BEST AVAILABLE SCIENCE

FOR THE CITY OF CLE ELUM, WASHINGTON

Prepared by
Herrera Environmental Consultants, Inc.

On Behalf Of
AHBL, Inc.

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will print correctly when duplexed.

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LIST OF ABBREVIATIONS

BAS	best available science
City	City of Cle Elum
CEMC	Cle Elum Municipal Code
Ecology	Washington Department of Ecology
FWHCA	Fish and Wildlife Habitat Conservation Area
GIS	geographic information system
GMA	Growth Management Act of Washington
GWMA	Ground Water Management Area
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWPL	National Wetland Plant List
PHS	Priority habitats and species
RCW	Revised Code of Washington
SR	State Route
UGA	urban growth area
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

DISCLAIMER

The recommendations included herein are purely based on the review and analysis of the best available scientific information cited in this document. These recommendations have not been evaluated from the legal perspective. The legal implications of these recommendations should be evaluated by the City's counsel/attorney.

EXECUTIVE SUMMARY

The City of Cle Elum (the City) is mandated by the Growth Management Act of Washington (GMA) to review and update its comprehensive plan and development regulations according to RCW 36.70A.130(5). The City is also mandated to update its shoreline master program. The update must include a review and update of critical area regulations per RCW 36.70A.130(1)(c). If the review shows that the plan or regulations do not comply with GMA, then revisions must be made. The review of critical area regulations under RCW 36.70A.172(1) must be based on best available science (BAS). This report serves as the first BAS review.

The City's critical areas regulations have a deficiency in that they do not contain any discussion of buffers for any critical areas other than wetlands. Buffers are an integral component to critical areas regulations and to protect human safety and environmental quality. In addition to buffers, there are updates that will be required that reflect best available science, as outlined by this document. Finally, there are some updates that should be considered based upon the results of this document. Table ES-1 provides a summary of required changes (shown in bold) and suggested updates for specific critical area regulatory elements covered in this report. The required code changes and updates to be considered are discussed in more detail within the main body of the report.

Table ES-1. Recommendations for Certain Critical Area Regulatory Elements for the City of Cle Elum.			
Code Section	**Regulatory Element**	**Compliant with Best Available Science**	**Recommendations and Notes**
Fish and Wildlife Habitat Conservation Areas (CEMC 18.01.030.B.5)	Classification, designation, and determination	No	**To be consistent with City's definition of Fish and Wildlife Conservation Areas (Section 18.01.020), the classifications of Waters of the State according to the State's Water Typing system should be included at a minimum.**
	Buffers	No	**Buffers should be established for fish bearing (Type F) streams based upon the findings of this document.**
	Non-fish bearing streams	No	Non-fish bearing streams (Water Types Ns and Np) should also be included as protected critical areas and designated buffers established as protective measure.
	Terrestrial wildlife	No	Consider protective measures for the species in Table 5-1.
Wetlands (CEMC 18.01.030)	Designation	Yes – however citations of approved methodology resource documents could be more effective.	Wetlands delineation is according to the field methodologies outlined in the federal wetland delineation manual (Environmental Laboratory 1987) and applicable regional supplement (USACE 2008). Ecology Publication #14-06-030 is the Updated 2014 Version of the Washington State Wetland Rating System for Wetlands in Eastern Washington (Hruby 2014).
Wetlands (CEMC 18.01.055.A and B)	Determination	No – Qualified Professional Assessments are limited to areas City staff has identified as a critical area, rather than incorporating a review of a greater general area (200-feet, for example) of the project limits.	The City could increase requirements for environmental assessments to include review of projects located within the general vicinity (200-feet, for example) of a potential critical area. The City should define standards for technical report submittals to include the results of a preliminary environmental data review of available information applicable to the site in addition to a field investigation.
Wetlands (CEMC 18.01.020)	Buffers	No	Best available science recognizes that standard designated wetland buffer widths may not be the most protective measure. Considerations of habitat, as scored on the Ecology's revised 2014 wetland rating forms, and proposed changes in land use are additionally recommended for evaluating varying widths of wetland buffers that may be more effective in protecting wetlands according to their individual characteristics.

Table ES-1(continued). Recommendations for Certain Critical Area Regulatory Elements for the City of Cle Elum.

Code Section	Regulatory Element	Compliant with Best Available Science	Recommendations and Notes
Geologically Hazardous Areas (CEMC 18.01.020)	Buffers	No	Buffers should be considered to the known landslide and steep slope hazards identified by DNR (2020) and ESA (2012), respectively. Careful consideration and possible prohibition or regulation of activities identified by Powell (2005) that exacerbate risks (vegetation removal, regrading, loading, and recreational vehicle activity) should occur.
Geologically Hazardous Areas (CEMC 18.01.030.B.4)	Designation	No	**The known landslide areas documented by DNR (2020) should be included explicitly in the geologically hazardous areas designated in CEMC 18.01.030.B.4.**
Wildfire	N/A	N/A	Consider formalizing some of the wildfire protection elements in existing Firewise communities in the city. These elements could be integrated across the city to fold in areas currently not covered by this program.
Frequently Flooded Areas (CEMC 18.01.030.B.3)	Designation	No	Consider adopting floodway from the latest FEMA Flood Insurance Rate Map. Add additional protection to those areas in the floodway, as development could impact existing development elsewhere by rerouting river floodwaters. Consider designating Crystal Creek and other ephemeral drainages identified by WDNR and WDFW (shown in Figure 4-1). Prohibit development in active stream channels, as defined in the designation.
Critical Aquifer Recharge Areas (CEMC 18.01.030.B.2)	Designation	Yes	Known intermingling of the local groundwater and the Yakima River system presents the risk of contaminants entering the City's water supply, which has not been documented previously. Existing code sufficiently documents the designated areas correctly but is speculative. The code could be edited to be more definitive considering recent work.
Critical Aquifer Recharge Areas (CEMC 18.01.060)	Permits	Yes, but it is not specific	Code section could be more specific about the types of activities and the substances of concern. The City could use ESA (2014) as the basis for the determination.
Mitigation–Performance Standards (CEMC 18.01.070.4)	Mitigation Ratios and Measures	No	**Mitigation ratios for impacts to City designated Wetland and Fish and Wildlife Conservation Area buffers are not provided and should be for all Type S and F streams**. Measures for wetland buffer width averaging, reduction or increasing and or enhancement are not provided, but should be considered.

NWI = National Wetlands Inventory CEMC = Cle Elum Municipal Code UGA = urban growth area

INTRODUCTION

The Growth Management Act of Washington (GMA) requires counties and cities to review their comprehensive plans and development regulations according to a schedule established by RCW 36.70A.130(5). Under the GMA, the periodic review or "update" means to review comprehensive plan and development regulations and make amendments necessary to ensure internal consistency and compliance with the GMA. Compliance with GMA comes via the City's Critical Areas Ordinance (CAO).

Chapter 173-26-090 of the Washington Administrative Code (WAC) require local municipalities to update their shoreline master programs (SMPs) according to a schedule laid out in WAC 173-26-090.1. The chapter states that "local governments are encouraged to consult department guidance for applicable new information on emerging topics such as sea level rise [and climate change]." The City does not have a Best Available Science document that guides its code development, so it was determined that the City would develop one as a part of both the update of its SMP and its periodic update of its Critical Areas Ordinance.

Critical areas and shorelines are recognized by the City and, therefore, addressed in this document. These areas include wetlands, fish and wildlife habitat conservation areas, critical aquifer recharge areas, frequently flooded areas and geologically hazardous areas. The City's review of critical area regulations under RCW 36.70A.172(1) must be based on best available science (BAS) and consider conservation and protection of anadromous fisheries. This report serves as the City's first BAS review.

The science presented in this addendum was gathered following the BAS rules contained in WAC 365-195-900 thru 925. The rules define BAS as science that has the characteristics of a valid scientific process. Those characteristics include peer review, following a replicable method, making logical conclusions based on reasonable assumptions and supported by data, using appropriate statistical or quantitative methods for analysis, and referencing relevant and credible information sources [WAC 365-195-905(5)(a)]. Common sources of scientific information include research, monitoring, inventory and survey data, mathematical modeling, site-specific assessment, and synthesized information by experts and expert opinion [WAC 365-195-905(5)(b)].

METHODS

Analysis and conclusions presented in this report are based on a review of existing information including published studies, technical reports and databases prepared by private and public entities, geographic information system (GIS)-based information and mapping, and aerial and oblique photography of critical areas within the city and its urban growth area (UGA). This report was prepared using the most current, accurate, and complete scientific and technical information, peer-reviewed research, best available science summaries, technical literature, and other scientific information related to critical areas and their functions. For this report, scientific and technical information was defined according to the criteria provided by WAC 173-26-201(2)(a). Information sources used in the BAS review are listed in Section 9, *Literature Cited*.

GEOGRAPHIC AND GEOLOGIC SETTING

The City of Cle Elum is in Kittitas County, in central Washington state, on the eastern slopes of the Cascade Mountains (Figure 3-1). The City straddles Interstate 90 (I-90) from exits 80 to 85.

