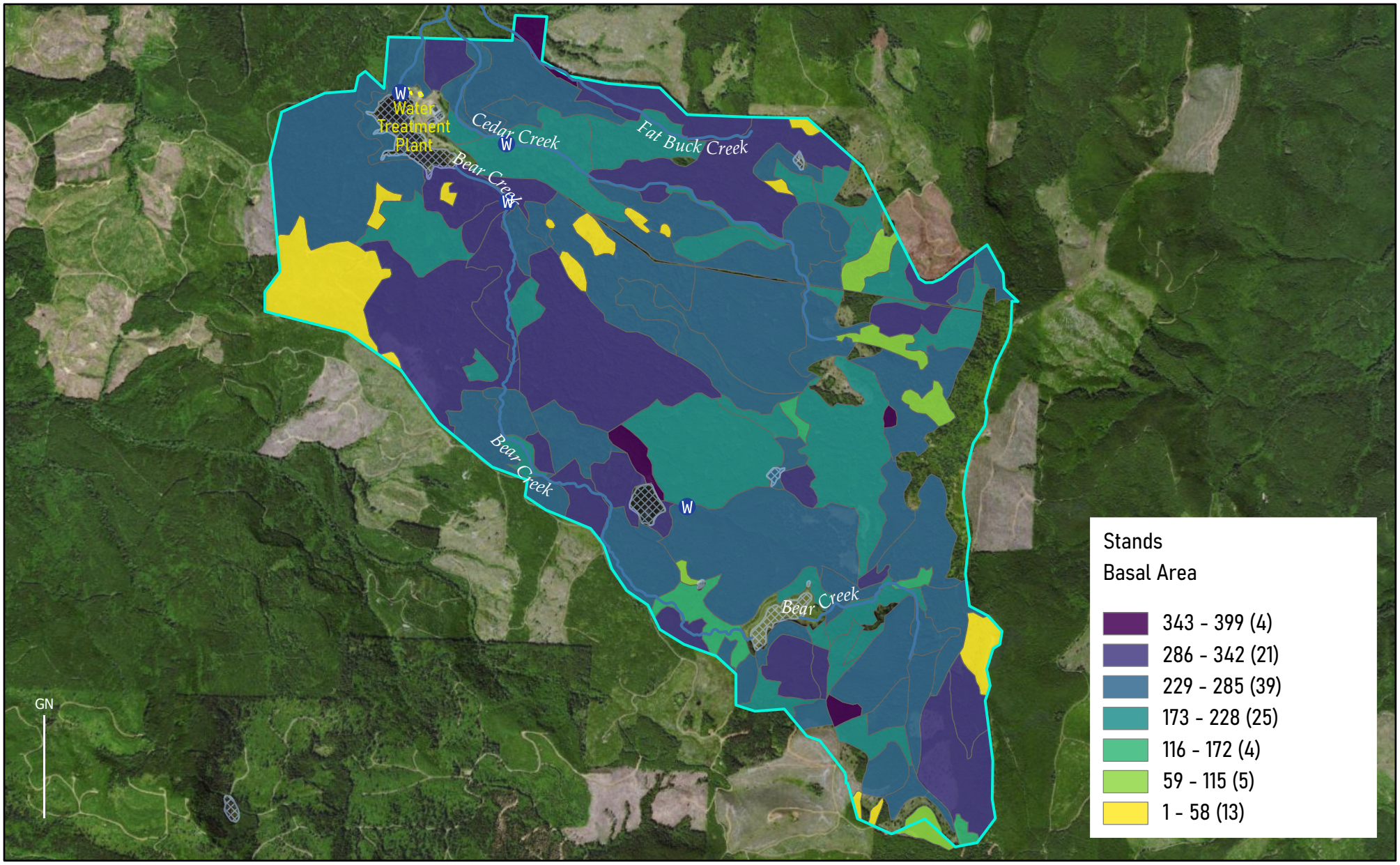
Slope

88°

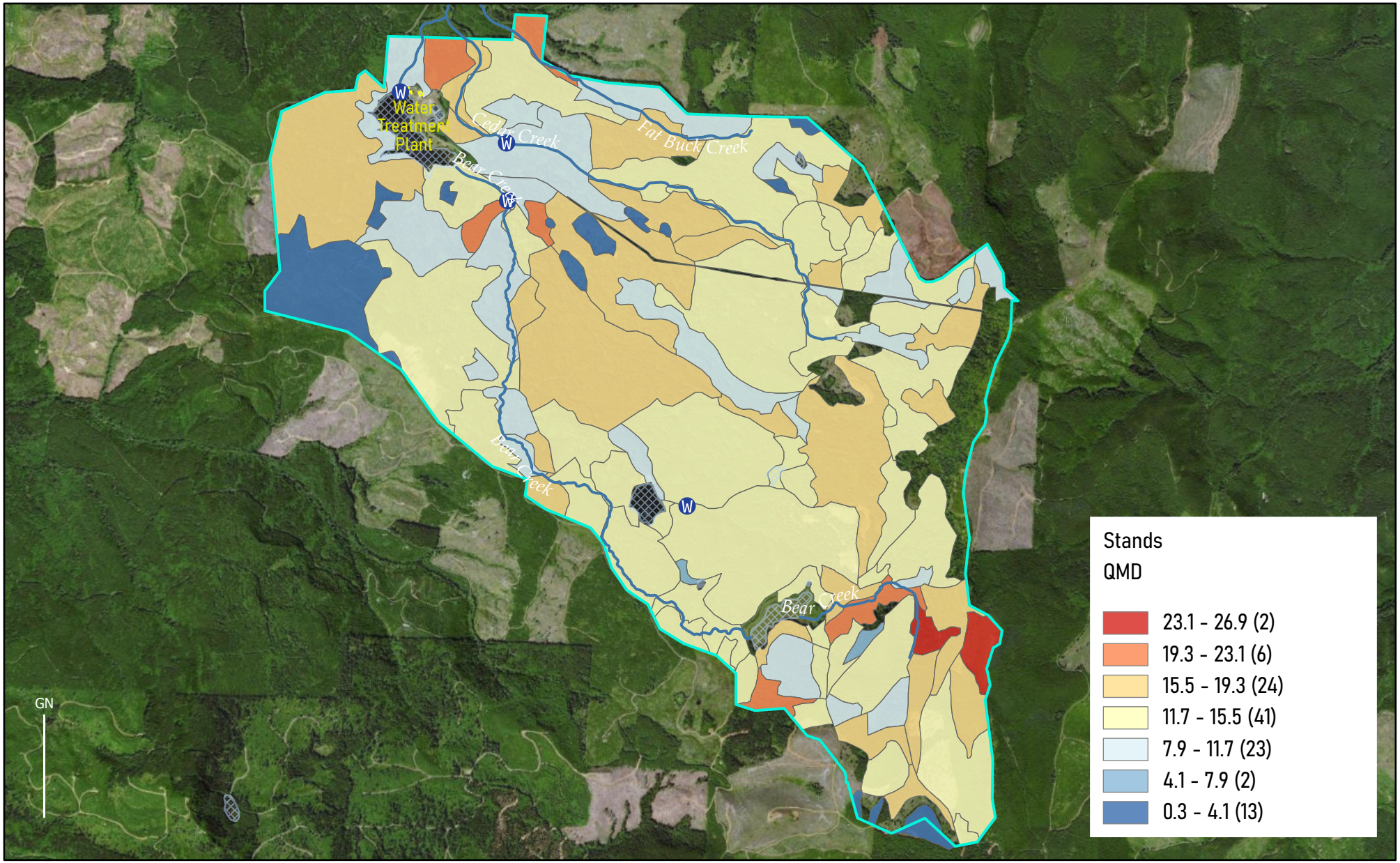
0°


Water Treatment Plant
Cedar Creek
Bear Creek
Fat Buck Creek
Soils
25D,Hemcross silt loam, 3 to 30 percent slopes (6)
26E,Hemcross-Klistan complex, 30 to 60 percent slopes (3)
28,Humitropepts-Tropaquepts complex, 0 to 20 percent slopes (2)
31E,Klistan-Harslow complex, 30 to 60 percent slopes (2)
31F,Klistan-Harslow complex, 60 to 90 percent slopes (1)
32D,Klootchie silt loam, 3 to 30 percent slopes (11)
33E,Klootchie-Necanicum complex, 30 to 60 percent slopes (13)
38F,Laderly-Rock outcrop complex, 60 to 90 percent slopes (2)
46D,Murtip loam, 3 to 30 percent slopes (4)
50E,Necanicum-Ascar complex, 30 to 60 percent slopes (3)
58D,Skipanon gravelly silt loam, 3 to 30 percent slopes (8)
58E,Skipanon gravelly silt loam, 30 to 60 percent slopes (7)
59D,Svensen loam, 3 to 30 percent slopes (5)
59E,Svensen loam, 30 to 60 percent slopes (4)
60D,Templeton silt loam, 3 to 30 percent slopes (3)
9D,Caterl-Laderly complex, 3 to 30 percent slopes (2)
9E,Caterl-Laderly complex, 30 to 60 percent slopes (5)
W,Water (3)
Miles
0 ¼ ½ ¾ 1

