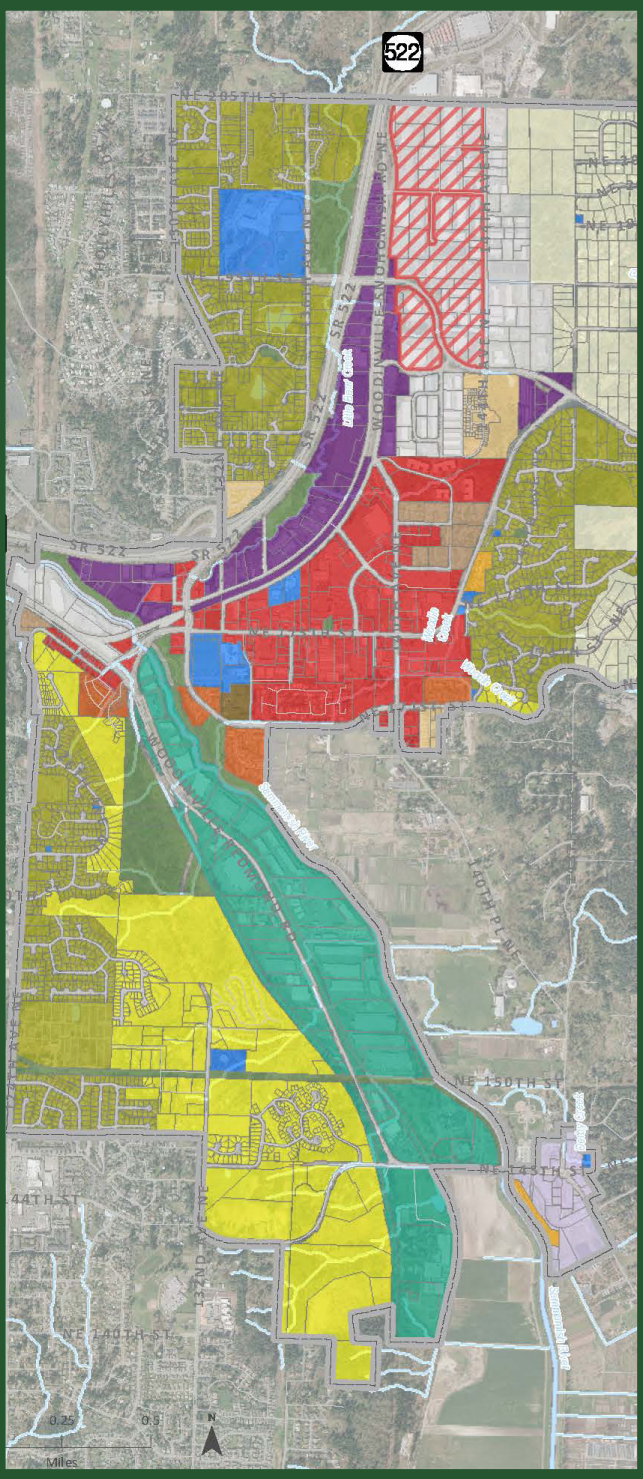
Exhibit 3

DRAFT



City of Woodinville

2015 Comprehensive Plan & Municipal Code Update

Municipal Code Update & Best Available Science Review

November 2014

Prepared by:
BERK Consulting
MAKERS Architecture
The Watershed Company
Transportation Engineering Northwest
Golder Associates

Prepared for:
City of Woodinville

PROPOSED WOODINVILLE MUNICIPAL CODE AMENDMENTS ASSOCIATED WITH 2015 COMPREHENSIVE PLAN UPDATE

Summary

GROWTH MANAGEMENT REVIEW OF DEVELOPMENT REGULATIONS

The Growth Management Act (GMA) requires that counties and cities including Woodinville periodically review and update their comprehensive plans and development regulations, with the minimum review consisting of review of the community's growth allocation and critical areas regulations:

> *(1)(a) Each comprehensive land use plan and development regulations shall be subject to continuing review and evaluation by the county or city that adopted them. Except as otherwise provided, a county or city shall take legislative action to review and, if needed, revise its comprehensive land use plan and development regulations to ensure the plan and regulations comply with the requirements of this chapter according to the deadlines in subsections (4) and (5) of this section.*
>
> ***
>
> *(c) The review and evaluation required by this subsection shall include, but is not limited to, consideration of critical area ordinances and, if planning under RCW 36.70A.040, an analysis of the population allocated to a city or county from the most recent ten-year population forecast by the office of financial management.*
>
> ***
>
> *(2)(a) *** "Updates" means to review and revise, if needed, according to subsection (1) of this section, and the deadlines in subsections (4) and (5) of this section or in accordance with the provisions of subsection (6) of this section. ****

The City's proposals with respect to accommodating growth and its review of critical areas regulations follows.

ZONING CODE AMENDMENTS

The City's evaluation under its Comprehensive Plan Update has found that allocated growth can be accommodated by 2031, the year of Countywide Planning Policies' population and employment allocations, but a deficit of capacity is found by the year 2035, the horizon of the 20-year planning period.

The City has developed land use alternatives for study that address refinements to the City's land use plan and zoning map– namely, greater mixed uses opportunities in employment areas and regional retail and tourist uses in conjunction with industrial areas – that would allow the City to meet 2035 growth estimates while retaining its overall community vision. Therefore, zoning amendments that implement the changes to the future land use map to accommodate the 2035 growth estimates are proposed concurrent with the Comprehensive Plan. Primarily these changes include:

- A new Amenity Mixed Use Zone along the Sammamish River adding in mixed use residential/commercial opportunities while continuing to support industrial and tourist uses.
- Added mixed use residential allowances in the General Business Zone west and north of Downtown.
- A new Regional Retail Overlay on the City's northern industrial area.

In part to balance the City's exploration of a permanent R-1 acre lot residential zoning in east Woodinville (in place of a system that allows rezones to 4 units an acre where there are urban services), the City intends to evaluate opportunities to improve its accessory dwelling unit provisions and its Downtown density and height incentives. Additional evaluation by A Regional Coalition for Housing and the City's consultants is attached.

Also proposed as part of the zoning code amendments are recommendations to simplify the permitted uses table for greater readability and usability.

To date, land use plan and zoning concepts have been the subject of Planning Commission and City Council briefings in 2014, particularly the mixed use elements. City Council dockets have identified the study of employment uses in the northern and southern industrial areas. Concepts regarding code simplification have also been the subject of a City Council briefing.

CRITICAL AREAS REGULATIONS AMENDMENTS

Likewise, the City's consultants, The Watershed Company, have evaluated its critical areas ordinance following a best available science (BAS) review (see Appendix D). A gap analysis with recommendations has been prepared (see Appendix D). These documents have been reviewed by staff in spring 2014. All topics except for geologic hazards and grading have been the subject of two Planning Commission meetings.

Further amendments may be developed as a result of targeted geologic hazards review by Golder Associates (see Appendix D).

ATTACHMENTS

The following documents are attached to this summary for City staff review:

- Attachment A: Woodinville Land Use Code Update: First Draft Chapters 21.08 and 21.12
- Attachment B: Accessory Dwelling Unit Outline of Example Provisions
- Attachment C: Downtown Residential Incentives
- Attachment D: Critical Areas Best Available Science (BAS) Review and Gap Analysis and Geologic Hazards Review

Attachment A

Woodinville Land Use Code Update:

First Draft Chapters 21.08 and 21.12

September 30, 2014

Below is a first draft of code updates to be undertaken in conjunction with the larger Comprehensive Planning effort. Included is a portion of Chapter 21.08 Permitted Uses and Density and Dimensions that implement Alternative 2 of the draft Comprehensive Plan and changes to make the chapter easier to use. Notable changes:

- Updated chart format with repeating headers and shaded columns which help the user navigate the charts and find the right use provisions in a particular zone.
- Removal of the NAICS (North American Industry Classification System) references. Updated definitions and the use of good design standards make it easier to eliminate the cross references to the classification system (which often just add a layer of confusion to codes)
- Simplify the use chart by consolidating/reducing the number of uses listed in the charts. This will generally occur more in the services and retail use charts. The idea is to use more detailed definitions for the use types to help explain the ranges of uses that fall under each use type listed in the chart. Furthermore, more detailed design standards (that are largely in place already) that shape the look, feel, density, and impacts of development help to simplify the use chart.
- Add easy cross-references to standards that apply to particular uses (WMC references that often are listed below a use).