Cle Elum is located 1900 feet above sea level just east of the Cascade crest, which marks the transition between the North Cascades and the Eastern Cascade Slope and Foothills ecoregions. This area is characterized by glaciated valleys and narrow-crested ridges, surrounded by high relief peaks up to 8000 feet in elevation. Forested areas are composed of fir, hemlock and in drier areas; ponderosa and lodgepole pine. The area is like the North Cascades but has more undulating terrain, receives less precipitation, and has higher temperature extremes.

The upper valley of the Yakima River surrounds the Cle Elum, with the Cascade Mountains to the west, and Wenatchee Mountains to the north. The Kittitas Valley and Wenatchee Mountains are a valley and ridge systems resulting from the Yakima Fold Belt. Regional tectonic stresses create the southeast trending ridges and valleys, which are still active today. The valley is filled with alluvial materials from the surrounding mountains and glacial deposits (ESA 2014). It is underlain by various consolidated rocks, ranging in age from Tertiary to Quaternary age.

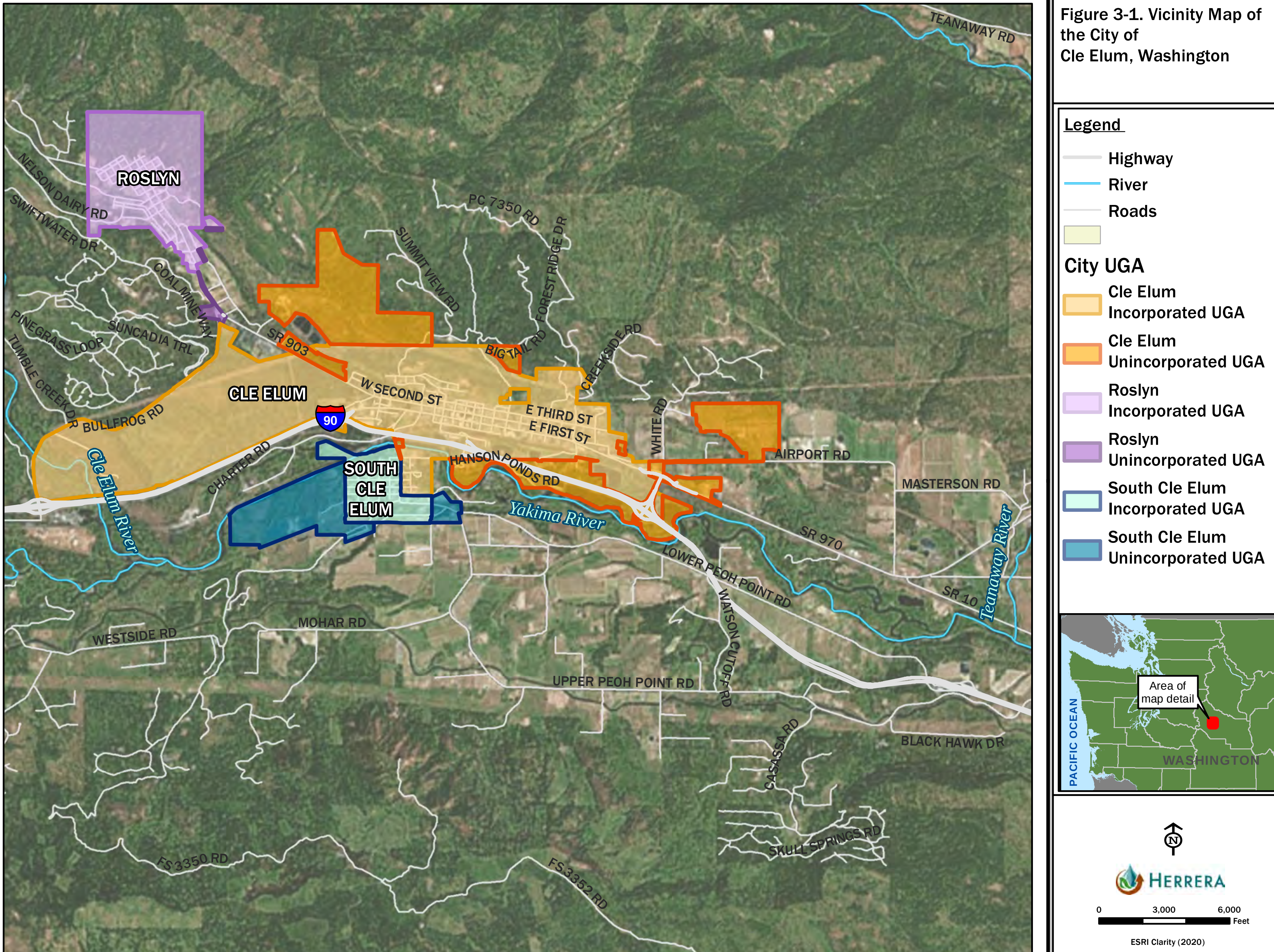

Figure 3-1. Vicinity Map of the City of Cle Elum, Washington

WETLANDS

DESIGNATION

The City defines wetlands as designated critical areas in Section 18.01.030 according to the procedures outlined in WAC 173-22-035, which references the approved federal wetland delineation manual and applicable regional supplements as methodologies for the identification and delineation of wetland boundaries.

The current federal manual is the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and all applicable guidance that is not superseded by the Regional Supplement to the 1987 Wetland Delineation Manual developed by the USACE, which, for the Cle Elum area is the Arid West Regional Supplement (Environmental Laboratory 2008). In addition, the following two documents must be used as resources in the methodology for delineating a jurisdictional wetland boundary:

1. National Wetland Plant List (NWPL). The current NWPL (USACE 2018) should be used in any wetland delineations or determinations. The USACE plans to update the NWPL annually, so each wetland critical areas report must use the most current list and reference it in the documentation.

2. Field Indicators of Hydric Soils in the United States (NRCS 2018). The soil field indicators presented in the USACE regional supplements are a subset of the National Technical Committee for Hydric Soils "Field Indicators of Hydric Soils in the United States" that are commonly found in the region. Any change to those field indicators represents a change to the subset of indicators for the regions. Field indicators for hydric soils may be updated occasionally in regional supplements.

Additionally, Ecology Publication #14-06-30 is the most current updated version of the Washington State Wetland Rating System for Wetlands in Eastern Washington (Hruby 2014). The City should consider providing precise references to these resources, and as updated, for clarification of methodologies required.

DETERMINATION

Section 18.01.055A of CEMC states that maps and data maintained by the City and a site inspection, if appropriate, may be reviewed to determine if a proposal is within a critical area or critical area buffer. Section 18.01.055B of CEMC states that if a critical area is present, additional assessments, prepared by a qualified professional best suited for the type of identified critical area, may be required.

The City may consider modifying these sections of the code to allow for more flexibility by City staff to request qualified professional assessments for projects that may be **situated within the vicinity (200-feet, for example) of a potential critical area, and or its buffer based** on applicable environmental data resources or maps that are made publicly available by other resource agencies. For example, the National Wetland Inventory (NWI) identifies a concentration of riverine and palustrine emergent, forested and shrub wetland areas and freshwater ponds in association with the Yakima and Cle Elum rivers near the southern and western edges of the city (USFWS 2020) (Figure 4-1). Although the NWI data is based on aerial imagery and is not complete; it may provide guidance for determining if a project proposed within the vicinity of the mapped wetland areas may require additional assessment.

Local soil maps, as provided on the NRCS web soil survey, can additionally be utilized as a reference for identifying areas where potential wetlands may be present (NRCS 2020). Hydric Xerofluvents (Soil Unit #205) are mapped in areas with slopes of zero to five percent along the Yakima River floodplain. Although not mapped as a hydric soil unit, Quicksell loam (Soil Unit #207) that is associated with terraces of zero to five percent slopes, includes a clay loam component, that could limit drainage capacity and thus contribute towards jurisdictional wetland conditions. Adjacent to Crystal Creek, the mapped Quicksell soil unit is mapped downstream of the local gravel mine facility near the northwest end of the city. Non-hydric Patnish-Mippon-Myzel soil complex (Soil Unit #208) (0 to 3 percent slopes) and non-hydric Roslyn ashy sandy loams (#201) (0 to 5 percent slopes) are the dominant identified soil units mapped, respectively, in the City's developed areas and the relatively non-developed areas near its west end. Non-hydric Nard ashy loam (#164), Ampad ashy sandy loam, warm (#166), Dystroxercepts (#206), and Teenaway ashy loams (#211, 1441) are mapped on terraces and or in surrounding areas of the city with slopes greater than 5 percent.

These and other agency data resources and maps (FEMA, WDNR, WDFW) could be referenced for applicants to review prior to project designing and or submittal of permit applications to City staff.

Details outlining a qualified expert's technical report submittal could also be defined to facilitate City staff review and applicant understanding of a project's requirements. For example, a wetland delineation report should provide the results of a preliminary environmental agency data resources review applicable to the site, field investigation data forms and site photographs, and a map of the delineated critical area and associated buffer area as it relates to the property's extent and the proposed project footprint. Appendix H of Ecology's March 2006 publication #06-06-11b, Mitigation in Washington State, Part 2, Version 1 includes a checklist and sample outline for a delineation report (Ecology 2016).