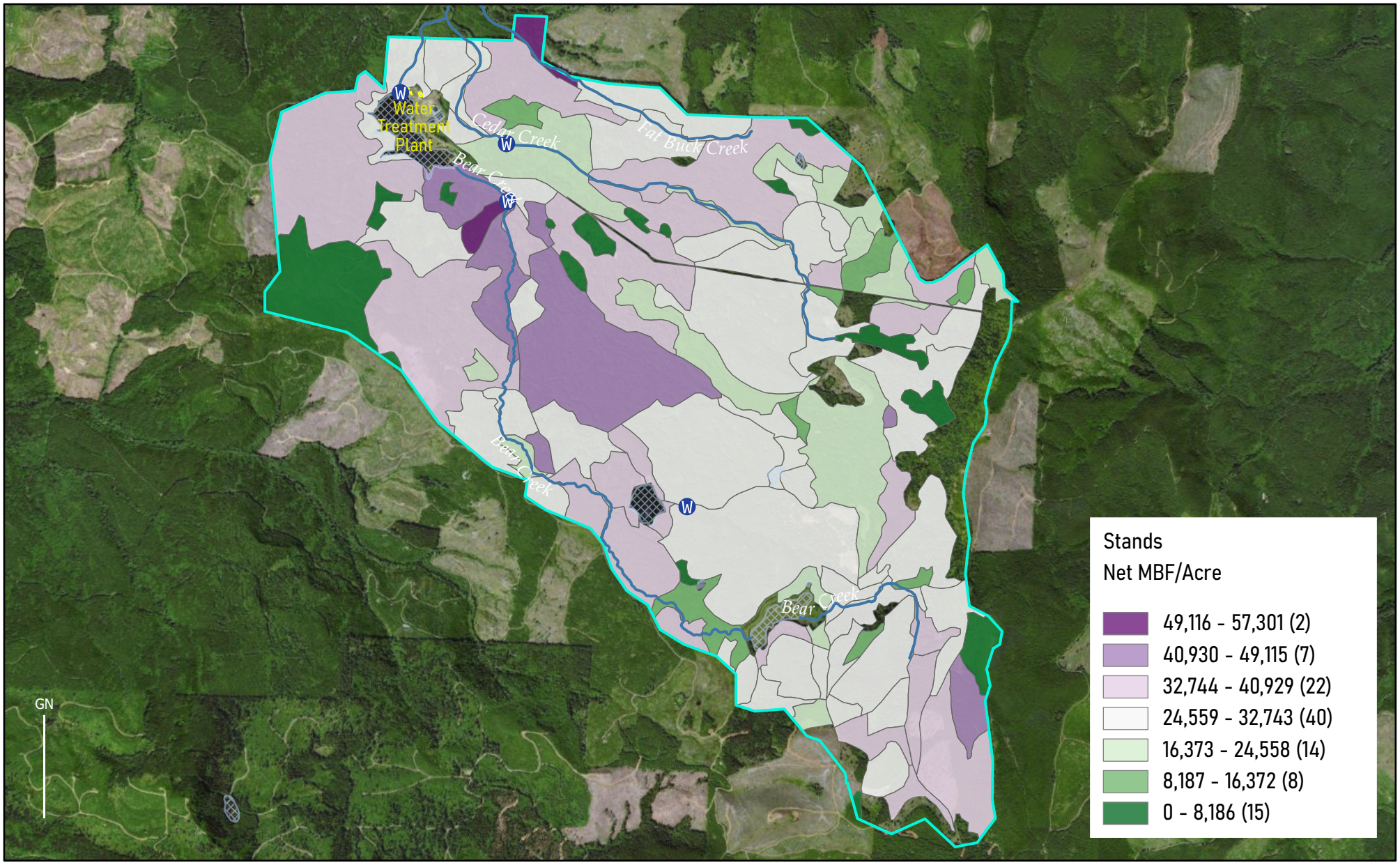
SOIL TYPES


Water Treatment Plant
Cedar Creek
Fat Buck Creek
Bear Creek
Bear Creek
Bear Creek
GN
Stands
Basal Area
343 - 399 (4)
286 - 342 (21)
229 - 285 (39)
173 - 228 (25)
116 - 172 (4)
59 - 115 (5)
1 - 58 (13)
Miles
0
¼
½
¾
1
Bear Creek Watershed
Water Treatment Plant
Source Water Diversions

BASAL AREA



QUADRATIC MEAN DIAMETER



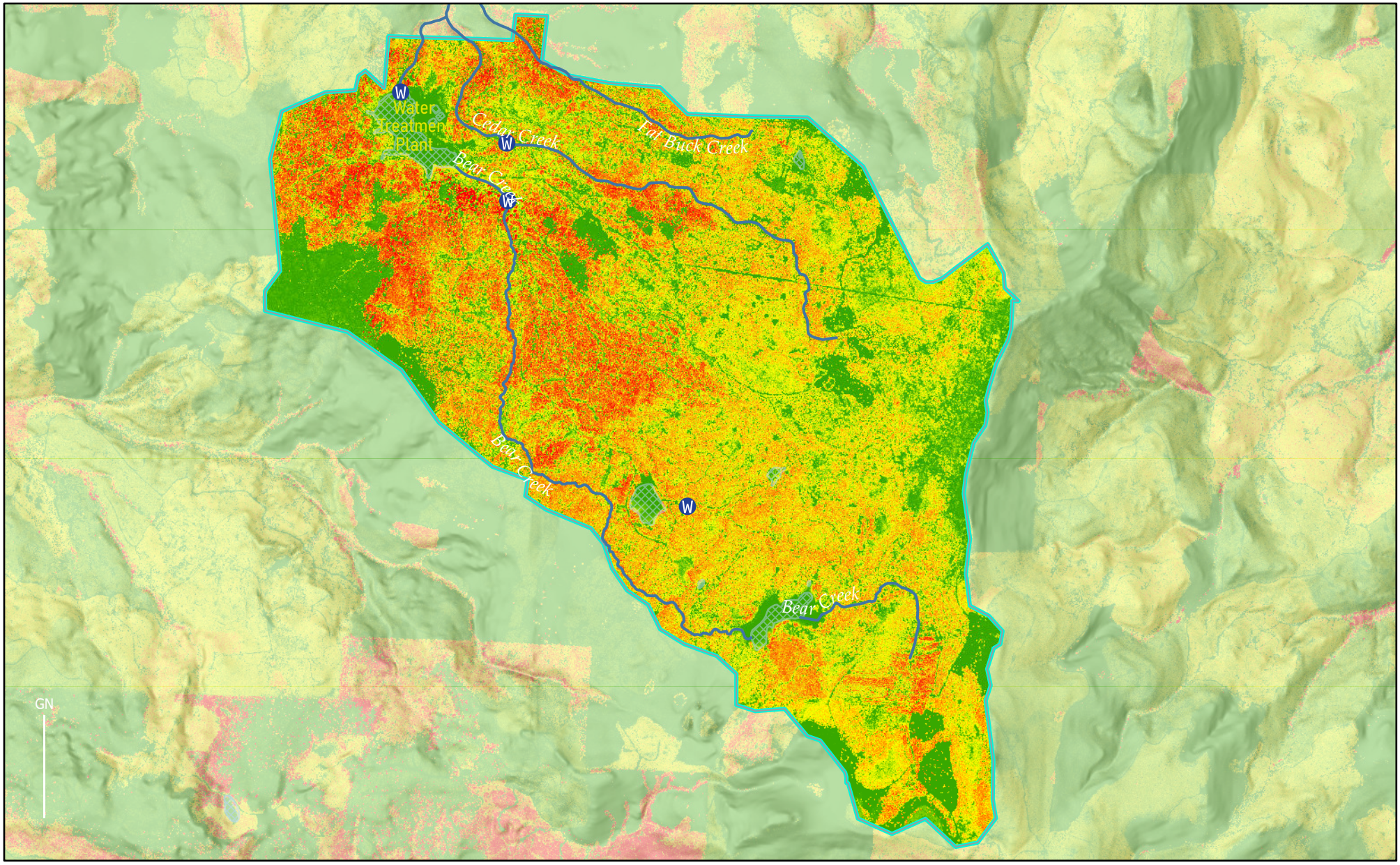
MBF/ACRE (NET)

0 ¼ ½ ¾ 1 Miles

Bear Creek Watershed

Water Treatment Plant

Source Water Diversions



TREE HEIGHTS (2015)

0 ¼ ½ ¾ 1 Miles

Bear Creek Watershed

Water

Source Water Diversions

Tree Heights

Value

234.736

0

Water Resources

The Bear Creek Watershed provides water for consumption by the citizens and businesses of the City of Astoria and surrounding users. The primary asset of the watershed is quantity and quality of water.

The watershed has an extensive stream network and three large artificial impoundments. There are about 32 miles of major streams and tributaries on the city ownership, which represent a drainage density of about 5.5 miles per square mile. This stream density contributes to a relatively rapid runoff response.

Stream flows rise and fall quickly with individual storms and dry periods. The three main impoundments total about 53 acres or 1.7 percent of the watershed area.

The estimated storage capacity of the three impoundments within the ownership totals approximately 300 million gallons; Bear Creek representing the highest holding capacity with approximately 200 million gallons.

The Bear Creek dam and the diversion dam on cedar creek prevent the upstream movement of fish species. A resident population of cutthroat trout can be seen in all three reservoirs and are present in available stream reaches above the reservoirs.

Due to the entire watershed being classified as a community water source all streams are considered to be category A under the Pacific Coast Region Standards, or considered type D under the Oregon Forest Practices Act (with Type F designation exceeding type D requirements in most cases).

Wildlife and Fish

The Bear Creek Watershed provides habitat for many of the species of wildlife that are commonly found in or near the forests of northwest Oregon, including Roosevelt elk, black tailed deer, cougar, black bear, beaver and mink. No formal surveys of these relatively common species have been conducted on the watershed. Their specific activity and abundance have not been specifically identified. Due to the closure of the watershed to all outside traffic, the level of these species is probably higher than the surrounding forested areas within the constraints of acceptable habitat types for specific species.

The presence of threatened, endangered, or sensitive species as defined by federal law is important because this can significantly affect management plans and decisions. Several different species have been observed in neighboring watersheds and may occur within the Bear Creek Watershed in the future. Bald Eagles have been observed near the Columbia River with specific nest sites having been identified. Marbled Murrelets were found on State Forestry lands southeast of the watershed. A murrelet study conducted in the spring/ summer of 1999 found no flights into the canopy of the watershed. Northern Spotted Owls were traced into the Columbia slope are to the west of the watershed but to this date (2007), no resident populations have been observed in the watershed.

The barriers to fish passage on Bear Creek and Cedar Creek have been in place for decades. The 100 foot high dam on Bear Creek was built in 1913. It presents a significant barrier that would require funding beyond the capacity of the city to allow for upstream passage. The barrier on Cedar Creek is less formidable. The City will continue to explore funding opportunities to develop fish passage into the upper reaches of Cedar Creek.

A comprehensive evaluation was conducted in 2012 by the Nature Conservancy. The evaluation is watershed based. The potential wildlife and plant communities for the Bear Creek Watershed is found in Attachment C.

MURRELETS & OWLS

There is one forest stand in the Bear Creek watershed that may be suitable for nesting of marbled murrelets. However, current habitat guidelines suggest that although the trees in this stand are within the age and structure requirements for nesting, the size of the stand and its lack of proximity to other similar stands make it unlikely murrelet habitat. A murrelet survey in the spring of 1999 found no birds flying over or into the forest canopy. Murrelets have been found roosting southeast of the watershed near the community of Jewell, however, and thus periodic monitoring of the local presence of this species seems prudent.

The Bear Creek watershed has areas that may be suitable for spotted owl nesting, roosting and foraging. Some forests have trees that could function as nesting platforms, as well as downed wood to support populations of rodent prey. No surveys of spotted owls were conducted recently and no populations have been identified in the past, but their importance merits some ongoing attention. Potential habitat for both spotted owls and marbled murrelets is likely to increase generally as the existing forests mature and develop greater canopy structure, snags, and down wood. If desired, silvicultural treatments can be used to further promote the development of such habitat. The presence of spotted owls or marbled murrelets on the watershed can necessitate a detailed Habitat Conservation Plan (HCP) and approval by the U.S. Fish and Wildlife Service before conducting nearby management activities. Similarly, Oregon's Forest Practice Rules Act now calls for a written plan for operations that can affect a known spotted owl nesting site, as well as the maintenance of a 70 acre core area of suitable habitat around such sites. Such habitat includes 60-80% canopy closure, a multi-layered and multi-species canopy dominated by large trees, and large snags and down wood.