Also see the comments in the column – which point out key changes, provide rationale, or ask key questions regarding a use of key standards.

21.08 Permitted Uses

21.08.010 Establishment of uses.
21.08.020 Interpretation of land use tables.
21.08.030 Residential land uses.
21.08.040 Recreational/cultural land uses.
21.08.050 General services land uses.
21.08.055 Institutional land uses.
21.08.060 Business services land uses.
21.08.070 Retail land uses.
21.08.080 Manufacturing land uses.
21.08.090 Resource land uses.
21.08.100 Regional land uses.

Attachment A

21.08.010 Establishment of uses.

The use of a property is defined by the activity for which the building or lot is intended, designed, arranged, occupied, or maintained. The use is considered permanently established when that use will or has been in continuous operation for a period exceeding 60 days. A use which will operate for less than 60 days is considered a temporary use, and subject to the requirements of Chapter 21.32 WMC. All applicable requirements of this code, or other applicable State or Federal requirements, shall govern a use located in the City of Woodinville. (Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 175 § 1, 1997)

21.08.020 Interpretation of land use tables.

(1) The land use tables in this chapter determine whether a specific use is allowed in a zone district. The zone district is located on the vertical column and the specific use is located on the horizontal row of these tables.

(2) If no symbol appears in the box at the intersection of the column and the row, the use is not allowed in that district, except for certain temporary uses.

(3) If the letter "P" appears in the box at the intersection of the column and the row, the use is allowed in that district subject to the review procedures specified in Chapters 17.07 through 17.17 WMC and the general requirements of the code.

(4) If the letter "C" appears in the box at the intersection of the column and the row, the use is allowed subject to the conditional use review procedures specified in Chapters 17.07 through 17.17 WMC and the general requirements of the code.

(5) If the letter "S" appears in the box at the intersection of the column and the row, the regional use is permitted subject to the special use permit review procedures specified in Chapters 17.07 through 17.17 WMC and the general requirements of the code.

(6) Clarification of uses and special conditions.

(a) If a * appears after the use, then the use is defined in Chapter 21.06 WMC.

(b) Where an WMC reference/link appears after a use, then the use is subject to standards set forth in that section or chapter.

~~(a)~~ (c) If a number appears in the box at the intersection of the column and the row, the use may be allowed subject to the appropriate review process indicated above, the general requirements of the code and the specific conditions indicated in the development condition with the corresponding number immediately following the land use table.

~~(b)~~ (d) If more than one letter-number combination appears in the box at the intersection of the column and the row, the use is allowed in that zone subject to different sets of limitation or conditions depending on the review process indicated by the letter, the general requirements of the code and the specific conditions indicated in the development condition with the corresponding number immediately following the table.

~~(c)~~ (e) All applicable requirements shall govern a use whether or not they are cross-referenced in a section.

~~(6)~~(7) Only public parks or recreational facilities shall be allowed to locate in the Park zone (P). (Ord. 554 § 6, 2013; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 175 § 1, 1997)