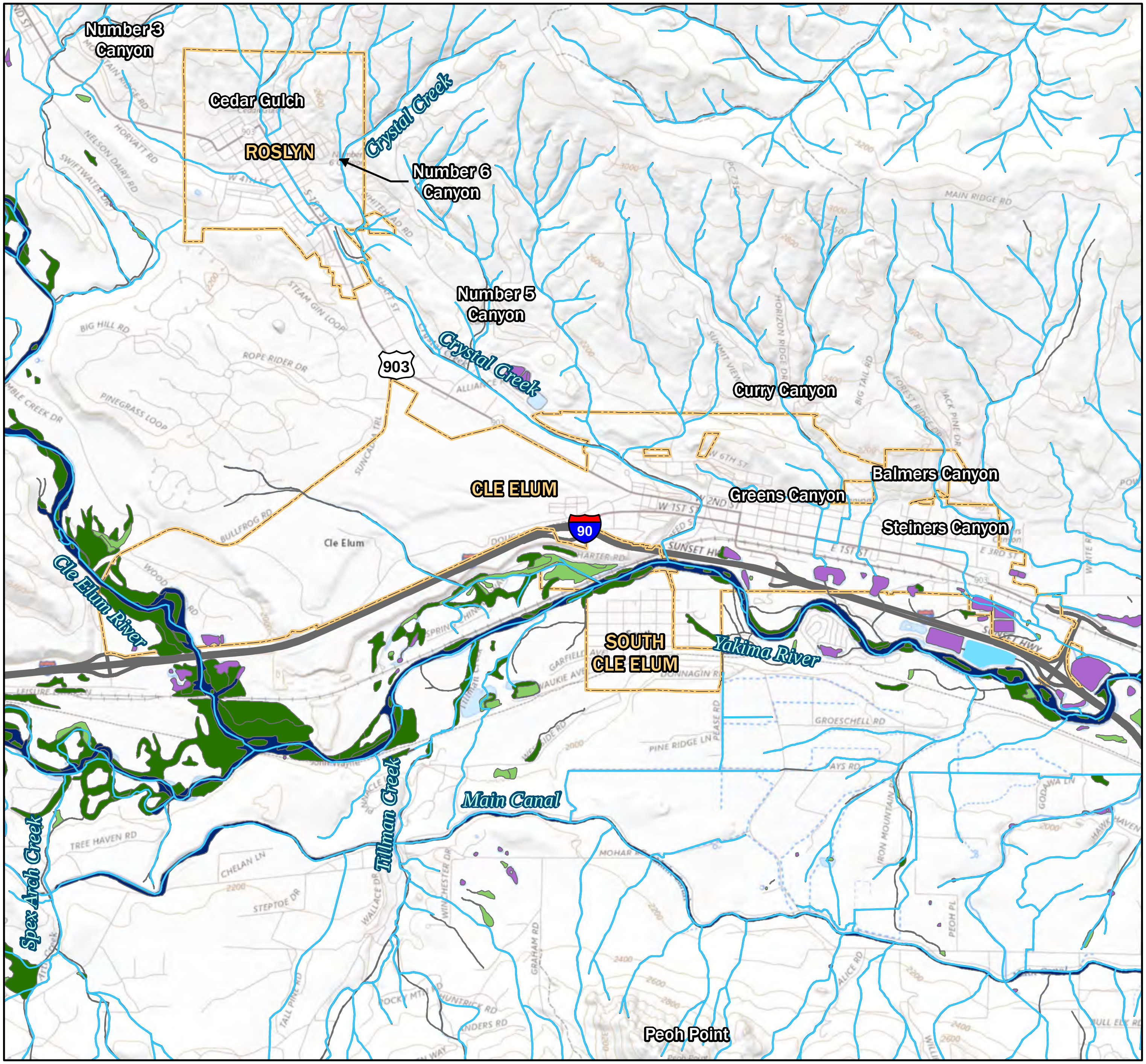

Figure 4-1. NWI-Mapped Wetlands and WDFW Mapped Streams Within and Near Cle Elum,

WETLAND BUFFERS

Ecology guidance uses the following four basic criteria for determining the width of a wetland buffer:

- The functions and values of the aquatic resource to be protected by the buffer;
- The characteristics of the buffer itself and of the watershed contributing to the aquatic resource;
- The intensity of the adjacent land use (or proposed land use) and the expected impacts that result from that land use and;
- The specific functions that the buffer is supposed to provide, including the targeted species to be managed and an understanding of their habitat needs.

Ecology's 2013 *Update on Wetland Buffers: The State of the Science*, recommends a focused approach to buffer widths that is based on the many functions provided by a buffer and specifies buffer widths that are larger than those previously recommended in the 2005 synthesis (Hruby 2013; Sheldon, et al. 2005).

Section 18.01.020 of CEMC defines standard wetland buffer widths according to the wetland's category, as scored on Ecology's rating forms. Table 4-1 compares the standard width buffers currently designated in CEMC with those recommended by Ecology based on the categories of wetlands in eastern Washington (Ecology 2014). **According to Ecology's recommendations, the City's existing wetland buffer regulations, based on the wetland's categorical rating, do not meet GMA requirements for BAS.**

Table 4-1. City Standard Width Designated Buffers Compared to Ecology Recommendations for Buffer Widths Based Only on Wetland Category.

Category of Wetland	City of Cle Elum Existing Designated Buffers	Ecology Recommended Buffer Widths
Category IV	40 feet	50 feet
Category III	60 feet	150 feet
Category II: Based on total score	75 feet	200 feet
Category I: Based on total score	75 feet	250 feet

There is concern that fixed-width buffers may not adequately address the issues of habitat fragmentation and population dynamics or be responsive to landscape condition. Several researchers have recommended a more flexible approach that allows buffer widths to be varied depending on site-specific conditions (Environmental Law Institute 2008; Qiu 2009; Richardson, et al. 2012; Yuan, et al. 2009). However, related research reinforces the fact that buffers and fragmentation are only two of many variables that affect the dynamics of wildlife populations (Hruby 2013). Other factors that have been found to affect the survival of wetland- and stream-dependent species are surrounding land use, the structure of the plant community, and the intensity of human disturbance. For protection of water quality in wetlands and streams, factors that need to be considered are slope, soil chemistry, soil structure and the plant community. Given as a means to increase regulatory flexibility, Ecology recommends several alternative methods for establishing buffer widths according to individual or combined characteristics of the wetland, such as habitat functions or wetland classification (vernal pools, riparian forest), proposed land use intensity, existing adjacent infrastructure and roadways and or implementation of impact reducing measures including individual rural stewardship plans (Ecology 2014).

Table 4-2 presents Ecology's recommendations for the width of buffers to protect wetlands in eastern Washington based on wetland categories and considerations of proposed land use. Use definitions are outlined below. Table 4-3 presents Ecology's recommendations for protecting wetlands in eastern Washington according to wetland category and habitat functions, as scored on the rating forms (Bunten et al. 2016).

Table 4-2. Width of Buffers Needed to Protect Wetland Buffers in Eastern Washington Considering Impacts of Proposed Land Uses.

Category of Wetland	Land Use with Low Impact	Land Use with Moderate Impact	Land Use with High Impact
Category IV	25 feet	40 feet	50 feet
Category III	75 feet	110 feet	150 feet
Category II	100 feet	150 feet	200 feet
Category I	125 feet	190 feet	250 feet

The City's wetland buffers of 190-feet that are designated to protect Natural Heritage Wetlands and Category I bogs and 150-feet for alkali wetlands based on Ecology's recommendations to protect wetlands with special characteristics when moderate intensity land use changes are proposed. Category I and II forested wetlands are protected in the city with a 75-foot wide buffer. Ecology recommends that forested wetland buffer sizes should be based on scores for habitat functions or water quality functions (Ecology 2014).

Table 4-3. Ecology Recommended Wetland Buffers Based on Wetland Category and Habitat Score on Rating Forms.

Wetland Category	Habitat Points Scored on Wetland Rating Forms			
	3-4	5	6-7	8-9
Category IV	40 feet			
Category III	60 feet	75 feet	120 feet	150 feet
Category II	75 feet	90 feet	120 feet	150 feet
Category I	75 feet	90 feet	120 feet	150 feet

The buffer recommendations in Table 3 can be further refined to consider land use intensity changes and other factors (Ecology 2016). Ecology recommends that local governments consider that the following proposed changes in land uses, based on common zoning area, as high impacting: commercial, urban, industrial, institutional, retail sales, residential (more than 1 unit/acre), hobby farms, and high-intensity recreation (golf course, ball fields, etc.) and conversion to high-intensity agricultural (dairies, nurseries, greenhouses, growing and harvesting crops requiring annual tilling and raising and maintaining animals, etc.). Ecology identifies proposed changes in land use that result in a moderate level of impact: as residential development (1 unit/acre or less), parks with biking, jogging, etc., paved trails, building of logging roads, conversion of agricultural related to orchards, hay fields, etc., and utility corridor or right-of-way shared by several utilities and including access/maintenance road. Low intensity land uses include forestry (cutting of trees only), open space (hiking, birdwatching, preservation of natural resources, etc.), unpaved trails, and utility corridors without a maintenance road and little or no vegetation management (Ecology 2014).