AMPHIBIANS

In addition to riparian areas adjacent to reservoirs and streams on the watershed, the most notable habitat for amphibians is the roadside along Spur 11, west of the "A-line" road. There are a few potential ditch habitats elsewhere in the watershed, but these were not surveyed. In general, what is good for native amphibian species is also good for producing clean, cold water, and thus quality water and the habitat needs of amphibians are not in conflict in riparian areas. However, the Spur 11 road system has many ditches and culverts identified as clogged or partially clogged, yet these areas also contain good habitat for "pond breeding" amphibian species. If the clogged areas are modified for better drainage and runoff, amphibian habitat may be lost in these areas or amphibian populations may become stressed.

FISH

Past surveys and observations show that Bear Creek was historically and is likely still used by chum, steelhead, coho, chinook, Pacific lamprey, and sea-run cutthroat. Since 1911, chum, coho, chinook, and lamprey have disappeared from the upper reaches of Bear Creek due to the construction of the main dam. Fish are still found throughout the stream system and reservoirs above the Bear Creek dam, but it is not known whether they are remnant steelhead and cutthroat or other resident or stocked species. Cedar Creek (Waterworks) and John Day Creek likely contain anadromous fish since they join Bear Creek below the main dam, but their type and distribution are unknown.

Oregon's Forest Practice Rules have somewhat different streamside protection requirements for fish-bearing streams than for streams solely used for domestic water supply. However, because the Rule requirements to maintain fish habitat are actually more restrictive overall, there is basic compatibility with management objectives for water quality. As with amphibian habitat, what is good for native fish is generally good for domestic water quality. Thus, management plans to improve riparian and in-stream conditions (e.g., increase number and size of conifers, large debris in streams) can provide multiple resource benefits on the

PROPERTY DESCRIPTION

watershed. In both cases, the policies adopted by the City of Astoria for the Bear Creek Watershed exceed all state, federal and certification requirements for stream protection.

State law currently requires passage for game, anadromous, and food fish around all artificial obstructions across a body of water (ORS 498.351 and ORS 509.605). Upon periodic review, the owner of an obstruction may be notified that they must "provide free passage within a reasonable time" (ORS 509.605). Appeals must be on the ground that "providing the dam or artificial obstruction with a fishway would impair or be detrimental to the public interest." (ORS 509.645). It is possible that the proposed improvements to the main Bear Creek dam would instigate review of the dam's fish passage status and notice from ODFW that passage needs are not being met.

GAME SPECIES & OTHER WILDLIFE

Future forest management strategies are likely to influence the diverse species that are now observed or expected on the watershed (e.g., Roosevelt elk, black-tailed deer, cougar, black bear, beaver, mink). For example, the extent and target rotation age of even-age silviculture practiced on the Watershed can favor or discourage certain species. Both Elk and black-tailed deer benefit from a variety of habitats, but black-tailed deer populations would benefit from larger amounts of habitat in early seral condition (e.g., recent clearcuts). While no recent formal studies of these relatively common species have been conducted, due to the closed nature of the watershed, one can assume that the wildlife populations on the watershed is higher than the surrounding forested areas within the constraints of favorable habitat types for specific species.

Similarly, populations of black-tailed deer and some songbirds would likely decrease if even-age management was significantly reduced or if rotation ages were significantly lengthened resulting in much fewer acres of young vegetation. Clearly, the Watershed is large enough to allow some combination of silvicultural systems to be used if there is interest in broadening the current diversity of habitats and species.

A notable concern with wildlife in domestic watersheds is potential contamination of water supply by pathogenic organisms. Beaver and other mammals can contaminate streams and other surface water with *Giardia lamblia*, a protozoan that causes severe gastro-intestinal discomfort when ingested by humans.

Wildlife may also contaminate water with harmful strains of *E. Coli, Salmonella*, and other pathogens. Generally, the combination sand filtration and chlorination treatment system used by Astoria is highly effective in killing or removing such pathogens. However, some risk remains, particularly where wildlife is very abundant or may contaminate water after treatment through contact with the distribution system.

FOREST MANAGEMENT POLICIES

In order to achieve the objectives of the City of Astoria, the Bear Creek Watershed will be managed in accordance with the following 9 policies. These policies create a framework for determining operational plans and financial feasibility. These policies meet or exceed the requirements of the Oregon Forest Practices Act and Forest Stewardship Council Pacific Standard and align with historic management practices on the Bear Creek Watershed. The Bear Creek Watershed also must comply with state and federal policies pertaining to both forest management and source water. The relevant policies for forest practices can be found in the Oregon Forest Practices Act. In addition, the City of Astoria may want to consider both a stewardship agreement with the Oregon Department of Forestry and a Habitat Conservation Plan, with state and federal fish and wildlife agencies.

The policies include specific requirements and tolerances related to:

- Stream Buffers
- Harvest Levels
- Opening Size
- Tree Retention
- Road Maintenance
- Chemical Use
- Invasive Species
- High Conservation Value Forest

These policies are intended as the minimum level of watershed protection intended. Each section begins with a description of the policy question. An outline of policy function follows. Then, the section concludes with the policy adopted for the specific resource issue.

- Definition
- Purpose
- Policy

Stream Buffers

STREAM BUFFER DEFINITION:

Stream buffers represent the first line of defense in stream protection. Technical terms for stream buffers include riparian management zones (RMZs) or riparian areas. Buffers are typically measured in feet of distance from bank full width of a stream, with various activities allowed in "inner" versus "outer" buffers. Inner buffers allow no logging while outer buffers require a specific basal area retention and / or equipment limitations for ground-based logging. Both state laws and forest management certifications specify both where buffers should be applied, and how large buffers must be. Oregon's system relies on the size of the stream as well as fish presence. Streams can be identified through a statewide streams geodatabase administered by the Oregon Department of Forestry, although streams not listed in the database also require survey and protections.

STREAM BUFFER PURPOSE:

Stream protections provide a range of water quality, ecological, and resilience benefits. Water filters through intact riparian vegetation, removing sediment and decreasing the velocity of rainfall– runoff patterns. The protection also decreases the potential of sediment mobilization, particularly from exposed mineral soil in the riparian area. This filtration and limits on soil disturbance are most important immediately adjacent to the stream channel, however the full extent of a riparian buffer has been shown to decrease sediment transport and provide filtration. The decreased runoff velocity is particularly important for decreasing peak flow events and retaining soil moisture in order to maintain base flows. While less of an immediate concern for water filtration, the long-term impacts are significant and there are direct benefits of increased buffer widths.

In addition to filtration, stream buffers provide shade and have the potential of increasing hyporheic flow. Both shade and hyporheic flow serve to cool warm water or maintain already cold-water temperatures. This has habitat benefits but also can dramatically influence filtration costs. Water temperature has become a significant summertime issue in all three Bear Creek reservoirs. As a general rule, colder water tends to decrease both filtration costs and the need to

add chlorine to filtered water through the transmission system.

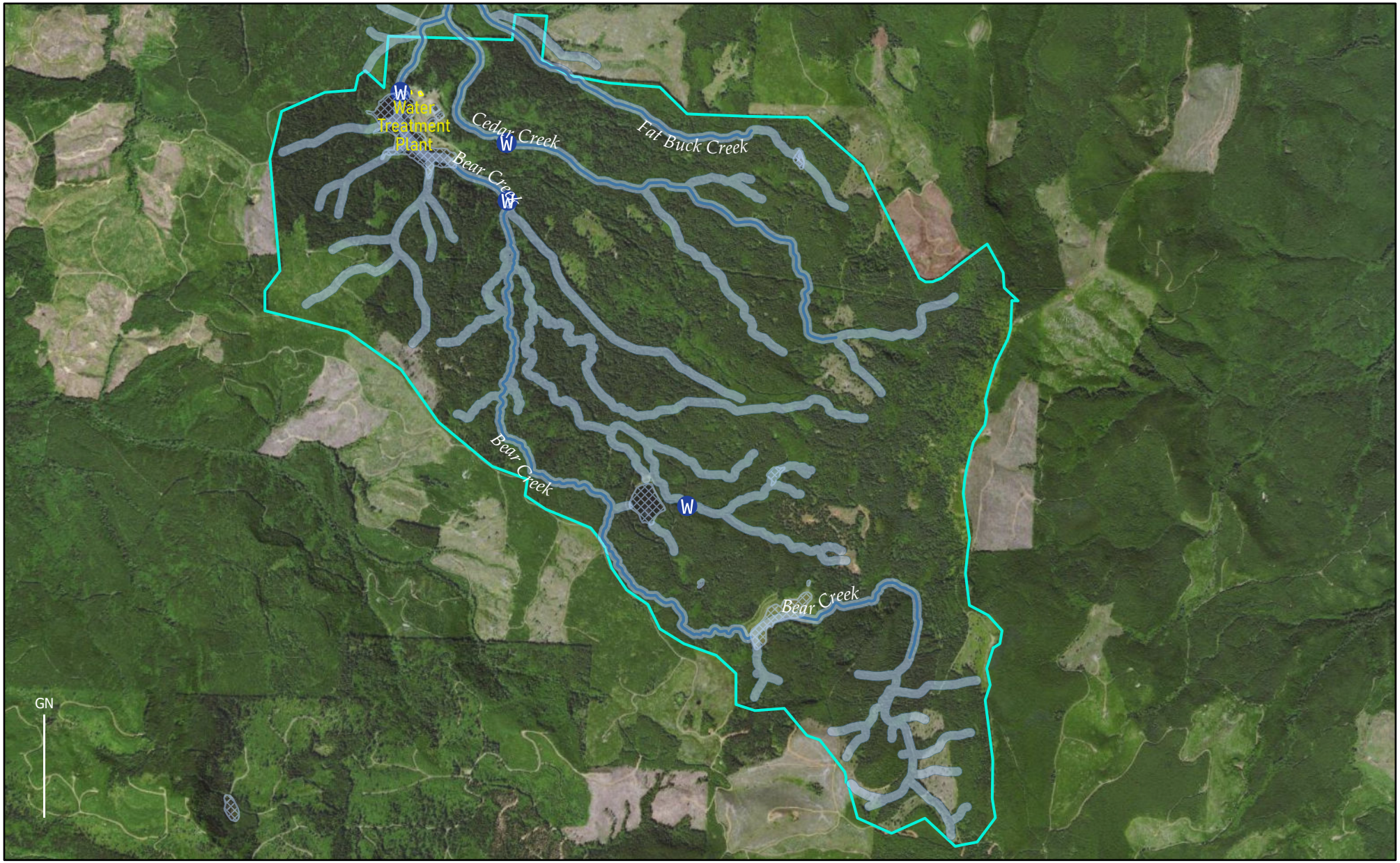
Finally, stream buffers benefit natural forest structure and species diversity, as well as wildlife habitat. The presence of increased species diversity and structural complexity surrounding streams creates greater system resilience. In practice this means that a specific disturbance, whether endogenous or exogenous, has a decreased probability of fully replacing a stand of trees. Instead, the riparian areas may be retained post disturbance, or some component or species of the riparian area may survive. This was exhibited during the 2020 fires in western Oregon when some riparian areas with older, more complex, and moister forest types exhibited lower mortality levels than surrounding even-age plantation forests.