Attachment A

21.08.030 Residential land uses.

A. Residential land uses table.

NOTE –THE CONDITIONS HAVE BEEN RENUMBERED – TO APPEAR IN THE ORDER THEY GENERALLY OCCUR IN THE CHART. OTHERWISE – THE ONLY CHANGES TO THE USE CHARTS ARE MARKED IN TRACK CHANGES FORMAT.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**AMU**	**I**	**P/I**
Dwelling Unit Types											
Single detached*	P[1]	P[1]	P					P[2]			
Cottage* (WMC 21.14.xxx)	P	P	P								
Duplex* (WMC 21.14.xxx)	P~~[2x]~~	P~~[2x]~~	P~~[2x]~~	P~~[2x]~~							
Townhouse* (WMC 21.14.xxx)	C[3]	C[4]	P	P		P[5]		P[6,7]	P		
Apartment* (WMC 21.14 Article 2)		P[8]	P	P			P[9]	P[6,7]	P		
Dwelling, live-work*						P		P	P		
Manufactured ~~Mobile~~ home park*			P	P				P[7]			
Group Residences											
Community residential facility*	P[10]	P[10]	P[10]	P[10]				P[6,7,10]			P[10]
Senior citizen assisted*		P[8]	P	P			P[9]	P[6,7]			
~~Dormitory*~~											
Accessory Uses											
Residential accessory use*	P	P	P	P			P	P	P		P
Accessory dwelling unit* (WMC 21.14.xxx)	P	P	P	P				P			P
Home occupations* (WMC 21.30.040)	P	P	P	P			P	P	P		
Home industry* (WMC 21.30.050)	C	C	C	C							
Temporary Lodging											
Hotel/motel*						P	P	P	P		

Comment [b2]: Suggest moving the duplex standards out of this chapter and consolidated into Article 1 of 21.14

Comment [b1]: Suggesting adding design standards for duplexes and integrating them into Article 1 of Chapter 21.14.

Comment [b3]: Suggesting adding design standards for townhouses and integrating them into Article 1 of Chapter 21.14.

Comment [b4]: Consider allowing apartments in portions of the zone where integrated into a mixed-use development (particularly office use) and where use integrates creek trail and wetland enhancements?

Comment [b5]: Another use type that we suggest adding. Consider allowing in any district/area that allows both commercial and residential – but allow this housing type to meet the requirement of ground floor commercial, regardless of whether the ground floor is actively being used for commercial. The main point here is the design – which is capable of accommodating commercial uses.

Attachment A

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**AMU**	**I**	**P/I**
Bed & breakfast inns* (WMC 21.30.xxx)	P	P	P			P		P			
~~Organizational hotel/lodging~~Rooming & boarding houses*	C[11]	C[11]	P[11]	P[11]				P[6,7,11]		P[11]	P[12]
Temporary shelter*								P[13]			
Youth hostel*						P		P			

B. Development conditions:

1. A conditional use permit is required for a single-family structure exceeding 8,500 gross square feet in the R-1 through R-6 zones.
2. No new single-family detached dwelling units are permitted except on the sites with existing single-family detached dwelling units on December 24, 2012.
3. Permitted only in the R-4 and R-6 zones, on parcels where protection of critical areas prohibits traditional single-family development.
4. A conditional use permit is not required if the townhomes are approved through subdivision review or if the project is in the R-8 zone.
5. Residential development is not permitted on the ground floor and is only permitted as part of a development that integrates residential with tourist-oriented business development and is conditioned through a development agreement with the City that ensures a City-approved economic analysis will be provided and the proposed mixed use development meets the vision and goals of the Tourist District Master Plan. No more than 25 percent of the entire area development may include residential uses. No direct residential dwelling unit entrances or exits may be permitted onto NE 148th Avenue NE, NE 145th Street, or Woodinville-Redmond Road.
6. Residential dwelling units are not permitted on the ground floor or below grade abutting a public street. Foyers or lobbies providing access to dwelling units may front onto a public street.