Section 18.01.070.B. Wetland Areas of CEMC identifies project design or management measures, such as directing lights away from wetlands, that can be implemented to reduce potential impacts. Ecology guidance includes provisions for reducing buffers required in association with high intensity land use changes to buffers and required for moderate intensity land use changes when such impact minimizing measures are implemented (Ecology 2014). The City could consider expanding the language of Sections 18.01.20 and 18.01.070B to reflect Ecology’s expanded flexibility in establishing required buffer widths.

FISH AND WILDLIFE HABITAT CONSERVATION AREAS

DEFINITION

Fish and Wildlife Habitat Conservation Areas (FWHCAs) defined in Section 18.01.020 of CEMC include:

1. Areas with which endangered, threatened and sensitive species have a primary association
2. Habitats and species of local importance
3. Naturally occurring ponds under twenty acres and their submerged aquatic beds that provide fish and wildlife habitat;
4. Waters of the State;
5. State natural area preserves and natural resource conservation areas.

DESIGNATION

The City's designation of FWHCAs in Section 18.01.030.5 CEMC includes:

1. Federally Designated Endangered, Threatened and Sensitive Species;
2. State Designated Endangered, Threatened and Sensitive Species;
3. State Priority Habitats and Areas Associated with State Priority Species and;
4. Habitats and Species of Local Importance.

Although not specified, the City's designation of FWHCAs may include rare plant species and high-quality eco-systems. Preliminary project reviews of the Washington State Heritage Program data, as maintained by WDNR, should be referenced prior to development permitting (WDNR 2020).

Table 5-1 lists federally and Washington state listed endangered and threatened fish and wildlife species and candidate species proposed for listing documented to occur within the vicinity of the city and its urban growth areas (USFWS 2020; WDFW 2008, 2020). WAC 220-610-010 lists wildlife classified as endangered in Washington State.

Washington State priority species documented within the city and its immediate vicinity, but which are not listed as endangered or threatened nor are candidates for listing are presented in Table 5-2 (WDFW 2020).

Table 5-1. Fish and Wildlife Species Documented as Occurring in Cle Elum and its Immediate Vicinity That are Federally and/or State Listed as Endangered, Threatened and/or Candidate/Proposed for Listing.

	Federal Status	State Status	Critical Habitat	Documented Locations and or Preferred Habitat
Fish				
Bull trout (*Salvelinus confluentus*)	Threatened	Candidate	Designated	Yakima River
Chinook salmon Upper Yakima River Stock (*Onchrynuchus tshawytscha*)	Not Warranted	Candidate		Yakima River – Occurrence/Migration Chrystal Creek–Occurrence
Steelhead (*Onchrynuchus mykiss*)	Threatened	Candidate	Designated	Yakima River–Breeding
Wildlife				
Marbled Murrelet (*Brachyruamphus marmoratus*)	Threatened	Endangered	Designated in county but not in city	Old growth and mature forest lands for nesting
Northern Spotted Owl (*Strix occidentialis caurina*)	Threatened	Endangered	Designated in county but not in city	Old growth and mature forest lands for breeding and nesting Documented locations masked for species protection
Yellow-billed Cuckoo (*Coccyzus americanus)*	Threatened	Endangered	Proposed in county but not in city	Breeding is associated with deciduous riparian forest habitats
Northern Goshawk (*Accipiter gentilis*)	Not warranted	Candidate	Not Applicable	Multiple PHS data points documented during WDFW stock surveys in forest north/northeast of the city
Sage Thrasher (*Oreoscoptes montanus)*	Not Applicable	Candidate	Not Applicable	Breeds April 15 to August 10 within general area (USFWS 2020)
White-Headed Woodpecker (*Piciodes albolarvatus*)	Not Applicable	Candidate	Not Applicable	Breeds May 1 to August 15 within general area (USFWS 2020)
Canada Lynx (*Lynx canadensis*)	Threatened	Endangered	Designated in county but not in city	Forest

Table 5-1 (continued). Fish and Wildlife Species Documented as Occurring in Cle Elum and Its Immediate Vicinity That are Federally and/or State Listed as Endangered, Threatened and/or Candidate/Proposed for Listing.

Gray Wolf (*Canis lupus*) (ALL US with Portions of A, NM, OR, UT and WA, Mexico)	Endangered	Endangered	Designated	
Gray Wolf (*Canis lupus*) Western Distinct Population Segment	Proposed Endangered		Not Applicable	
North American Wolverine (*Gulo gulo luscus*)	Proposed Threatened	Candidate	Not Applicable	Mountains
Sharp-tailed snake (*Contia tenuis*)	Not Applicable	Candidate	Not Applicable	Yakima River slough – 1 Occurrence

Table 5-2. Non-Listed Washington State Priority Fish and Wildlife Species Documented as Occurring in Cle Elum and Its Immediate Vicinity (USFWS 2020).

Species	Documented Locations
Fish	
Westslope cutthroat (*Oncrhynchus clarki lewisi*)	Yakima River –Migration
Coho (*Onchrynuchus kitsutch*)	Yakima River –Migration
Rainbow Trout (*Onchrynuchus mykiss*)	Yakima River
Dolly Varden	Yakima River
Wildlife	
Elk *(Cervus elaphus*)	Domiere Flats Elk Winter Concentration Area along Cle Elum River below dam, cross Bullfrog Road and use cemetery and athletic fields

Washington State Priority Habitat Areas and Features

Washington State's priority terrestrial habitat areas that appear to be applicable to the general vicinity of Cle Elum include aspen stands and old growth and mature coniferous forest. Aquatic habitat areas are associated with the Yakima and Cle Elum rivers and Crystal Creek. Priority habitat features classified by WDFW include cliffs, snags and logs, talus and caves (WDFW 2008). Protection of cliffs and caves, for example, can additionally protect Washington priority species, such as bats, that utilize such features.

PHS polygons documenting occurrences of several priority species are mapped by WDFW along the western edges of the city associated with the Yakama River, Washington State Horse Park and overlapping the Suncadia developments and the town of Roslyn (WDFW 2020). PHS polygons are additionally mapped by WDFW in the forests located to the northwest of the city and areas north and south of the Yakima River along the eastern edge of the city.

Eagles and Migratory Birds

The Migratory Birds Treat Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 protect certain bird species and their habitats. USFWS identifies the breeding season for bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) within the general region from December 1 to August 31 (USFWS 2020). USFWS identified additional species of birds of conservation concern, which are not listed or classified as Washington State priority species, but which warrant special attention due to their probability of being present within the general vicinity of Cle Elum during breeding (Table 5-3) (USFWS 2020).

The City should consider documenting a list of species and habitats of local importance, such as these as identified by USFWS, and or others as recommended by the community, to amend to its code.

Table 5-3. Migratory Bird Species that Seasonally Breed in the Cle Elum Vicinity (USFWS 2020).

Species	Breeding Season
Black swift (*Cypseloides niger*)	June 15 to September 10
Brewer's sparrow (*Spizella brewei*)	May 15 to August 10
Lewis's Woodpecker (*Melanerrpes lewis*)	April 20 to September 30
Olive sided flycatcher (*Contops cooperi*)	May 20 to August 31
Williamson's sapsucker (*Sphyrapicus thyroideus*)	May 1 to July 31
Willow Flycatcher (*Empidonax traillili*)	May 20 to August 31

Aquatic Habitat (Waters of the State)

Although Waters of the State are defined as a FWHCA in Section 18.01.020 of CEMC, Waters of the State are not designated in Section 18.01.030.5 of the City's code Waters of the State are defined in RCW 90.48.020 and includes lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and water courses in Washington. Stream types are classified in Title 22 WAC, the forest practices regulations. County and Cities may use the classification system established in WAC 222-16-030 or (interim) WAC 222-16-031 to classify waters of the state, according to the following three definitions, **but this typing does not exist in the City and should be completed to be compliant with Ecology recommendations.**

Type S Waters

Type S Waters mean all waters, within their bankfull width, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW including periodically inundated areas of their associated wetlands. In Cle Elum, Type S water is limited the Yakima and Cle Elum rivers.

Type F Waters

Type F Waters mean segments of natural waters other than Type S Waters, which are within the bankfull widths of defined channels and periodically inundated areas of their associated wetlands, or within lakes, ponds, or impoundments having a surface area of 0.5 acre or greater at seasonal low water and which in any case contain fish habitat or are described by one of the following categories. Waters, which are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type F Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less. Waters, which are within a federal, state, local, or private campground having more than 10 camping units: provided, that the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit, trail or other park improvement. Riverine ponds, wall-based channels, and other channel features that are used by fish for off-channel habitat. These areas are critical to the maintenance of optimum survival of fish. This habitat shall be identified based on whether the site must be connected to a fish habitat stream and accessible during some period of the year; and whether the off-channel water must be accessible to fish. Crystal Creek is a Type F stream throughout its length in the city, and so is Steiners Canyon (Town Ditch).

Type N Waters

There are two types of Type N Waters. Type Np Water means all segments of natural waters within the bankfull width of defined channels that are perennial nonfish habitat streams. Perennial streams are flowing waters that do not go dry any time of a year of normal rainfall and include the intermittent dry portions of the perennial channel below the uppermost point of perennial flow. Type Ns Water means all segments of natural waters within the bankfull width of the defined channels that are not Type S, F, or Np Waters. These are seasonal, nonfish habitat streams in which surface flow is not present for at least some portion of a year of normal rainfall and are not located downstream from any stream reach that is a Type Np Water. Ns Waters must be physically connected by an above-ground channel system to Type S, F, or Np Waters. The ephemeral streams identified by WDFW (2020c) and shown in Figure 4-1 that run through the center portion of the city (with the exception of Crystal Creek and Town Ditch) are likely Type N streams.