STREAM BUFFER POLICY:

The Bear Creek Watershed riparian buffers are designed to comply with both the Oregon Forest Practices Act (OFPA) and the Forest Stewardship Council (FSC) certification. In addition, on type D (domestic source water) all perennial streams will receive a 150 ft. no-harvest zone in absolute (non-averaged) horizontal distance. The total riparian management zone on type D perennial streams will be 150 ft. or comply with the FSC or OFPA standards, whichever provides a higher level of protection.

Non type-D streams, ponds and wetlands must comply with the higher of FSC or OFPA standards. Seasonal streams will be treated as a small non-fish streams (Type N) under OFPA standards.

These standards and additional protections have been designed based on the risk presented by soil disturbance in the inner buffer zone, as well as the benefits provided by increased species diversity and forest structural complexity afforded by thinning in the outer zone.



STREAM BUFFERS

Miles
0 ¼ ½ ¾ 1

- Bear Creek Watershed
- Stream Buffers
- Water Treatment Plant
- Source Water Diversions
- Water

Harvest Levels

HARVEST LEVEL DEFINITION:

The specific harvest level on a property indicates the proportion of overall forest growth subject to harvest over an extended period of time. If the annual timber growth on the subject property is X, the harvest level could be greater than X, which over time would deplete the inventory, or less than X, which would create a long-term increase in inventory. Harvest level may also vary depending on ecological disturbances such as wind damage or pest / pathogen outbreak. A standard approach to harvest level is "sustained yield" where harvest level equals growth on an averaged basis, creating a steady flow of logs from a property and stabilizing both inventory and age distribution.

HARVEST LEVEL PURPOSE:

The harvest level over an extended period will determine the overall stocking and composition of a forest ownership. Over the past 50 years, the harvest level on the Bear Creek watershed has been less than ⅓ of annual growth. The result of this has been a high stocking level and mature stands. The continued low harvest level will result in a continued increase in standing inventory. This pattern allowed for the 2015 carbon project and will create continued opportunities.

HARVEST LEVEL POLICY:

The Bear Creek Watershed will be managed with harvest not to exceed 1/3 of growth on commercially viable stands, in accordance with the 2015 Bear Creek Carbon Project. Assuming approximately 4 MMBF of volume growth per year across the ownership and 1 million board (MMBF) removed from accessible timber (steep slopes, riparian areas and reserves), the annual allowable harvest should not exceed 1 MMBF. This volume may be combined into non-annual harvests, when harvest volume will exceed 1 MMBF. Historical harvest volumes have ranged from 620 thousand board feet (MBF) to 870 MBF.

Opening Size

OPENING SIZE DEFINITION:

Forest harvest activities generally occur for a specific "unit" of land. That unit may be a stand, which shares similar attributes in terms of species composition, site characteristics and structure, but it could also constitute part of a stand or extend across multiple stands. For any overstory removal type harvest, various restrictions exist to limit the maximum size of opening created. These harvest size restrictions apply to both clearcuts and other overstory removals, however thinning units may be larger. In addition, harvest may not occur on adjacent units until one has healthy growing seedlings and a specific distance is required between non-adjacent units.

The Oregon Forest Practices Act stipulates a maximum opening size of 120 acres. The Forest Stewardship Council standard caps total opening size to 60 acres with the average across an ownership not to exceed 40 acres. The Forest Stewardship Council also requires a graduated level of tree retention such that a 40-acre harvest unit appears more akin to a variable retention harvest than a true clearcut.

OPENING SIZE PURPOSE:

Opening size plays a critical role in determining the overall mosaic of future forest stand characteristics. Opening size also helps to define forest structure under FSC requirements as a result of the graduated tree retention requirements. Later sections provide a details description of retention requirements.

Historically, smaller opening size was seen as a positive in terms of watershed protection and forest ecology. Current research indicates that the importance of harvest prescription (e.g., clearcut versus variable retention, versus thinning) can have greater importance than unit size. For variable retention and thinning activities, large units provide both efficiency benefits and create larger-scale structural complexity than small units. Large harvest units can also create aesthetic issues, especially when visible from major roads.

FOREST MANAGEMENT POLICIES

OPENING SIZE POLICY:

Management on the Bear Creek Watershed will comply with both the Oregon Forest Practices Act and Forest Stewardship Requirements for openings size. This means that no openings will exceed 60 acres and an average not to exceed 40 acres. Harvest units may be larger than 60 acres but only for treatments that do not create large openings (e.g., thinning or single tree selection harvesting).

Tree Retention

TREE RETENTION DEFINITION:

Any harvest type removes trees, but almost all harvests also leave trees behind. These trees are "retained" and represent some proportion of the pre-harvest forest condition. Tree retention ranges from large proportions of the healthiest trees, for instance in a thinning treatment, to no tree retention in a small patch cut. Tree retention requirements exist for live trees, snags, and woody debris. Retention may also be dispersed or clumped, with clumping often occurring around stream buffers. Retention is often specified as representative of trees in the stand pre-harvest, meaning that a forester cannot only leave small or less valuable trees. In addition to standard retention, foresters often select wildlife trees based on unique, habitat-friendly tree characteristics such as broken tops, large scaffold branches, or other form.

TREE RETENTION PURPOSE:

Tree retention creates the long-term legacy of forest structure. Prior plans referred to retention trees as "transition trees," implying a long-term transition towards old forest stand structure. In a thinning treatment, the retained trees may retain even-age monoculture characteristics in a stand. On the other extreme, a variable retention harvest will often leave a diverse mix of species and tree sizes in clumped and / or dispersed retention. This level of retention creates high levels of structural complexity and species diversity with a multi-strata stand. Over the long-term this type of retention can also create natural regeneration. Harvest units with high levels of diverse tree retention, over time, have the potential to increase the ecological resilience of the forest in the face of disturbances such as wind, fire and pathogen outbreak.

Harvest with high levels of tree retention is also generally more expensive to complete than clearcuts and present some risk in terms of regeneration, especially if managers rely on natural regeneration. Retention creates an operational obstacle and increases the difficulty of yarding logs. The difficulty mandates hiring experienced loggers willing to work around retention without creating damage. Logging often costs more based on the difficulty of the work. This is

particularly the case with thinning, which may be quite expensive due to the high value of the retention trees and the additional cost of appropriate equipment.

TREE RETENTION POLICY:

The management of the Bear Creek Watershed will comply with the requirements of both the Oregon Forest Practices Act and Forest Stewardship Council certification. This mandates a graduated level of retention based on opening size, with the maximum retention reached at 40 acres overall harvest unit size.

Retention must serve to increase stand diversity through tree selection. Retention may be clumped, dispersed, or a combination of both. The high windthrow risk present on the Bear Creek Watershed will mandate a majority of retention in linear clumps oriented in-line with prevailing storm winds. Over the past decade this approach has proven successful. Retention areas will also be located around streams, adding to the existing riparian buffers to provide further protection in areas with windthrow or erosion risk.

Road Maintenance

ROAD MAINTENANCE DEFINITION:

Road maintenance includes all activities associated with the road network, as well as the prioritization and monitoring of roads. At a basic level, scheduled maintenance includes vegetative control (brushing or herbicide application), grading and possibly rolling, addition of crushed rock as necessary, cleaning of cross-drain structures, and replacement or addition of drainage infrastructure as needed.

Road maintenance relies on an iterative prioritization of needs and uses. Mainline roads require maintenance in addition to what smaller spur roads may require. Small spurs may simply be allowed to re-grow while roads with drainage issues may require decommissioning. Decommissioning ranges from relatively minor excavation to complete re-grading and revegetation of abandoned road surfaces.

ROAD MAINTENANCE PURPOSE:

A forest road network provides essential access throughout a property for a multitude of tasks. These range from harvest activities to fire suppression, monitoring, forest health treatments, and recreation. A well-maintained road network improves the feasibility of harvest activities while decreasing the risk of high-cost repairs or road damage.

Road maintenance is also critical to source water management for two primary reasons: 1) to decrease the risk of catastrophic failure events and associated erosion issues and 2) to minimize the fine sediment mobilization in runoff from road surfaces. These issues are critical to the quality of source water and accordingly the cost of water treatment.

1. Catastrophic Failure Risk: Road systems both run parallel to streams and perpendicular to streams at existing crossings. Roads additionally interrupt sub-surface runoff and transfer it to surface runoff in roadside ditches. This concentration of water combined with active erosion in and around streams creates a significant risk of catastrophic road failure. This could be as minor as a blocked culvert overtopping the road surface or as significant as a landslide or major slump. These events are almost always attributable to either poor initial road design or a lack of maintenance. Regular maintenance and monitoring protect against the risk of catastrophic failure. Catastrophic failure presents a source water risk in terms of large quantities of mobilized sediment, although they often occur as a short pulse and larger particles may settle out if the failure is sufficiently far from intakes.
2. Fine Sediment Mobilization: While catastrophic road failure events are noticeable and usually fixable, fine sediment mobilization from road surfaces are an ever present and significant cause of source water contamination and increased filtration costs. Roads, particularly when heavily used, generate fine sediment and concentrate it in roadside ditches. These ditches contribute the fine sediment directly to streams. Fine sediment remains suspended in the water column through the stream and source water intakes, creating significant water filtration issues. Any logging activity will generate increased sediment through any road system. Accordingly, a challenge exists in building and maintaining a road system with minimal risk from fine sediment.

ROAD MAINTENANCE POLICY:

An up-to-date map of roads and inventory of condition is critical to prioritizing maintenance activities. Smaller or less frequently used roads either require decommissioning or have been / will be abandoned. Mainline and essential spurs are be maintained on a scheduled basis with repairs as needed.

Road maintenance will focus on updating roads to current watershed best management practices. These practices focus on transferring water to the downhill side of all roads while minimizing the potential or water concentrating in roadside ditches. Strategies include out-sloping roads where possible, frequent cross drains, and disconnecting culverts from active stream channels. Natural forest understory vegetation provides the best sediment filter available for forest roads.

In addition to planning for and maintaining the road system, logging schedules will focus on dry-season operations and close monitoring of truck traffic and road conditions. Active log hauling was found to increase fine sediment contribution 7.5x from background levels in a regional study, while infrequent use by non-hauling vehicles contributes only 0.9% as much sediment as during logging. As a result, logging only during dry seasons and monitoring roads is critical for source water quality.

Road inventory is included in this plan and maintenance activities are included in annual operating plans to be presented to the Astoria City Council.