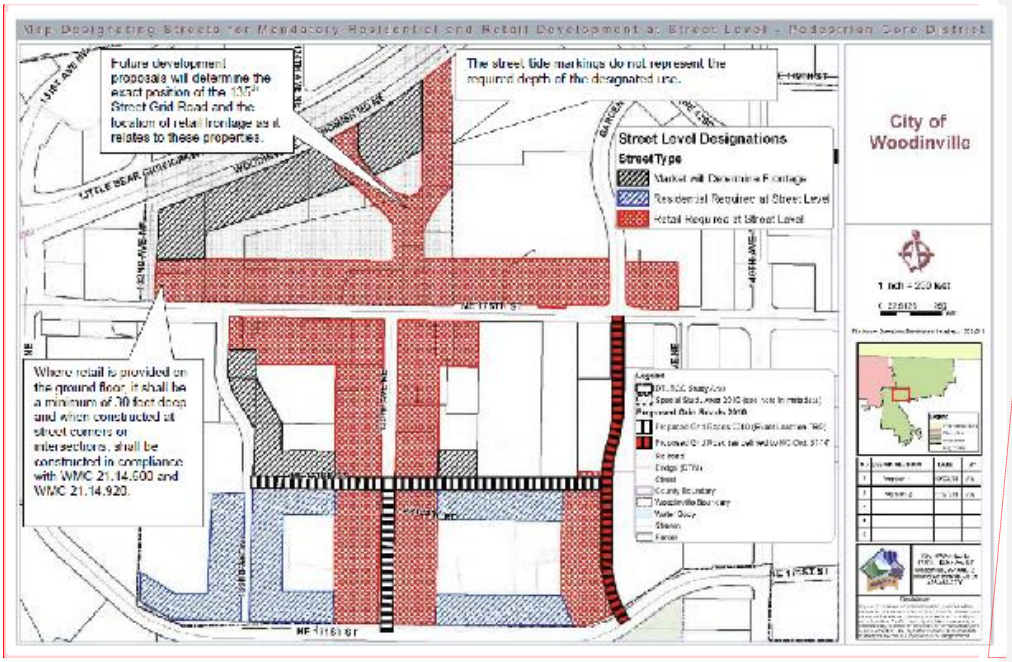
~~7. 7. Residential dwelling units are not permitted within 300 feet of State Route 522.~~

~~8.~~7. In the Pedestrian Core Design District only, residential and/or retail uses shall be required for all new development on the ground floor as shown on the map titled "Map Designating Streets for Mandatory Residential and Retail Development at Street Level – Pedestrian Core Design District." Where retail is provided on the ground floor, it shall be a minimum of 30 feet deep and when constructed at street corners or intersections, shall be constructed in compliance with WMC 21.14.600 and 21.14.920.

~~9.~~8. Permitted only in the R-8 zone.

9. Apartments are allowed in the General Business zone provided the subject property is within 1,200 feet of a park or transit stop and the use is integrated with non-residential uses. At least 33 percent of developable areas of the site (excludes critical areas and associated buffer areas) shall be reserved for non-residential uses or mixed-use buildings where non-residential uses occupy at least 50 percent of the ground floor.

10. The number of occupants shall not exceed the occupant load of the structure, calculated as provided in Chapter 15.04 WMC, Building Codes, or as may be hereafter amended.
11. Only as an accessory to a school, college/university, church, or fire station.
12. Only as an accessory to a public school.
    (a) Only as an accessory use to an institution, school, public agency, church, synagogue, temple, or nonprofit community organization.



Comment [b6]: Insert a higher resolution image of this map here.

(Ord. 539 § 6, 2012; Ord. 524 § 2 (Att. A), 2012; Ord. 511 § 3, 2010; Ord. 496 § 4 (Att. C), 2010; Ord. 489 § 4 (Att. C), 2010; Ord. 465 §§ 15, 19, 2008; Ord. 448 § 11, 2007; Ord. 428 § 5, 2006; Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 242 § 3, 1999; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997)

NOTE – NEW DEFINITIONS PROPOSED ASSOCIATED WITH CHANGES ABOVE.

Cottage Housing. "Cottage housing" means a type of housing design established in WMC 21.14.XXX that consists of small, detached dwelling units arranged in a cluster of four to 12 dwelling units around a common central open space at a density greater than the underlying zoning district. Such dwelling units may not exceed 1,200 total square feet in size and may be configured as condominiums or fee simple lots.

Dwelling, live-work unit. "Live-work unit" means an individual dwelling unit that is used for residential and non-residential use types. The dwelling unit type may be any type that is permitted in the applicable zoning district. Permitted non-residential uses may be those that are permitted in the applicable zoning district.