Rather than relying solely on WDNR mapping of water types, counties and cities should develop a process to verify actual stream conditions, identify flow alterations, and locate fish passage barriers through field verification. For intermittent or nonfish bearing streams, field verification should be conducted during the snow-free freshet between May and July, or possibly early fall before snow cover (October). Counties and cities may consider the following factors when classifying waters of the state as fish and wildlife habitats:

- Species present which are endangered, threatened or sensitive and other species of concern
- Species present which are sensitive to habitat manipulation
- Historical presence of species of local concern
- Existing surrounding land uses that are incompatible with salmonid habitat
- Existing water rights
- The intermittent nature of waters of the state (Washington State Department of Community, Trade and Economic Development 2018)

The Yakima and Cle Elum rivers are designated shorelines of the state or Type S waters. Crystal creek is documented by WDNR as a Type F, fish bearing stream, consistent with the fish use found in WDFW (2020). Multiple tributaries to Crystal Creek and other vicinity creeks draining from the mountainsides to the Yakima and Cle Elum rivers are mapped as ephemeral or intermittent Ns type streams (Figure 4-1), though some reaches may qualify as perennial (thus Np) at or just outside of the city limits. Lakes and ponds planted with game fish by a government or tribal entity, such as Hanson Ponds, are considered FWHCAs by some jurisdictions for protection.

Performance Standards – Protection and the Role of Buffers

Section 18.01.070C–Performance Standards for Fish and Wildlife Habitat Conservation Areas of CEMC states that flora and fauna identified as protected shall be sheltered from construction activities using Best Management Practices and that the replacement of any flora shall be maintained by the applicant for three years to establish viable plant life.

Designated FWHCA buffers, currently not established in the City's code, should be defined according to size and quality of required habitat for consistent regulation and protection. Buffers reduce impacts on such resources from adjacent land uses through various physical, chemical, and/or biological processes. There remains no simple answer for what constitutes an effective buffer width for protecting wildlife. Buffer needs are dependent upon the species in question and its life-history needs, whether the goal is to maintain connectivity of habitats across a landscape, or whether one is simply trying to screen wildlife from human disturbance (Sheldon et al. 2005). For wetland-dependent species that require both aquatic and terrestrial habitats to complete their life cycle, vegetated buffers are paramount (Hruby 2013).

The need for appropriate upland habitat has been well documented for amphibians and continues to be a focus of research (Crawford and Semlitsch 2007; Cushman 2006; Gamble, et al. 2006; Harper, et al. 2008; Homan, et al. 2004; Rittenhouse and Semlitsch 2007; Semlitsch 2007; Trenham and Shaffer 2005). Research is also focused on wetland-dependent birds (Glover, et al. 2011; Honowski, et al. 2006; Henning and Remsberg 2009; Martin, et al. 2006; Rodgers and Schwickert 2003; Weston, et al. 2009). In addition, research on this issue has expanded to include invertebrates such as dragonflies (Bried and Ervin 2006).

In 1997, WDFW recommended riparian buffer widths according to the State's water typing system. Riparian buffers ranging from 250-feet for Type S (formerly Type 1) streams to 150-feet for Type F streams (Formerly Type 2 and 3 streams). Buffers of 150-feet and 225-feet were recommended for the protection of non-fish bearing Type Np and Ns drainages (formerly Type 4 and 5 waters) according to their respective, low to high, mass wasting potential (WDFW).

WDFW's recent Science Synthesis and Management Implications for the Protection of Riparian Ecosystems (WDFW 2018) recommends that riparian protection should be focused within the area defined as the Riparian Management Zone or RMZ. The RMZ is the area in which full riparian function can potentially occur and is thus not synonymous with buffers as used in previous guidance or existing regulations. The RMZ differs from buffers in one important way. Buffers are established through policy, whereas the RMZ is a scientifically based description of the area adjacent to rivers and streams that has the potential provide full function.

WDFW outlines multiple methods for defining the RMZ, such as determining the Site-Potential Tree Height and or designating inner- and outer-buffer zone definitions within the RMZ to reflect varying levels of protection or of existing conditions. The buffer zone approach is based on the understanding that relatively undisturbed vegetated areas close to the stream provide a greater percentage of the functions that those areas further from the stream (WDFW 2018).

WDFW recommends the width of RMZs in the Columbia Plateau ecoregion be based on the widest of three riparian functions: shade, wood (large and small) or pollutant removal. The role of buffers to perform specific functions, as evaluated through best available science, is discussed in the following sections.

Water Quality

Ecology's 2005 synthesis of the science for determining the effectiveness of wetland buffers to protect water quality was based primarily on studies conducted in the buffers of streams [called the riparian zone (Sheldon, et. al. 2005)]. Buffers were determined to protect water quality through the following several documented mechanisms:

- They remove sediment (and attached pollutants) from surface water flowing across the buffer;
- They biologically treat surface and shallow groundwater through plant uptake or by biological conversion of nutrients and bacteria into less harmful forms;

- They bind dissolved pollutants by adsorption onto clay and humus particles in the soil;
- They help maintain the water temperatures in the wetland through shading and blocking wind;
- They remove pollutants from groundwater flows through interaction of the soils and deep-rooted plants (Mayer, et al. 2007; Polyakov, et al. 2005);
- They infiltrate polluted surface waters and slow flows so pollutants can be removed more effectively (Buffler, et al. 2005; Polyakov, et al. 2005).

The role of buffers in attenuating stormwater flows is less well studied but it can be assumed that reducing sediment loads in runoff prior to discharging to a wetland will help protect its storage capacity and, in that manner, protect wetland hydrologic functions (Bullock and Acreman 2003).

Recent research and guidance focuses on identifying the characteristics of buffers that provide the protection of wetland and stream functions (Environmental Law Institute 2008, Slawski 2010). For water quality, they include soils, the size of sediment particles, water source and flow convergence, infiltration rate, surface roughness (influenced by vegetation type and density of plants), slope gradient and length and surrounding land uses (Buffler, et al. 2005; Polyakov, et al. 2005; Yuan, et al. 2009). Mayer, et al. (2007) analyzed 45 studies on nitrogen removal and found that soil type, subsurface water regime (e.g., soil saturation, groundwater flow paths), and subsurface biogeochemistry (the supply of organic carbon and inputs of nitrate) are also important factors. While significant reductions in some pollutants, especially coarse sediments and the pollutants adhered to them, can occur in a relatively narrow buffer of 16 to 66 feet (5 to 20 meters), removal of fine sediments requires substantially wider buffers of 66 to 328 feet (20 to 100 meters) (Sheldon, et al. 2005). The Planner's Guide to Wetland Buffers for Local Governments, prepared by the Environmental Law Institute (2008), recommends buffers ranging from 30 to 100 feet (9 to 30 meters) for sediment removal, 100 to 180 feet (30 to 55 meters) for nitrogen removal, and 30 to 100 feet (9 to 30 meters) for phosphorus removal.

Removal of dissolved nutrients requires long retention times and contact with fine roots in the upper soil profile (i.e., soils that are permeable and not compacted). Distances (i.e., buffer width) for dissolved nutrient removal are quite variable, ranging in the literature from approximately 16 to 131 feet (5 to 40 meters) (Sheldon, et al. 2005). Also, there are differences in the processes that remove different pollutants. Site-specific conditions such as soil type, flow paths, and pollutant loading affect pollutant removal efficiencies (Mayer, et al. 2007).

Nevertheless, recent research and reviews confirm that, in general, it takes a proportionally larger buffer to remove significantly more pollutants because coarse sediments and the pollutants associated with them drop out in the initial (outer) portions of a buffer. It takes a longer time for settling, filtering, and contact with biologically active root zones to remove fine particles and dissolved nutrients (Mayer, et al. 2007; Yuan, et al. 2009; Zhang, et al. 2010).

Wildlife Habitat

Wetland and stream buffers help maintain viable wildlife habitat as they provide an ecologically rich and diverse transition zone between aquatic and terrestrial habitats. Buffers can also screen habitats from human disturbances, and they can provide connectivity between otherwise isolated habitat areas (Sheldon, et al. 2005).

For habitat, research has reinforced that buffer requirements need to be targeted at the species of interest. For example, a forested buffer is optimal for some species but not for others. Fish may need only a 100-foot (30-meter) buffer, but some species of amphibians are better protected with a 1,000-foot (300-meter) buffer.

Some ecologists now refer to buffers that provide critical life requirements for wetland-dependent species as core habitats rather than buffers (Crawford and Semlitsch 2007, Semlitsch and Bodie 2003, Semlitsch and Jensen 2001, Slawski 2010). Core habitats are those areas within watersheds that contain the most productive and diverse habitats. The distinction is based on the idea that a buffer is not reducing impacts on the functions provided by a wetland or stream. Rather, wetlands and streams in proximity to adjacent upland habitats provide a critical habitat function. The combination of wetland and upland habitat types provided by buffers is essential to a suite of species that would be absent from either habitat alone. Core habitats are essential to a number of wetland- and stream-dependent species, particularly amphibians (Semlitsch and Jensen 2001). For example, inadequate quantity or quality of core habitat will increase the probability of local amphibian population extinction (Semlitsch 2007).