Invasive Species

INVASIVE SPECIES DEFINITION:

Invasive plant species such as Scotch broom (*Cytisus scopwius*), tansy ragwort (*Seneciojacobea*) and Himalayan (*Rubus thyrsanthus*) and evergreen (*Rubus laciniatus*) blackberry are found in many parts of the watershed. These species have successfully invaded the region because they seed or sprout prolifically and are strong competitors with native vegetation, including tree seedlings.

Many watershed activities or events have the potential to promote the spread of exotic plants by transporting seeds, opening areas to light, or exposing mineral soil (e.g., vehicle traffic, road clearing, timber harvest, wildfire).

Major diseases of North Coast conifer forests include pathogenic fungi that cause stem rots, root rot and needle diseases which can each individually drastically reduce stand vigor and wood quality, and can lead to blowdown or tree death.

Although not yet evident, root rots present a significant general hazard to forest management on the Watershed. Careful monitoring can help identify and control problems before they become widespread. Control measures for root rots include managing for non-susceptible species such as western red cedar and red alder.

Management for Douglas-fir on the watershed entails significant risks due to an extensive outbreak of a needle fungus, Swiss needle cast (*Phaeocryptopus gaeumannii*). At the current level of infection, Swiss needle cast, while not immediately fatal, significantly reduces tree growth and vigor.

Most tree species have developed effective resistance and tolerance mechanisms to help ensure their reproduction and long-term survival when faced with common pests. However, this may not be the case with exotic insects and diseases. Exotic pests such as chestnut blight, root rots, and others can cause high mortality as the host tree exhibits little resistance. Given the proximity of the Bear Creek Watershed to a major shipping route, the potential for a major exotic insect or disease outbreak is an important consideration to incorporate into a complete management plan.

Sitka spruce tip weevil (*Pissodes strobi*) is commonly associated with young Sitka spruce. It is present on the vast majority of young spruce on the watershed, causing stem deformity and leader dieback. It is not

fatal except where the attacks are frequent and severe enough to retard height growth, allowing the trees to be overtopped by competing species. Tip weevil is likely to be present as long as there are young spruce present. As the current stands age and the trees reach a height no longer favorable to the insect, the infection levels are expected to decline. For example, recent studies show that beyond about 25 years of age, infection levels decline to about 10 percent infected at age 45 (Turnquist and Alfaro 1996).

Significant damage from Douglas-fir bark beetle (*Dendroctonus pseudotsugae*) is primarily a hazard after major windthrow occurs. The downed trees provide good rearing habitat and allow insect populations to reach a level where successful attacks are made on standing trees. Strategies to prevent windthrow, prompt salvage of windthrown Douglas-fir, and use of beetle pheromone attractants can minimize risk from bark beetles. Although the Douglas-fir on the Watershed are being impacted by Swiss needle cast, there is no indication yet that the weakened trees are more susceptible to bark beetles. Regular, careful monitoring can help identify changes and points of concern.

Massive defoliation of western hemlock by hemlock looper (*Lambdinn fzscellaria lugubrosa*) occurs periodically in this region. Conditions that favor hemlock looper outbreaks are not well understood but there are indications older hemlocks, Sitka spruce and silver fir are most susceptible. This is an important consideration in long-term forest management in the watershed

INVASIVE SPECIES PURPOSE:

Invasive plants present a competitive challenge to native vegetation. This includes significant risk from blackberry and Scotch broom, which can overwhelm all native species and create a monoculture thicket. By competing aggressively for light and moisture, these invasive species will either kill native species that occupy a site or preclude the establishment of native plant communities.

Invasive species can create challenges for working forestry and source water. In order to grow a healthy forest, native trees, primarily conifers, must outcompete any invasive species present on a site during stand establishment. If a risk exists of failure to establish a forest, foresters typically consider mechanical and chemical treatment of invasive at significant expense. Many commercial forest managers proactively broadcast treat harvest units in order to decrease the risk of invasive and to decrease competition from invasive and native herbaceous plants.

Invasive species also present a range of risks to source water. Some of these species, such as Reed canary grass, change stream channel patterns and present erosion risk either in the stream channel or from cutbanks. Others may establish along riparian corridors and outcompete native vegetation. These plants can increase overall evapotranspiration, decreasing overall soil moisture. Over time, this condition will lead to decreased base flow and less reliable summertime source water.

INVASIVE SPECIES POLICY:

The City of Astoria will work with partners to utilize the best available science and treatments for the management of invasive species. Invasive species are an inevitable component of ecosystems on the Oregon Coast, but forest managers will strive to manage for native species and diverse ecological communities.

The most viable and permanent treatment for most sun-loving invasive species is shade. The establishment of mature stand structure across the property and, where possible, retaining a component of overstory trees through harvest rotations, has the potential of shading out most invasive species.

Careful planning and conduct to minimize wounding are desirable in all forest operations where trees are left growing. This includes the equipment used, harvest layout and timing, and species selected for harvest and reforestation. Strategies to avoid or reduce stem damage include using light weight, maneuverable logging vehicles, employing skillful and aware timber fallers and operators, avoiding spring & early summer logging activity when bark is most easily damaged, and managing for mixed stands with species of varying susceptibility to damage.

Strategies to minimize Sitka spruce tip weevil impacts include growing young spruce at high densities to encourage height following top death, favoring spruce regeneration in small gaps not adjacent to young weevil-infected spruce, limiting the production of young even-aged spruce stands.

Because no effective strategies have yet been found to minimize Swiss needle cast while still managing for Douglas-fir, discouraging Douglas-fir regeneration and managing for alternative species (including species selection during thinning) seems prudent for some areas. However, Douglas-fir is clearly well adapted to many sites on the Watershed and thus deserves continued careful consideration in current and future management plans.

Chemical Use

FOREST CHEMICALS DEFINITION:

Forest chemicals include herbicides, pesticides, and fertilizers. A wide range of products exist and are applied through a variety of methods. The most common forms of chemical use in coastal Oregon forests are broadcast and spot herbicide application. These applications are either focused on decreasing herbaceous competition or treatment for specific invasive species issues. Pesticide use is rare and fertilizer application varies between landowners. Fertilizer use is extremely rare on public lands.

FOREST CHEMICALS PURPOSE:

Forest chemical treatments generally focus on three forest stewardship goals.

Controlling plant competition during regeneration in order to improve seedling survival and growth.
Treatment of invasive species that pose a risk of spread or competition with native plants.
Maintenance of road systems in order to control grass, invasive plants, and brush. Road spraying allows for less frequent brushing and retains rock surfaces.

Some extreme circumstances, such as widespread Scotch broom, exist with few alternatives to herbicide treatment. These circumstances do not currently exist on the Bear Creek Watershed and efforts will be taken to avoid future invasive species issues.

FOREST CHEMICALS POLICY:

The City of Astoria will not use any herbicide, pesticide, or fertilizer for any type of treatment on the Bear Creek Watershed. The City of Astoria will work proactively with neighbors to establish agreements for herbicide use adjacent to or within the watershed. In addition, operating plans will include roadside mowing and manual treatment as needed post-harvest.

High Conservation Value Forest

HIGH CONSERVATION VALUE FOREST DEFINITION:

The Forest Stewardship Council and other conservation non-governmental organizations provide guidance for the identification of high conservation forest. The standard methodology identifies six criteria: 1) species diversity, 2) landscape level ecosystems, 3) ecosystems and habitats, 4) critical ecosystem services, 5) community needs and 6) cultural values. The HCV methodology then relies on a standards adaptive management framework for identifying a value, assessing the value, developing management plan, plan implementation, monitoring, and adaptive long-term management. At a tangible property scale, this process includes a range of discovery tasks to determine high conservation value forest, incorporation into existing or new plans, followed by long-term iterative management, monitoring, and adaptation with the goal of providing an additional level of protection for the underlying conservation value.

HIGH CONSERVATION VALUE FOREST PURPOSE:

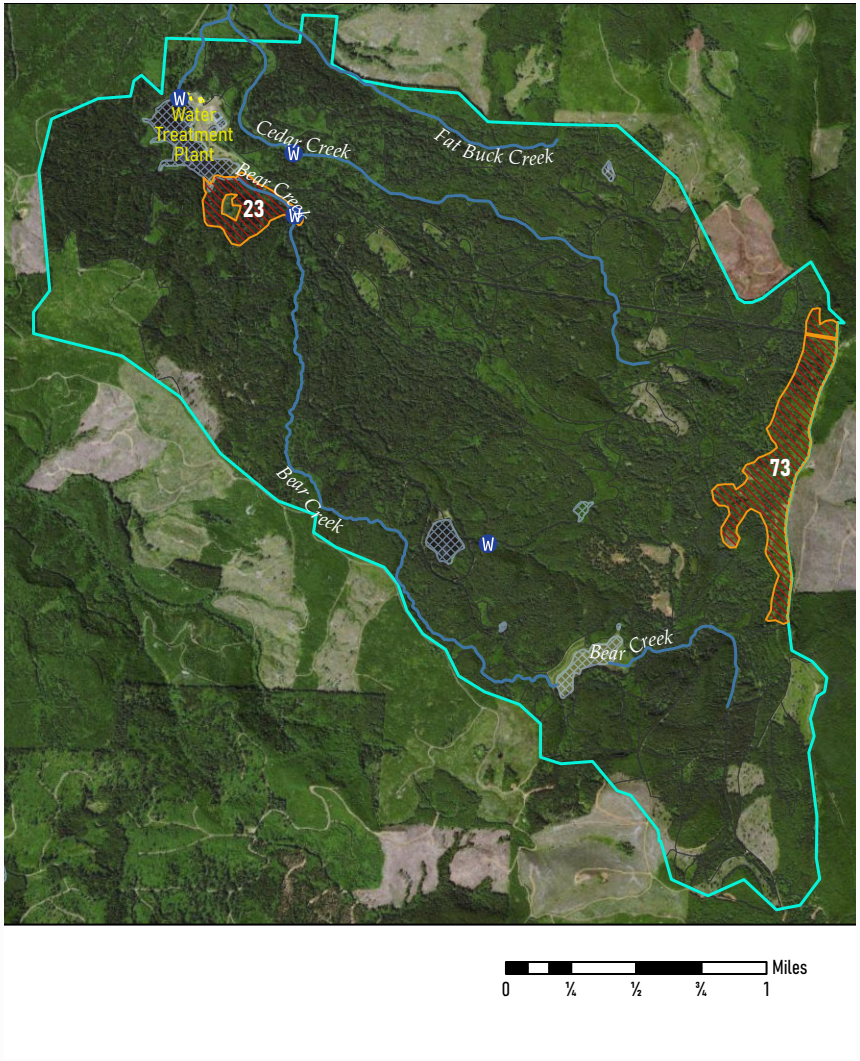
High Conservation Value Forest provide protection for unique values, such as drinking water, as well as an additional layer of decision-making oversight for ecologically unique landscapes. In the case of a drinking watershed, designation as High Conservation Value draws attention to the importance of the landscape in providing reliable quantities of clean, safe drinking water. Other areas that will receive an additional level of scrutiny include forests with unique tree species or legacy areas of old growth forest.