Attachment A

21.08.040 Recreational/cultural land uses.

A. Recreational/cultural land use table.

NOTE – BELOW IS AN UPDATED CHART SHOWING REC/CULTURAL USES – INCLUDING SOME CONSOLIDATED USE TERMS WITH COMMENTS.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
PARK/RECREATION											
Parks*	P[1]	P[1]	P[1]	P[1]	P[1]	P[1]	P	P	P		P
Trails*	P	P	P	P	P	P	P	P	P	P	P
~~Destination resorts*~~								~~C[2]~~			
~~Marina*~~			~~C[4]~~	~~C[4]~~		~~P5~~	~~P~~	~~P~~		~~P~~	
AMUSEMENT/ENTERTAINMENT											
Theater*						P[2, 3, 4]	P[3]	P[3]	P[2,3]		P [2,3, 4]
~~Theater, drive-in~~							~~C[6]~~	~~C[6]~~			
Recreation - outdoor (commercial)*	C[5]	C[5]	C[5]	C[5]			P	C[6]			
Recreation - indoor (commercial)*						P[7]	P[8,9]	P		C[8]	
Sports club	C[11]	C[11]	C[11]	C[11]		C	P	P	P		C
CIVIC & CULTURAL											
Library	P[11], C	P[11], C	P[11], C	P[11], C		P	P	P	P		P
Museum and art galleries	P[11], C	P[11], C	P[11], C	P[11], C		P	P	P	P		
Arboretum	P	P	P	P		P	P	P	P		
Places of assembly									P		
Performing arts, and recording studios							P	P	P		
Civic center											P
Community center											P
Conference center	P[11], C	P[11], C	P[11], C	P[11], C				P	P		

Comment [b7]: Suggest creating a new definition to include both cinema, plays, and live music.

Comment [b9]: Consider a threshold where a use exceeds what's permitted based on size and impacts of use.

Comment [b8]: Consider this: "Recreation – outdoor commercial" means a commercial recreation land use conducted primarily outdoors, including, but not limited to water parks, amusement parks, and miniature golf courses.

Comment [b10]: Consider combining bowling, indoor tennis, amusement arcades, indoor shooting range, indoor batting cage, and indoor go-cart facilities –however – we'll want to figure out the differences between sub uses, what's conditional, and how/where to put use specific standards.

Comment [b11]: **Places of assembly.** "Places of assembly" means a structure for groups of people to gather for an event or regularly scheduled program. Examples include but are not limited to arenas, religious institution acess, lecture halls, banquet facilities, and similar facilities.

B. Development conditions:

1. The following conditions and limitations shall apply, where appropriate:
   a. No stadiums on sites less than 10 acres;
   b. Lighting for structures and fields shall be directed away from residential areas;
   c. Structures or service yards shall maintain a minimum distance of 50 feet from property lines adjoining residential zones.

2. Except cinemas containing more than 20,000 sf of floor area.

~~2.~~3. Adult use facilities shall be prohibited within 660 feet of any residential zones, any other adult use facility, or school-licensed daycare centers, public parks, community centers, public libraries or churches that conduct religious or educational classes for minors.

~~3.~~4. Only plays or theatrical production uses are allowed in this zone as an accessory use to another permitted use.

~~4.~~5. Includes only golf facilities. Structures, driving ranges, and lighted areas shall maintain a minimum distance of 50 feet from property lines of adjoining residential zones.

~~5.~~6. Excludes golf facilities.

~~6.~~7. Includes only arcades.

~~7.~~8. Indoor batting facilities are subject to the following conditions and limitations:

a. Facilities open to youth under the age of 18 shall not be located in the Sexually Oriented Business Overlay District;

b. The facility shall require the minimum safety standards as provided for a national youth baseball association such as the Little League Association;

c. Signs regarding safety rules must be prominently displayed;

d. Pedestrian walkways shall be clearly marked;

e. The business owner shall provide to the City a signed statement by the building owner declaring that High Hazard Occupancies (Type H Occupancies as defined in Chapter 15.04 WMC, Building Codes) shall not be located in any spaces adjacent to the indoor batting facility; or the facility shall be located in a single occupancy building;

f. Retail sales at an indoor batting facility shall be limited to baseball-related items (except where such uses are permitted in the subject district), and the retail sales area shall not exceed 500 square feet;

g. Children under the age of 15 are not permitted on the premises without a supervising adult;

h. On-site food preparation is prohibited (except where such uses are permitted in the subject district);

i. A safe pedestrian "pick-up/drop-off" area that does not interfere with local traffic shall be provided.