It seems logical that buffers would screen wildlife and habitat areas from disturbances related to noise and other human activities. Even a narrow buffer, if undisturbed, can provide a closer connection between nearby wetlands, streams, and other upland habitats, or it may directly connect with adjacent wetland systems, reducing habitat fragmentation and increasing habitat connectivity.

In general, buffers needed to support wildlife species reported in those studies are many times wider than buffers needed for water quality protection and are often unobtainable in already developed urban environments. For example, recent recommendations specify buffer widths that go beyond 300 feet (91 meters) for many wildlife species. The *Planner's Guide to Wetland Buffers for Local Governments* prepared by the Environmental Law Institute (2008) recommends a range of 100 to 1,000 feet (30 to 300 meters) for wildlife, and the Southeast Wisconsin Regional Planning Commission (Slawski 2010) recommends a minimum range of 400 to 580 feet (122 to 177 meters) for birds, salamanders, turtles, snakes, and frogs based on the research and synthesis work by Semlitsch and Bodie (2003). Current research indicates that a broader approach to protecting wildlife is needed (Hruby 2013) because buffers alone may not prevent the populations of many species from declining. Wetland protection policies that rely solely on buffers may be ineffective at protecting amphibians or other wetland- and stream-dependent species that disperse across the landscape.

Plant Communities

The role of buffers in protecting the microclimate of streams is well documented (Leinenbach et al. 2013). Shading by trees significantly reduces air and water temperatures. Fallen trees in buffers provide refuge and foraging opportunities as large woody debris features for many species of insects, birds, amphibians and mammals.

Studies indicate that buffers of at least 230 to 330 feet (70 to 100 meters) are needed to protect the diversity of a wetland plant community. Houlahan et al. (2006) monitored plant diversity in 58 wetlands in Ontario, Canada, and found that forest cover in the buffer was an important predictor of species richness in the wetlands. Statistically significant changes in overall plant richness were observed when the forest cover was changed to other land uses as far as 820 to 990 feet (250 to 300 meters) from the wetland. The richness of the different functional groups of plants in the wetlands (e.g., native, exotic, annual, perennial, forest, open, aquatic), however, did not respond in the same way even though the overall trend was that larger buffers increased plant richness.

Rooney, et al. (2012) found that the integrity of the plant community in 45 wetlands in Alberta, Canada, was best predicted using data on land cover within 330 feet (100 meters) of the wetland rather than other distances ranging up to 1.9 miles (3,000 meters). Ervin (2009) found that the presence of a forested buffer of at least 230 to 330 feet (70 to 100 meters) was associated with an increase in the richness of wetland plant species.

Because invasive plants can adversely affect habitat quality in buffers, Ecology (2012) recommends replacing noxious weeds and invasive plants with native plants along shorelines. Conservation of native plants and replacing invasive or noxious weeds with native vegetation is beneficial for all wetland shorelines and should be added to the City’s wetland buffer regulations.

Buffer Maintenance and Effectiveness over Time

Human actions can reduce the effectiveness of buffers in the long term through removal of buffer vegetation, soil compaction, sediment loading, and dumping of garbage (Environmental Law Institute 2008; Sheldon, et al. 2005; Wade and Theobald 2010). Buffers may lose their effectiveness to disperse surface flows over time as flows create rills and channels, causing erosion within the buffer (Polyakov, et al. 2005; Sheldon, et al. 2005; Yuan, et al. 2009). In addition, buffers may become saturated with sediment over time and become less effective at removing pollutants (Sheldon, et al. 2005).

Regulatory recommendations for riparian buffer establishment, protection and setbacks, as outlined in WDFW's Land Use Planning for Salmon, Steelhead and Trout (Knight 2009) include:

- Establish natural vegetation buffer widths based on best available science and sufficient space to maintain functions and biological processes.
- Proposed modifications to buffers including native vegetation clearing, hazard tree removal and or buffer width averaging and or reduction should be evaluated by a qualified habitat biologist and or arborist to ensure no net loss to fish and wildlife habitat occurs. Consideration should also be given to assessing the temporal loss of function(s) from such clearing. Although functions recover over time, interim measures to enhance recovery times and trajectories should be implemented. Preferably, some measures (e.g., replacement plantings) should be conducted prior to or concurrent with clearing activities to minimize overall temporal losses.
- Extend buffers to include adjacent critical areas buffers (such as those associated with wetlands, lakes, floodplains, and channel migration zones).
- Avoid permitting development that will require bank protection. If bank protection cannot be avoided, follow bank protection recommendations in the Washington State Integrated Streambank Protection Guidelines.
- Adopt a setback of at least 15 feet from the edge of riparian buffers to protect buffer habitat from impacts associated with construction and buildings.

Additionally, mitigation ratios for impacts to streams and buffers should be established. Typically, mitigation for impacts to wetland and stream buffer impacts are compensated at a 1:0 to 1:0 ratio.

To be consistent with the Shoreline Management Guidelines and considering channel migration risks (described below), 200-foot-wide buffers are recommended for the protection of the City's Type S waterways–the Yakima and Cle Elum rivers. The recommended buffer width for the establishment of the protection of Crystal Creek and Town Ditch, the only fish bearing streams mapped within the city, is 50 feet. Buffer widths are to be measured horizontally from the Ordinary High Water Mark (OHWM). Smaller ephemeral streams should have a smaller corridor to protect habitat when water occurs and reduce risks of future flooding. Modest buffers (20-30 feet) are suggested, but not required.

Table 5-4 presents recommendations for the establishment of riparian buffer widths within the City of Cle Elum based on Water Type. Additional protection of riparian associated wetlands, channel migration zones (see Erosion Hazard Areas) and floodplain restrictions (see Frequently Flooded Areas) may result in even greater protection within specific areas of the city.

Table 5-4. Ecology Recommended Riparian Buffers for City of Cle Elum.	
Name of Stream and or Water Type	**Ecology Recommended Buffer Width**
Yakima River–(Type S)	200 feet
Cle Elum River–(Type S)	200 feet
Crystal Creek–(Type F)	50 feet
Non-fish bearing perennial, seasonal (ephemeral) streams–(Type Np and Ns)	25 feet

Terrestrial habitat buffers of 100 feet are recommended for areas where listed and or priority wildlife species are documented to be present. No clearing of vegetation or land disturbances shall be allowed within the terrestrial buffer area without review by an approved habitat biologist and development of an appropriate mitigation plan

CRITICAL AQUIFER RECHARGE AREAS

The GMA defines critical aquifer recharge areas as “areas with a critical recharging effect on aquifers used for potable water.” Washington Administrative Code (WAC) Chapter 365-190 further defines critical aquifer recharge areas: “areas with a critical recharging effect on aquifers used for potable water, including areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water, or is susceptible to reduced recharge.” In Ecology’s critical aquifer recharge areas guidance document (Ecology 2005), Ecology states that identifying “areas with a critical recharging effect on aquifers used for potable water” depends on understanding aquifer recharge and what is meant by “a critical recharging effect.”

To understand what makes a critical aquifer recharge area in the city, it is helpful to explain the geology of Cle Elum. As mentioned above, the city is in a formerly glaciated, alluvial valley in the Yakima Fold Belt. Surrounding bedrock-dominated mountains funnel rainwater into the alluvial sediments of the valley. Water in this alluvial sediment exchanges flow with the major rivers [Yakima, Cle Elum, and Teanaway (Figure 2: Gendaszek, et al. 2014)]. Damming of both the Yakima and Cle Elum rivers has elevated this already high groundwater table (Ely, et al. 2011). As a result, groundwater is at or near the surface throughout much of the city. The primary drains for the groundwater are the major rivers (Gendaszek, et al. 2014).

Although the City has the Yakima River as its primary water source, a well field in the valley serves to provide backup for this resource. The exchange between groundwater and the Yakima River documented by Gendaszek, et al. (2014) also makes it crucially important for the City to protect the quality of its groundwater, since contamination of the groundwater could ultimately end up in the Yakima River and its water supply. Therefore, all lowland areas of the city that have alluvial soils should be considered a critical aquifer recharge area, as is currently stated in its code.

ESA (2014) provides a list of management recommendations, though many of these have already been implemented in the City’s existing code. In particular, consistent with this document, new underground storage tanks, and any activities involving fertilizers, herbicides, and pesticides and should be specifically called out as requiring hydrogeological reports, as they present a risk to the contamination of the City’s water supply.

FREQUENTLY FLOODED AREAS

The Yakima and Cle Elum rivers have floodplains and floodways defined through the city and its UGA according to the Flood Insurance Rate Maps (FIRMs) for the City of Cle Elum and adjacent unincorporated areas of Kittitas County (FEMA 1981a,b,c,d). These maps are in the process of being updated (FEMA 2019), though these new maps have not been formally adopted by the City or Kittitas County. The new maps reflect numerical modeling of flood conditions, while the earlier maps did not. The new map also shows generally reduced flooding potential. Therefore, it is recommended that City adopt the new maps and prepare its code for that eventuality.