HIGH CONSERVATION VALUE FOREST POLICY:

The City of Astoria exists in a unique position where 100% of the Bear Creek Watershed is considered High Conservation Value Forest under FSC standards due to the drinking watershed delineation matching the property line. While the entire property is considered high conservation value, individual stands require additional consideration. These include the following:

Stand 23. This 34-acre unit contains characteristics of a late successional forest and will be managed as an FSC Type 2 old growth stand. The trees vary in age from less than 30 to greater than 200 years. Numerous snags of varying height and diameter are found within the stand.

FOREST MANAGEMENT POLICIES



Species composition is dominated by hemlock and Sitka Spruce with cedar and certain hardwoods also present. This area will be protected to the extent possible to enhance its value as a unique area. No harvest activities or road construction will be conducted in this area.

Wickiup Ridge Stand 73. The higher slopes of the Wickiup Ridge contain a unique combination of non-forested rock out-croppings and low height tree and shrub vegetation. This site is host to a variety of flora and fauna. The area will not be scheduled for any harvesting or rehabilitation activities. The current rock pit may be used to produce rock for use in the watershed.

While Active harvesting and forest management may continue within the High Conservation Value forest areas, many areas of the watershed have been removed from harvest for the following reasons: ecological uniqueness, riparian buffers, steep slopes, and highly erodible soils. Due to the entirety of the Bear Creek Watershed being identified as High Conservation Value, no slash pile or controlled burning will be permitted. Instead, small slash piles will be allowed to naturally decompose, both decreasing the rate of carbon emitted from slash and reducing fire ignition risk.

Stewardship activities on the Bear Creek Watershed include road maintenance, invasive species treatment, thinning, and commercial harvest activities. These activities are described in the following sections.

Monitoring

Watershed Units: The forested areas of the watershed have been divided into stands (units of common species, age etc.) which are identified in the Watershed Inventory. The units will be marked to indicate environmentally unique areas, roads and other important features. The units will be reviewed annually to ensure its continued accuracy.

Permanent Plots: Permanent plots may be established within selected stands to be used in providing stand growth and composition information. Plots will vary in size according to the age and composition of the stand. Plots will be marked on the ground using GPS coordinates and be evaluated at least once every 5 years.

Stand Management Records: A record shall be kept for each stand to include: Description of stand Management and harvest activities Plantings by seedling type and source Description of transition trees and snags Forest Health issue

Other Observations: All management unit records should be reviewed periodically for accuracy and compliance with the management policies in this plan and to access experience and progress toward achieving management objectives.

Resident water resource manager monitors the road, forest and water conditions on a daily basis. Any concerns are addressed as needed.

Timber and Carbon Inventory

A comprehensive forest inventory was completed in January 2014 and updated in July 2020. While the 2014 inventory was completed for both forest management and carbon project development purposes, the 2020 inventory focused specifically on forest carbon and utilized 5 strata of forest stand types, providing statically accurate carbon data at a property scale but relatively coarse data for forest stand characteristics at the stand level. Due to the most recent inventory approach, future inventories will be used to verify the carbon project but the 2014 inventory will continue to be grown forward using growth and yield software, with new plots incorporated on a 5-year basis.

Allowable Annual Harvest

The 2014 Inventory indicated a standing volume of one hundred million board feet (100 MMBF). The conservative growth projections indicate an annual growth rate of 4%. Under business-as-usual practices the annual harvest level would be set at three million board feet per year which would retain the current standing volume.

In 2014, the City of Astoria engaged with L&C Carbon and the American Carbon Registry to develop a carbon project. This project achieved climate mitigation outcomes by committing to long-term sequestration of carbon in the form of standing timber inventory. The result of this was an agreement to not harvest below existing inventory levels, and to subsequently constrain annual harvest levels in order to generate additional carbon credits. The result of this has been an annual harvest level set under 1 MMBF with approximately 3 MMBF accumulating in the overall standing inventory. Based on growth and yield modeling, the current inventory is approximately 121 MMB.

The primary purpose of the Bear Creek Watershed is to supply quantity and quality of water to the city of Astoria and other users. Forest management activities as described under this plan are undertaken to improve the health and maintenance of the watershed and provide funding for approved projects.

All forest areas designated for tree removal shall use the following guidelines when selecting trees for removal and retention. Specific circumstances may require deviation from these guidelines and will be documented prior to implementation.

GUIDELINES FOR THE SELECTION OF TREES TO BE HARVESTED FROM BEAR CREEK WATERSHED:

Closed Canopy- These stands consist of fully stocked stands of conifers that have a common age of 40-60 years. These stands are the result of previous management and have components of natural and planted regeneration. The dominant species are Douglas-fir and Hemlock. In these stands, the removal and retention guidelines shall include:

1. Basal area targets shall be established appropriate for each removal area. They will vary from 110 to 170 square feet of basal area. Operators will be trained and have appropriate tools to assist with meeting the selected basal are target. Operators will be given the responsibility of selecting the appropriate trees for removal and retention after training. Monitoring shall ensure compliance with the guidelines.
2. Trees selected for removal shall include injured (bear) or diseased (Swiss needle cast) trees.
3. Species that occur infrequently within the stand shall be retained if possible. These may include cedar, spruce or true firs.
4. Older stand components from previous stands shall be retained
5. Non-merchantable segments and debris shall be left within the area
6. Dead trees shall be left to meet snag retention goals.
7. Large non merchantable log segments that meet course woody debris criteria shall be left within the harvest areas.
8. Patch cuts may be designated for harvest. These will vary in size from two to fifteen acres. These patch cuts will contribute to the regeneration component of the desired future forest condition. All trees within the patch cut shall be removed unless marked for retention.
9. Areas larger than 15 acres will be planned as thinning or variable retention harvest with a minimum of 35% retention in accordance with the FSC Pacific Standards.

Mature Forest Stands- These stands have developed or will develop characteristics described under forest conditions. Current stands have been thinned in the past. They are dominated by Hemlock with a mix of Douglas-fir, Spruce and True Firs. The larger and older segments of these forests have significant defect and low quality log characteristics. In these stands the removal and retention guidelines shall include:

1. Areas selected for removal shall be marked by City representative.
2. Areas selected for removal shall improve or maintain the condition of residual trees
3. Areas may be selected for removal to improve the growth of or encourage the emergence of natural regeneration.
4. Segments of the current stand shall be identified for retention. This shall include species and age distribution. This will allow for the stand to move toward an older forest condition.
5. Areas of natural regeneration shall be protected to the extent possible.
6. Trees exhibiting old forest conditions shall be considered for retention. The characteristics may include large diameter, limb structures that form platforms and dead tops.
7. Debris from harvest shall be left distributed in the area.
8. Large non-merchantable segments shall be left to meet large wood goals.
9. Snags or dead trees shall be left to meet snag goals.

Pre-Operation Review

Before operating in any unit an assessment of the unit and its surroundings will be conducted to determine the least ecologically disruptive and most economical method of operation and requirements for resource protection. This should include retention of transition trees and snags, and the development of coarse woody debris. Wildlife and unique tree and plant communities should be identified, and their protection considered before tree removal is started.

Timber harvesting can greatly benefit from careful planning and implementation. This is especially true where resource values like water quality are a high priority. One of the first questions in harvest planning for specific areas such as forest stands on the Bear Creek tract is the choice of a logging system. Because of their availability and economy, ground-based systems are often the first to be considered. Given the moderate terrain found in most of the Watershed, these systems are a reasonable choice for many areas, although careful harvest planning remains important both for logging efficiency and resource protection. Small cable systems may be preferable for areas with steeper slopes, soil types, moisture conditions or other limitations for vehicle traffic.

Timber harvest systems are inextricably linked to forest roads because: a) the latter nearly always provide the means for transporting logs to markets, and b) the local need for logging roads is directly controlled by the practical yarding distance of each harvest system. The link between harvest system and road density is an important planning consideration with respect to both economic and resource concerns. For example, the higher costs of cable logging relative to ground based systems may be partly or fully offset by a reduced need for new road construction or for improvements of existing roads. Similarly, the reduced need for additional roads might help avoid some of the erosion and sedimentation problems that could occur with such roads. The current road system on the Bear Creek Watershed is generally of sufficient density to accommodate either ground based or cable systems, but some additional spur roads may be desirable in a few areas for better access or landing locations.

Timber harvest scheduling is an important consideration in management planning for both long- and short-term objectives. In developing a long-term management and harvest plan for a large area like the Bear Creek watershed, it is easier to identify important needs and opportunities as well as more desirable sequences for related activities such as road construction or improvements or staggered harvests to

enhance riparian forest conditions. Careful scheduling of specific timber harvests and other activities in the near term also can help avoid potential soil and water problems. For example, although timber harvesting often can be done throughout the year in western Oregon, during wet weather soil disturbance from ground based logging often increases and log truck traffic is much more likely to increase sediment losses from forest roads.

Careful layout of individual harvest areas is important for both efficient logging and forest stand and watershed protection, with a well-planned harvest unit often helping serve both objectives. Designated skid trails are also especially desirable where multiple management entries for thinning is appropriate, like the many young forest stands found on the watershed. Layout of cable logging units can also benefit from careful planning to promote log suspension to avoid soil disturbance, as well as to reduce damage to residual stems.

All timber harvest plans will be presented to the Astoria City Council and contracts must be approved by City Council. All details for pre-operations review will be included in the annual operating plan.

Planting and Regeneration

Planting and regeneration will require active monitoring at all stages, including harvest planning, harvest operations, prior to regeneration, and particularly through the first 15 years of stand establishment. Natural regeneration will be encouraged after harvest in a variety of ways, including the exposure of mineral soil during tree removal and site preparation.

Where planting is necessary to assure regeneration or to encourage diversity only seedlings of a species and size appropriate to the site grown from a seed source matching the site, will be used. Certain species such as western red cedar which were present in greater numbers in previous conditions will be planted to increase current stocking. Planting and protection techniques will be developed to increase success of seedlings.

Selection Harvest

Selection harvest is unlikely to be fully successful or necessary throughout the watershed. However, some interesting opportunities now exist where past management activities have already created at least two-aged forests (e.g., stand 43). In older, windfirm, even-aged stands it may be possible to gradually shift to uneven-aged with a series of partial harvests, removing enough of the main canopy to encourage regeneration. Depending on objectives, it could take decades and several carefully planned harvests, followed by successful regeneration establishment and stand tending to move a forest stand from even- to uneven-aged.

Probably the most problematic stands are the densely stocked 50-60 year old forests. The lack of windfirm trees in these stands will be a challenge in any future silvicultural system that involves thinning or other partial cutting.

The Oregon Coast Range is well-known for its potential for intense brush understory during stand establishment. In addition, serious damage to young seedlings by browsing animals (e.g., rodents, deer, elk) also is common in the region. Thus, careful planning and prescription of regeneration practices is essential and can be most effective and economical when considered in conjunction with harvest planning.