~~8.~~9. Indoor go-cart racing facilities are subject to the following conditions and limitations:

a. Signs regarding safety rules must be prominently displayed;

b. Pedestrian walkways shall be clearly marked;

c. The business owner shall provide to the City a signed statement by the building owner declaring that High Hazard Occupancies (Type H occupancies as defined in Chapter 15.04 WMC, Building Codes) shall not be located in any spaces adjacent to the indoor go-cart racing facility, or the facility shall be located in a single occupant building;

d. A safe pedestrian "pick-up/drop-off" area that does not interfere with local traffic shall be provided;

e. Until and unless the City adopts an overriding noise ordinance, the maximum noise levels (dBA) associated with the operation of any go-cart racing facility shall not exceed the following maximum dBAs:

Receiving Property		
Residential Zones	Commercial Zones	Industrial Zones
57*	60	65

*Reduced to 10 dBA between the hours of 10:00 p.m. and 7:00 a.m.

f. Loitering outside the facility shall be strictly controlled by the facility's management; and

g. Prior to the opening of the facility, proof of suitable insurance is required.

~~9.~~10. Limited to recreation facilities for residents of a specified residential development.

11. Only as accessory to a park or in a building listed on the National Register as an historic site or designated as a landmark subject to the provisions of Chapter 21.31 WMC.

NOTE – NEW DEFINITIONS PROPOSED ASSOCIATED WITH CHANGES ABOVE.

Places of assembly. "Places of assembly" means a structure for groups of people to gather for an event or regularly scheduled program. Examples include but are not limited to arenas, religious institutions, lecture halls, banquet facilities, and similar facilities.

Attachment A

21.08.050 General services land uses.

A. General services land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Day care I facilities*	P[1]	P[1]	P[1]	P[1]	P	P	P	P	P	P[2]	P[3]
Day care II facilities*	P[4]	P[4]	P[4]	P[4]	P	P	P	P	P	P[2]	P[3]
General service establishments (WMC 21.06.xxx)					P[5]	P[5]	P	P		P	
Heavy services (see Heavy retail and services definition in WMC 21.06.xxx)*							~~P~~			P	
Funeral home/crematory	P[6]	P[6]	P[6]	P[6]			P	P			
Cemetery, columbarium	P[7] C[8]	P[7] C[8]	P[7] C[8]	P[7] C[8]			P[7] C[8]	P[7] C[8]			
Hospitals*								P[9]			
Offices, medical*					P[10]		P[10]	P[10]			
Kennels *							P	P	P	P	
Nursing homes*					C[9]		P	P[9]			P[9, 11]
Personal service establishments*					P[12]	P	P	P	P		P[11]
EDUCATION SERVICES											
Public schools*	P[9,13] C[9]	P[9,13] C[9]	P[9,13] C[9]	P[9,13] C[9]				P[9]		C[14]	P[9]
Vocational school*							P	P[9]		P[9]	P[9]
Specialized instruction school	P[15]	P[15]	P[15]	P[15]	P		P	P	P	C[16]	P[17]
Preschool	C[18]	C[18]	C[18]	C[18]	P		P	P	P		P[17]
School district support facility	C[19]	C[19]	C[19]	C[19]			P	P			
Gymnastic schools								P[20]		C[20]	
Sports & recreational instruction											

B. Development conditions:

1. Only as an accessory to residential use, provided:

a. Outdoor play areas shall be completely enclosed by a solid wall or fence, with no openings except for gates, and have a minimum height of six feet;
b. Outdoor play equipment shall maintain a minimum distance of 20 feet from property lines adjoining residential zones; and
c. Only two nonresident staff are present on site at any one time.