The new flood maps subdivide the previous floodplain into floodways and floodplains. Floodplains and floodways are not currently defined separately in the City's code. Floodplains are defined by FEMA as those areas that inundate in floods, but do not provide significant conveyance. Therefore, the main risk to these areas is inundation and loss of flood storage. The City's code currently adequately protects human life from these sorts of risks.

Floodways are those areas that provide conveyance to the river system. Development in floodways is much more detrimental than floodplains to the surrounding landscape and can initiate changes in the river channel pattern. Velocities are also often greater in floodways, making loss of property and human life more likely in these areas. As a result, it is recommended that the City make a distinction between floodways and floodplains in its code and strengthen protections to floodways.

The final set of frequently flooded areas are the seasonal and ephemeral tributaries to the main rivers. Much less is understood about these streams and none of these streams, including Crystal Creek, has explicit protection in the City's code, despite that they have the potential to damage infrastructure and could contain threatened or endangered species.

CLIMATE CHANGE

The hydrology of the Yakima River (and by extension, the Cle Elum River) is expected to evolve due to climate change (Elsner, et al. 2010; Mantua, et al. 2010). The Upper Yakima River (as defined by that part of the river in Kittitas County) is a "transition" river with respect to the dominant precipitation process that regulates flow (Mantua, et al. 2010). Currently the highest flows in the Yakima River occur during the spring freshet (meltwater period), sometimes exacerbated by a rain-on-snow event near the Cascade Crest (Elsner, et al. 2010), which are particularly relevant to flooding in the city. While these events are expected to continue to dominate for the next few decades, rainfall-driven fall and winter floods, as are currently dominant on the west side of the Cascades, will increase in magnitude, while the spring freshets will decrease in magnitude. Elsner, et al. (2010) predicts by 2080, even as far downstream as Parker (Yakima), these events could dominate the annual hydrograph of the river. Even though this much farther downstream and therefore less directly affected by snowmelt, it is expected that by this time, even in Cle Elum, fall floods in most years would exceed the magnitude of the spring freshet (Elsner, et al. 2010). This changing hydrology would affect the management of the Yakima River at Keechelus Dam and the Cle Elum River at Kachess Dam. Depending on that management, flooding patterns and timing could be dramatically changed in the city.

In addition to the impacts to flooding, these changes will affect summer low flows and stream temperatures. The reduced low flows in the middle of the summer (August) will cause stream temperatures to increase beyond mortality limits of and potentially imperil local salmon (Mantua, et al. 2010).

It is less clear how the hydrologic changes described by Elsner, et al. (2010) and Mantua, et al. (2010) will affect the smaller, local drainages, including Crystal Creek. In fact, these drainages may not behave the same. The expected increase precipitation in fall and winter at the Cascade Crest (Mantua, et al. 2010), and the increased water impounded behind the dams, might be more effective at sustaining baseflow in those creeks more dependent on surficial groundwater (i.e., Crystal Creek) than those that are entirely dependent on local precipitation in the foothills above the city.

NATURAL HAZARDS

Several different types of natural hazards are found within the City of Cle Elum, including landslides, steep slopes, active faults with considerable seismic hazards, and liquefiable soils. Each of these geohazards are discussed in greater detail below. Because the city is also at risk to wildfire, we have included a section covering it, since it profoundly impacts life in Cle Elum and represents a possible vector for issues associated with climate change.

WILDFIRE

One of the greatest risks to the Cle Elum community is wildfire. Wildfire has always been a part of the region's natural hazards however considerable changes have occurred that have led to increase risk from wildfire in recent decades. Historically, fire regimes ranged from over 900 years to as frequent as every 20 years. However, due to fire suppression, past methods of timber management and the build-up of fuels in the forest, fire regimes have trended toward larger, hotter and less frequent fires. Declining forest health over the course of recent decades has resulted in uncharacteristically overstocked forests and episodic droughts have increased competition and available moisture. Together, these conditions have resulting in less resistant forests to wildfire and insect and disease outbreaks, which has in turn led to increasingly large and expensive wildfires. Climate change is anticipated to increase the number of acres burned by wildfire (annually) by four times by the 2080s, compared to the median annual area burned from 1916 to 2006 (Littell, et al. 2010).

Cle Elum is located in the Northwest Plains and Plateau (NWPP) region in which the mean minimum monthly temperature 34 degrees Fahrenheit, and the mean maximum monthly temperature is 59 degrees Fahrenheit. Mean annual precipitation in the NWPP measures 15 inches and mean annual summer precipitation measures 2 inches (Sheenan, et al. 2015). Climate change modeling outputs report that both minimum and maximum temperatures will increase over the coming decades with additional changes in precipitation patterns (Sheenan, et al. 2015). Statewide average spring snowpack is projected to decline 38-46 percent by mid-century and 56-70 percent by the 2080s. Model outputs show that this area will have warmer winters with less snow, and a greater portion of the of winter precipitation occurring as falling rain.

These climate impacts will result in additional changes to surface water hydrology with streams and river flows driven more from rainfall events, rather than snow melt. This will alter the timing at which peak flows occur from the spring melt or freshet (historically occurring in mid-May in the Yakima watershed) to periods of peak rainfall, which are estimated to occur in mid-February by 2080 (Elsner, et al. 2010). Reduced snowpack will result in lower stream flows in summer, which will be compounded by projected decreased precipitation during summer months. Changes in the hydrography of the Yakima watershed are significant and indicating this watershed will shift from a transient rain-snow watershed to a rain-dominated watershed by the 2080s (Elsner, et al. 2010).

Summertime rains are directly related to the interannual changes in the forested areas burned by wildfire over the region (Littell, et al. 2009) as well as the timing (start and end) of the wildland fire season (Chiodi, et al. 2016). Summertime rain fall events do commonly occur in the region, on average two or three times per summer. Southeasterly rainfall events feature lightning strikes, while southwesterly circulation types include greater rainfall amounts.

In many forest and range landscapes, wildfire represents one of the main factors controlling landscape evolution through the promotion of enhanced erosion (Owens, et al. 2013). Denudation resulting from fire can result in enhanced mass movements, channel bank erosion. The magnitude of denudation depends on vegetation/tree cover and climate, thus fire frequency (Owens, et al. 2013). Post-fire impacts range from a multitude of natural resource risks and concerns. Suspended sediment was compared across two nearby watersheds in British Columbia, one of which was affected by a large recent fire in which 62 percent of the watershed was burnt. The major changes in the wildfire affected watershed included increased bank erosion and a channel migration due to loss of root strength and cohesion, which occurred 3-5 years after the fire (Owens, et al. 2013). Water repellant soils form during fires when organic material burns at high intensity, water repellent compounds vaporize and condense on the cooler soil layers below, which then prevent soil from absorbing waters. During heavy rains, water cannot penetrate the water repellent soils, so it runs off like pavement, which can cause flash flooding mud, debris and mudslides.

Wildfires alter ecosystems as they change in frequency, size and severity. They change vegetation structure, alter moisture inputs and energy fluxes that impact snowpack and hydrology. A variety of regional studies within or including the Pacific Northwest have examined potential climate-driven changes in the distribution of vegetation cover types. Model outputs show predominant conifer forests will be replaced by mixed forest. Modeling results also showed that fire suppression has a marked effect and will be even more important as vegetation changes will result in an increase in the dominance of wood vegetation in the future (Sheenan, et al. 2015). It is unclear how these interrelated effects are going to change the risk of wildfire in the City of Cle Elum. However, the possibility of warmer, drier summers and the reduction in groundwater levels from the known reductions in Yakima River flow (Elsner, et al. 2010; Mantua, et al. 2010) provide the possibility of increased wildfire incidence and severity in the future (Halofsky, et al. 2020). Therefore, the City should take steps to better protect itself from this threat. Although the City already has many individual Firewise Communities within its city limits (see next section), it should consider integrating these programs with other portions of the community that are not already in the program. This could take many forms, from formalizing Firewise programming elements into the City's development code, to the City developing its own Community Wildfire Protection Plan.

Several different strategies have been undertaken to counteract potential increases in wildfire risk (Kittitas County Conservation District and Anchor 2018). Most of them focus on reducing ladder fuels, such as removal of dead and downed wood and removal of dense immature saplings and shrubby vegetation. This can be achieved by physical/mechanical removal or controlled burns. Controlled burns could be more desirable, since they better approximate pre-development physical processes. It is important that the City's code be flexible to accommodate these types of activities and encourage them as development continues.

Fire-Adapted Communities

Actions to reduce wildfire risk to communities in Washington must be taken to reduce future widespread economic loss, loss of human life, further declining forest health and the occurrence of uncharacteristic wildfires. Kittitas County has experienced decades of population growth and home building, which has led to increased residential development in forests and into the Wildland Urban Interface (WUI). The WUI, as defined by Kittitas County Community Wildfire Protection Plan (CWPP: Kittitas County Conservation District and Anchor 2018), is any area where the combination of human development and vegetation have a potential to result in negative impacts from wildfire on the community. This includes the entire city and its UGA. New development in these sensitive areas results in greater risk to life, property and challenges for fire protection and prevention. Establishing a fire-adapted community through work on private property will build a more fire-resistant landscape, and a more integrated and successful fire response.