Although natural regeneration can play a significant role in many locations, planting of nursery seedlings is usually necessary where brush competition is expected or where species diversity is desirable. Planting large nursery seedlings immediately after harvest provides a competitive advantage and helps avoid the use of herbicides. To help ensure suitability for the local growing conditions, such seedlings can be grown under contract at a forest nursery from seed collected from healthy, well-formed trees on or near the watershed. This is particularly desirable for the silver fir, which is relatively rare in the region and represents a local, isolated population that is valuable to maintain.

Stakeholder and Public Involvement

The City of Astoria as a public entity provides an open process related to all decisions impacting the management of the Bear Creek Watershed.

This Forest Resources Stewardship Plan is maintained on the City of Astoria website and can be accessed by any person or entity for review. Any interested party can contact the City and obtain access to the management plan if they do not have web access.

Frequent articles in the Daily Astorian inform citizens of watershed management activities, and a popular "brewshed" series of presentations at Astoria breweries helped to further spread information about water and forest stewardship on the Bear Creek Watershed. City Council meetings serve as an important public forum for conversations about the watershed and all management decision go through a process with the City Council, allowing for public stakeholder input.

All harvest projects are submitted to City Council for review at a regularly scheduled meeting of the council. The information relative to the project is published for review prior to the meeting on the City website and notice of the meeting agenda is posted in the local paper prior to the meeting. Council accepts public comment prior to any decision regarding the project. The project is distributed to qualifying parties for review and opportunity to bid on the project. The project notice is also posted in the local paper. All responses are brought before Council for review and decision to award a contract. Public involvement is considered in all phases of the decision making process.

Public Access & Recreation

As noted in the property description, the Watershed has some desirable attributes for recreation. Interest in public access and recreation on the Bear Creek Watershed is likely to grow as the population of northwest Oregon increases. This raises a number of important questions, challenges and opportunities for management of the Watershed.

Humans are the primary exogenous force acting on the Bear Creek Watershed. From forest management decisions to recreational activities, human actions have and will continue to shape this landscape. Human impacts can be positive and negative in terms of water quality. Positive impacts would include invasive species treatments and resilience-oriented forest management decisions. Negative impacts are far more varied and include fire ignition, erosion, and source water contamination. This section focuses on the three latter issues.

While fire ignition is not fully tracked, anecdotally and from conversations with the Oregon State University fire resilience extension staff, most fire ignitions in the Oregon Coast Range are human-caused. Typically, fires start because of both a poor understanding of fire propagation risk and careless behavior, or a combination of the two. The primary method to limit human-caused fire ignition is to exclude humans from a landscape. This human exclusion has become an annual occurrence, with most private forestland owners closing all public access during periods of high fire risk. Other measures can be taken including limitations on vehicle and power-driven machinery use, campfire bans, smoking bans, limitations on slash burning, and improved signage and public education. Fires in Northwest Oregon have historically been large and stand replacing with relatively long (over 100 years) return intervals. More recently, a number of fires on and around the subject property have ignited due to slash burning. Improved slash treatment practices are mandatory for fire management, including considerations of chipping, small piles, and an outright ban on slash burning on the property. This again would be in-line with comparable watersheds on the coast that do not burn slash.

Another concern on the Oregon coast is water contamination risk associated with hunting and recreational use. Numerous examples exist of wounded animals dying in or near source water. If not immediately located and removed, these carcasses will cause significant issues. Careless hunters cleaning animal parts or tools in source water can also present a real, although significant smaller risk. This risk must

be balanced with erosion and stand establishment risks presented by an overpopulation of elk. Elk can habituate themselves to wallows in low-gradient streams and wetlands. In turn, these wallows create significant sediment pulses downstream. Elk also actively browse most conifer species with the exception of Sitka spruce, causing challenges for stand establishment post-harvest in areas with increased elk presence. Active hunting through a managed program can limit elk issues including erosion and tree browse. A program such as this should include active hunter education and follow-up to mitigate human-caused source water contamination risk. In addition to hunting risk, all recreational uses bring the risk of human waste, including bodily waste, in and around water sources. Evaluation of human waste risk and a plan for human management should be included in any recreation planning.

FSC Chain Of Custody

The following policy will provide procedures for the operations pertaining to the sale of certified products. While the Bear Creek Watershed holds FSC certification, for wood to be sold as FSC certified lumber it must retain a chain of custody through downstream purchasers (eg. sawmill and lumber yard).

1. Notice of timber sales shall include documentation that the timber is certified under FSC. All eligible purchasers have equal opportunity to bid on timber sales. Effort will be made to ensure that all potential FSC certified purchasers are aware of scheduled timber sales.
2. The city of Astoria Public Works Department is responsible for the control of all timber sales including those sold to FSC purchasers. Public Works Director or his appointed representative shall be responsible for all control procedures.
3. All logs sold to an FSC market shall be identified on the log load form as certified under the FSC Chain of Custody number. Such forms shall identify the date the logs left city forests, species, logger, trucker and destination. Copies of the forms shall be distributed to the logger, purchaser, and trucker. One copy of the form shall be retained by the city.
4. The city shall not allow products not originating from city certified FSC forests to be sold or distributed under city FSC Chain of Custody Certificate.
5. FSC purchaser shall be required to provide sale information to the city. Information shall include but not be limited to:

    - report of each load of logs received
    - quantity (bd ft or other measure)
    - species of products
    - log grades or other quality documentation
    - summary of quantity delivered for each reporting period as established in the contract of sale

6. Records of the entire sale process shall be retained for a minimum of 5 years. Records shall include but not be limited to the following:

    - presale information
    - sale bid packet
    - contract and other sale documents
    - record of log load documents
    - purchaser log load and summary documents
    - record of all correspondence relevant to the sale

Road Status and Maintenance

The roads in this review are divided in to 2 major categories, the main road systems and the spur roads from the main roads. All of the roads are travelled at least annually to remove the overtopping vegetation and to note any concerns that may need immediate attention. Annual Watershed road maintenance and improvement budget is estimated to be $40,000 per year with an additional $25,000-$75,000 budgeted for harvest activities. Additional significant improvements or road decommissioning projects are approved through the City Council process on a case by case basis.

Most roads on the Bear Creek Watershed are surfaced with loose rock that varies widely in depth and condition. Using and maintaining a good quality rock surface generally helps reduce sediment losses from low volume roads while also enhancing vehicle traffic and upkeep. Higher quality rock exists in a pit on Wickiup Mountain, but removal and transport from this location is more costly than from the other pits. This cost may be offset by the added life expectancy of this rock when used for road surfacing. Selective use of geotextile fabric over road subgrades also can be a cost-effective way to enhance the strength and operating life of rock surfacing.

Low use roads like those in the watershed can be an important site of management related erosion, and thus a source of sediment where they cross or are close to streams. Careful assessment of local erosion sites and processes can help identify priority locations (e.g., road sections nearest or crossing streams) and effective approaches for reducing or avoiding erosion and sedimentation problems from old or new roads. Management approaches can be very diverse and include considerations of road design, construction, traffic control, maintenance, and improvements.

Studies have shown that sediment losses from forest roads can increase significantly during periods of wet weather, and especially when traffic levels are heavy (Reid and Dunne 1984). Restricted access to the Watershed now provides substantial control of the impacts of vehicle traffic, although road maintenance and water quality protection may be enhanced further by limiting vehicle traffic and speed by City staff and other authorized personnel, particularly during wet weather.

Constructed drainage ditches are present along some road sections on the Watershed, but many are full of sediment and thus are not conveying water effectively from the road. Combined with in-sloped roads this can create issues, whereas outsloped roads often benefit

from roadside vegetation in order to filter sediment. This condition increases the risk of road structural damage or erosion and sedimentation during wet weather. An obvious remedy would be to identify the road sections with the highest risks of problems and then clean the ditches with heavy equipment. However, ditch cleaning itself can increase the risk of delivering a temporary pulse of sediment to streams. Careful comparison of the relative risks of plugged ditches and ditch cleaning is thus important. Where ditch cleaning appears prudent yet sediment losses remain a concern, a staged approach may be effective, i.e., cleaning only a portion of these ditches at one time to allow them to stabilize before cleaning more.

Aside from the A-Line that collects all traffic within the Watershed, perhaps the most traveled road is the N-Line to the summit of Wickiup Mountain. For most of its length , the N-Line is a steep, ridgetop road with few culverts (i.e., it drains to either side). Some slides have occurred along parts of the ridge, and there may be continued risk of erosion along this road due to the locally steep slopes and high rainfall. This road may be a priority for both maintenance and potential improvements because of its heavy use and importance in providing access to the communication equipment at the summit.

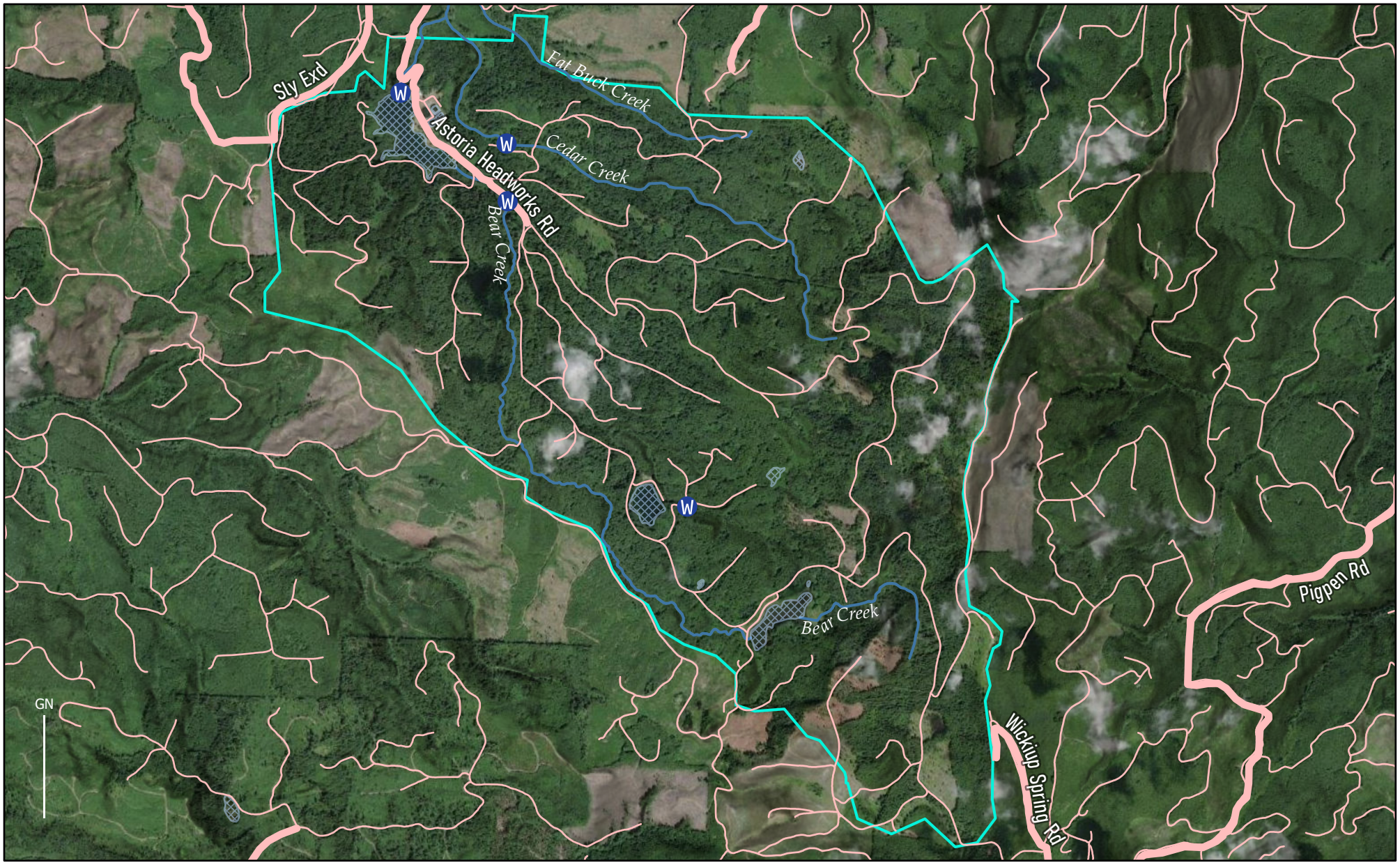
Culverts are an important feature of any road system, and on the Bear Creek Watershed they include a large number of both ditch relief pipes and stream crossing culverts. Ditch relief pipes, sometimes called cross drain culverts, collect water that has drained to the roadside from the road surface or cut slope, and direct it away from the road. Evaluation and maintenance of these culverts are important to help ensure they have appropriate spacing and flow capacity, do not discharge into potentially unstable fill slopes, and do not discharge sediment laded water in or near water bodies.

Surface drainage water also may accumulate sufficient volume and power to erode the ditch or road surface. Some ditch relief culverts were found to discharge directly onto potentially unstable fill or have a drop at the outlet that could lead to gullying or slope failure. This could present a growing risk with climate modeling predictions pointing to the rise of intense rain events during wet cycles.

A potentially valuable application of this information is to compare the current flow capacities of these pipes with the expected flows for large storm events (e.g., 50-year return interval). Large flows from intense rain events can be estimated from the acreage and average elevation of the drainage area above each stream crossing (Adams and others 1986). Where estimated

storm flows are found to be considerably greater than current pipe capacities, increased culvert monitoring and maintenance or upgraded installations may be desirable.

Fish passage can be a concern with stream crossing culverts because of potential barriers created by shallow flow depths or high stream velocities, as well as excessive jump heights below pipe outlets. Although anadromous fish cannot access much of the Bear Creek drainage because of the main dam, passage of ad fluvial fish, those that migrate within a stream system, may be limited by some existing pipe crossings above dam.



ROADS

Miles
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Bear Creek Watershed
Source Water Diversions
Water
Roads

Name	Description
A-Line	This is the main road system that enters the watershed and accesses the 3 reservoirs and the transmission towers on Wickiup Ridge. The road is well travelled and has been rocked with a layer of crushed rock for most of the distance. The mainline is approximately 7.5 miles in length. This road is scheduled to be rocked with additional crushed rock on an annual basis. All culverts are monitored annually and improved or replaced as needed. The intent is to rock the road to allow for periodic grading in future years.
Bridge Spur	This spur is approximately 0.5 miles in length. The road crosses Bear creek on an I-beam bridge of questionable construction. The Bridge must be analyzed to ensure passage by heave traffic (log trucks) prior to planning of any harvest activities. The road surface is pit run rock. The surface will be improved in future years if harvest activities are scheduled to use the road. The road will be mowed at least annually to control grass and other vegetation.
Clatskanie Cross Over	This spur connects with a road system accessing industrial lands to the west of the Watershed. It is gated at the entrance to the Watershed. The spur is approximately 0.7 miles to the boundary. It crosses a branch of Bear Creek. The road surface is pit run rock. The culverts are currently functioning. This spur is mowed annually to control vegetation.
M Spur	A short spur accessing a portion of the watershed. Road surface is pit run rock. This spur will be mowed annually to control vegetation.
Spur 17	A short spur accessing area between Middle and Wickiup Lakes. It is a pit run road surface. The road will be mowed annually to control vegetation.
Spur 18	This spur is approximately 0.7 miles in length. It crosses upper Bear Creek. The culvert is functioning and will be monitored to ensure proper flow. The road surface is pit run rock and the road will be mowed annually to control vegetation. Additional rock may be applied as harvest activities are scheduled.
Spur 19	A short spur that is covered with pit run rock for approximately .3 mikes. This spur connected with industrial lands to the west but is no longer usable due to the recent harvest activities on both sides of the boundary.
Spur 20	A short spur at the upper end of Wickiup Lake. It is a pit run rock surface. No activities other than annual mowing are scheduled for this spur.

Name	Description
Spur A-1	This spur originates from the industrial ownership to the west. It is gated at the entrance. It accesses the ridgeline above Wikiup Lake. It is approximately 1.1 miles in length. The road is covered with a pit run rock surface. It has not been used for several years and will be scheduled for improvement as harvest activities are scheduled.
N Line	This is an extension of the A Line that accesses the Transmission towers on top of Wikiup Ridge. The road was used for harvest activities by the City and the industrial ownership (Greenwood Resources). The road surface is pit run rock with some crushed rock placed on specific portions. The road is solid due to the rock ridge it travels along.
11 Line	
11	This road system is dived in to the 11A and 11B road systems. The 11A is approximately 2.5 miles in length and the 11B is approximately 1.5 miles in length
11A	This road system was improved in 2021 to access areas that experienced severe damage from the windstorm of 2007 and required subsequent thinning, and also for summertime harvest activities. The road has been rocked with crushed rock and 2 main culverts have been replaced.
11A-1	A short spur accessing area above Main Lake. It will not be used unless needed for access during future harvest activities. It is currently not accessible.
11A-2	Spur accessing areas above Main Lake. It has a pit run and dirt surface. Wet areas along the road make this spur unusable during any wet periods. The road received pit run rock during summer 2021 and will be decommissioned following harvest activities.
11A-3	This spur was used during the 2008 and 2021 harvest. It has a thin layer of pit run rock. It will be mowed to control competing vegetation.
11B	This spur is approximately 1.5 miles in length. It has a solid pit run surface. It will be rocked with crushed rock during future harvest activities. It accesses considerable area above Bear Creek. It will be mowed annually to control vegetation.
11B-1	A short spur 0.3 miles in length. Pit run road surface. It will be mowed annually.
11B-2	A short spur 0.3 miles in length. Pit run road surface. It will be mowed annually to control vegetation.
11B-3	A short spur 0.4 miles in length. Pit run road surface to be mowed annually to control vegetation.

Name	Description
Spur 1	A main spur approximately 2 miles in length that crosses Cedar Creek and Fat Buck Creek. It accesses the diversion dam on Cedar Creek which is where water is diverted from the stream to the sand filters. A large fill crosses Cedar Creek. This spur is crushed rock to the diversion dam area and pit run surface on the remaining portions of the system. A rock pit, which has been used in the past, is located at the 1.5-mile mark on the road. This pit is no longer in use but may be developed in the future. A large blockage has been dug at the 2 mile mark prior to where the road crosses Fat Buck Creek. The City does not use water from Fat Buck Creek but the Wickiup Water district does take water from the creek. Spur 1 requires a significant crossing reconstruction on Cedar Creek. This crossing is planned for summer 2022 as part of in-stream mitigation for the spur 12 reconstruction, completed in spring 2021.
Spur 1A	This spur is approximately 1 mile in length. It follows the Power transmission lines for a distance. It is a pit run rock surface. The road crosses a small branch of Cedar Creek. This road system may be improved during future harvest activities.
Spur 1B	A short 0.2 mile spur that is surfaced with pit run rock. It will be mowed annually to control vegetation.
Spur 1C and 1E	Two short spurs that are pit run roads. They will be mowed annually to control vegetation.
Spur 1D	This spur is blocked prior to the crossing of Fat Buck Creek. The Culvert on Fat Buck Creek will be evaluated to ensure proper flow in the future. This road was decommissioned just past Fat Buck Creek with a large tank trap and series of water bars.
Spur 12	Spur 12 and 12A access a significant portion of the Watershed. Spur 12 is approximately 2.7 miles in length and spur 12A is approximately 2 miles in length. Both of these spurs have been improved in the recent past. Spur 12 was improved in 2013. The majority of the road was rocked with crushed rock and 6 additional cross drainage culverts were installed. All culverts were inspected and cleaned as needed. The road crosses the upper reach of Cedar Creek. This culvert was replaced approximately 10 years ago. A gate was installed at the end of spur 12 where the road enters industrial ownership. Additional rock may be placed on spur 12 as future harvest activities are scheduled.

Name	Description
Spur 12A	This spur was improved in 2021, 2010, and 2006. Crushed rock was place over the pit run surface. A thinning activity and several patch cuts were completed along this spur. Additional crushed rock will be needed at the end of spur 12A and placed along the entire length to upgrade the road surface. A major culvert was replaced where Spur 12A crosses Cedar Creek, but the remainder of the road requires complete reconstruction and installation of 4 additional cross drain structures.
Spur 12B	A short spur 0.7 miles in length. It crosses a tributary of Bear Creek. The road surface is pit run rock. This spur will be improved in the future as harvest activities are scheduled
Spur 12C	A short spur 0.3 miles in length. It accesses a ridge above a branch of Cedar creek. It is a pit run surface and will be mowed to control vegetation.
Spur 12D	This spur connect with the spur 21 road system. The total length including spur 21 is approximately 3 miles. The road has a pit run surface but will need considerable improvement prior to any all weather use.
Spur 12A1	A short spur 0.7 miles in length. It is a pit run surface and has been used for harvest activities. It will be mowed annually to control vegetation.
Spur 21	T his main spur is approximately 3 miles in length. It crosses the upper branches of Cedar Creek and Bear Creek. Both of these crossings are blocked with significant washouts. The road surface is Pit run rock. This spur was used extensively for earlier harvest so the roadbed is very solid. The road across the first culvert will be improved during the summer of 2014. The stream crossing will be evaluated to determine the cost comparison for a culvert or a bridge. The road surface will be covered with crushed rock. All culverts along the improved portion will be evaluated. Culverts will be improved or replaced. Additional cross culverts will be installed as needed.
Spur 21 to Spur 12D	This portion of spur 21 will be improved with future activities. The washout on Cedar Creek will require the placement of a large culvert or a bridge. The road will require considerable rock to provide for all weather access. This road system is needed to provide access to the upper portions of Cedar Creek.