The Kittitas County CWPP developed a guidance document aimed at outlining eight necessary steps developing community wildfire protection plan, entitled; Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities (Communities Committee, et al. 2004). Promoting fire adapted communities focused on preventing, preparing for, and protecting lives and properties during wildfire events and ensuring a full recovery. There are many paths to becoming fire adapted such as though education, mitigation, policies and regulation.

Firewise Communities USA is a nationally recognized program that recognizes communities who have demonstrated their commitment to wildfire preparedness. The program is used as a tool to raise the level of landowner awareness in neighborhoods. There are several Firewise USA communities in the Cle Elum area including:

- Banti Creek,
- Buffalo Springs
- Goat Peak Ranch HOA
- Hidden Valley Terrace
- Hidden Valley Vistas – Hidden Valley Meadows
- Lauderdale Ridge HOA

- Sky Meadows Ranch
- Sun Country
- Suncadia
- Sunlight Waters
- Swauk Pines
- Teanaway Terrace
- Vistas at Cle Elum
- Tillman Creek

LANDSLIDES

Very few landslides have been documented within the City of Cle Elum. Mapped landslides within the City are limited to several shallow undifferentiated slides along the banks of the Cle Elum River at the western end of town. A single deep-seated slide is mapped directly west of Bullfrog Road, roughly 800 feet north of I-90 (at exit 80). Numerous landslides have occurred within the public lands found outside the City limits. An additional large deep-seated landslide is located at Lanigan Spring, just northeast of the City limits.

A landslide hazard inventory was conducted of the greater Cle Elum watershed in 2005 (Powell 2005). Powell's work was focused on better managing risks associated with mass wasting and forest harvest. Powell describes five types of mass wasting processes that occur in the Cle Elum watershed, including:

- Shallow soil sliding down bedrock surfaces in convergent headwalls and inner gorges. These soils are sensitive to disturbance and loss of vegetation (root strength)
- Toes of deep-seated landslides adjacent to streams
- Slope ravel and shallow landslides on glacial terrace faces along the Cle Elum River
- Large deep-seated landslides

Mass wasting is directly related to slope shape, angle, the occurrence of bedrock, colluvial/soil material and depth, hydrogeology, glacial history and forest practices. The areas most prone to mass wasting include steep convergent slopes on dipping bedrock units that have been folded, fractured and weathered to unstable minerals, draped by thin soils, or colluvium and/or glacially derived sediments are usually the most prone to failure (Powell 2005). These conditions occur along the higher relief areas north of downtown Cle Elum. **While this information does exist,**

it is not referenced in the CEMC and it should be to be compliant with Ecology recommendations.

When soils are severely disturbed, such with development activities including clearing vegetation, grading, road building, and forest practices, the combined loss of root strength with heavy precipitation initiates immediate mass wasting (Powell 2005).

Powell evaluated the mass wasting potential of seven landforms found in the Cle Elum study area. Mass wasting potential considered landslide process, failure density, lithology, geomorphology and topography. The landforms associated with the highest mass wasting potential in the area are described below and can be used to guide improved management of these critical areas in the City of Cle Elum.

High Mass Wasting Potential:

- Toes of deep-seated landslides, adjacent to streams. Slopes greater than 65 percent are most prone to failure.
- Inner gorges. Inner gorges fail as slopes ravel. Shallow landslides or debris slides often initiate debris flows, triggering sediment production.
- Terrace faces and outside of meander bends. These features are constantly being over steepened resulting in shallow landslides, and occasional deep-seated slides, raveling with rapid failures occurring during heavy precipitation.

Powell (2005) observed the impacts from vegetation removal, regrading, loading, and recreational vehicle activity, particularly along the terrace faces. These impacts have the potential to initiate and amplify mass wasting processes which can threaten public safely, impact critical infrastructure, such as roads, bridges and power lines.

STEEP SLOPES

The topography of Cle Elum and its UGA is a northwest to southeast trending Pleistocene glacially carved valley. Glacial erosion oversteepened valley walls in many locations (Powell 2005, ESA 2012). Slopes greater than 35 percent are mapped within the City of Cle Elum north of Fourth and Six Streets, and up Greens Canyon, Balmers Canyon, and Curry Canyons. Some steep slopes are found north of Crystal Creek and within the Bullfrog Flats areas, east of Wood Duck Road.

Geotechnical buffers from the top of these slopes are suggested for slopes that are continuous for at least 10 feet. Buffers can be set at a fraction of the slope height or a fixed distance (e.g., 50 feet). Development within these buffers should be accompanied by a report from a licensed geotechnical engineer.

Erosion Hazard Areas

The principal risk from erosion in Cle Elum is associated with channel migration of the Yakima and Cle Elum rivers. Kittitas County completed channel migration zone mapping of the Yakima River, including the Cle Elum and its UGA (ESA 2012). Much of the channel migration zone within Cle Elum is disconnected from the Yakima river by the I-90 corridor. All areas located south of I-90 are located within the (Tier 1) channel migration zone (ESA 2012). The channel migration zone for the Cle Elum River, is found within city limits, in the Bullfrog Flats area near the western edge of the city. Here it is also partially disconnected due to I-90.

Other erosion hazards could result on the bedrock hillsides found at the edges of the city. The bedrock nature of these areas means that they are resistant to erosion, but wildfire and climate change (i.e., increased intense rainfall) could increase their erodibility. Since the risk is not present now, these areas should be monitored for any change to their condition, but no designation is necessary at this time.

Seismic Hazards

Various seismic event scenarios have been modeled for Washington State with projected magnitudes and qualified levels of shaking and some additional information on damages associated with the specific conditions. The City of Cle Elum is vulnerable to ten potential seismic events, based on the likely magnitude of an earthquake and the town's proximity to the active fault lines. The greatest risk is likely associated with a potential Cle Elum Fault rupture, which has been modeled as a magnitude 6.8 earthquake. It would have the potential to produce strong to very strong shaking in the city. This scenario is based on a hypothetical rupture along a set of faults following Manastash Ridge and Cle Elum Ridge in the Yakima Fold Belt. The fault rupture scenarios that produce shaking in Cle Elum are:

- Cascadia, Magnitude 9.0. Moderate to Strong shaking
- Cascadia North, Magnitude 8.3. Moderate shaking
- Chelan, Magnitude 7. Moderate to Strong shaking
- Cle Elum, Magnitude 6.8. Strong to Very Strong shaking
- Mill Creek, Magnitude 7.1. Light to Moderate shaking
- Mount St Helens, Magnitude 7.0. Light to Moderate shaking
- Saddle Mountain, Magnitude 7.35. Moderate to Strong shaking
- Seattle, Magnitude 7.2. Moderate shaking

- Seatac, Magnitude 7.2. Moderate shaking
- Southern Whidbey, Magnitude 7.4. Moderate shaking

Due to the underlying unconsolidated geology of the valley floor, and much of the City of Cle Elum, liquefaction risk is a moderate to high risk and a high risk (Palmer, et al. 2004). The liquefaction potential would accentuate the shaking seen in the above rupture events. Examination of the City's building code was beyond the scope of this analysis, but it should account for these types of events.

MITIGATION

Unavoidable impacts on critical areas should be offset by mitigation. The City's critical areas ordinance is expected to include standards for the type, location, amount, and timing of the mitigation, as well as clear guidance on design considerations and reporting requirements (Ecology 2012). Mitigation follows a sequence, which is defined by WAC 197-11-768 as the sequential process of avoiding, minimizing, rectifying and reducing impacts, as well as compensating for unavoidable impacts and monitoring the impact per the following order of preference:

1. Avoiding the impact altogether by not taking a certain action or parts of an action;
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;
5. Compensating for the impact by replacing, enhancing, or providing substitute resources or environments; and/or
6. Monitoring the impact and taking appropriate corrective measures.

Section 18.01.070 of CEMC outlines this mitigation sequencing, however mitigation ratios are defined for wetland impacts only. **Mitigation ratios for impacts to all City regulated critical areas and associated buffers should additionally be stated in the code to be compliant with Ecology recommendations.**

With respect to wetland mitigation, the City's code follows recommended mitigation ratios for compensatory mitigation as outlined in the interagency (Ecology, US Army Corps of Engineers, and EPA) Wetland Mitigation in Washington State guidance documents, Parts 1 and 2, Publications #06-06-11a and #06-06-11b , prepared in 2006; however updates to these documents are anticipated for completion in 2020. The City may also allow for the use of the credit/debit method as an alternative to determining mitigation ratios as described in *Calculating Credits and Debits for Compensatory Mitigation in Wetlands of Eastern Washington: Final Report* (Hruby 2012).

Mitigation can be challenging in a small jurisdiction such as the City; thus, Ecology suggests that a critical areas ordinance include language that allows for interlocal agreements or similar instruments that would allow mitigation to occur in other jurisdictions (Ecology 2012). The City may consider allowing for mitigation banking and/or an in-lieu fee program. The USACE considers mitigation banks and in-lieu fee programs the preferred option for mitigation because they consolidate resources and involve more financial planning and scientific expertise (USACE 2017). Overall, the City's approach to wetland mitigation meets BAS standards; however, mitigation for impacts to all critical areas and associated buffers should be defined.

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