2. Permitted as an accessory use, see commercial/industrial accessory uses, WMC21.08.060(A).
3. Only as an accessory to a hospital or other permitted institutional use.
4. Only as a re-use of a public school facility subject to the provisions of Chapter 21.32 WMC, an accessory use to a school or church, provided:
   a. Outdoor play areas shall be completely enclosed by a solid wall or fence, with no openings except for gates, and have a minimum height of six feet;
   b. Outdoor play equipment shall maintain a minimum distance of 20 feet from property lines adjoining residential zones;
   c. Direct access to a developed arterial street shall be required in any residential zone; and
   d. Hours of operation may be restricted to assure compatibility with surrounding development.
5. Includes only gasoline service stations and any accessory repair services.
6. Only as accessory to a cemetery.
7. Limited to columbariums accessory to a church; provided, that existing required landscaping and parking are not reduced.
8. Structures shall maintain a minimum distance of 100 feet from property lines adjoining residential zones.
9. If use abuts an agriculturally zoned property, the following conditions apply:
   a. Buildings and parking areas must be set back 50 feet from the property line abutting an agriculturally zoned parcel;
   b. Fifty feet of Type II landscaping is required in the setback; and
   c. Nonemergency access through or to the agriculturally zoned parcel is prohibited.
10. Conditions for veterinarian services:
    a. No burning of refuse or dead animals is allowed;
    b. The portion of the building or structure in which animals are kept or treated shall be soundproofed. All run areas, excluding confinement areas for livestock, shall be surrounded by an eight-foot solid wall and surfaced with concrete or other impervious material; and
    c. The provisions of Chapter 21.30 WMC relative to animal keeping are met.
11. Only as an accessory to a hospital or other permitted institutional use.
12. Nail salons and similar uses designated as NAICS No. 812113 are permitted only if the business is connected to a public sewer.
13. Only as a re-use of a public school facility subject to the provisions of Chapter 21.32 WMC. An expansion of such school facility shall be subject to approval of a conditional use permit and the expansion shall not require or result in an extension of the sewer local service area (LSA), unless a finding is made that no cost-effective alternative technologies are feasible, in which case a tightline to a sewer sized only to meet the needs of the school may be used.
14. Limited to junior high/secondary schools grades seven through 12 and subject to the following conditions:
    a. Pedestrian walkways shall be clearly marked.

b. The business owner shall provide to the City a signed statement by the building owner declaring that high hazard occupancies (Type H occupancies as defined in Chapter 15.04 WMC, Building Codes) shall not be located in any spaces adjacent to the school; or the facility shall be located in a single occupancy.

c. A safe pedestrian "pick-up/drop-off" area that does not interfere with local traffic shall be provided.

d. Schools shall be located 330 feet from any adult entertainment facility.

e. A parking plan is required to assure enough available parking is on site.

f. The school will be a closed campus where students will remain on site during operation hours.

g. Class size shall be limited to the occupancy load permitted by the certificate of occupancy.

15. Only as an accessory to residential use, provided:

a. Students are limited to 12 students in any 24-hour period;

b. All instruction must be within an enclosed structure;

c. Structures used for the school shall maintain a distance of 25 feet from property lines of adjoining residential zones; and

d. Hours of operation may be restricted to assure compatibility with surrounding development.

16. Limited to dance instruction and subject to the following conditions:

a. Pedestrian walkways shall be clearly marked.

b. The business owner shall provide to the City a signed statement by the building owner declaring that high hazard occupancies (Type H occupancies as defined in Chapter 15.04 WMC, Building Codes) shall not be located in any spaces adjacent to the dance instruction facility; or the facility shall be located in a single occupancy building.

c. Retail sales shall be limited to dance-related items, and the total retail sales area shall not exceed 500 square feet.

d. On-site food preparation is prohibited.

e. A safe pedestrian "pick-up/drop-off" area that does not interfere with local traffic shall be provided.

17. Limited to publicly owned facilities.

18. Operation limited to the hours between 8:30 a.m. and 3:30 p.m., Monday through Friday. A maximum of 12 children at any one time may be present, with no more than 24 children permitted in a 24-hour period.

19. Only when adjacent to an existing or proposed school.

20. Gymnastics schools are allowed, subject to the following conditions:

a. A gymnastic school shall be a member in good standing of the United States Gymnastics Federation.

b. A gymnastic school shall demonstrate conformance to guidelines of the United States Gymnastics Federation for equipment used for gymnastics instruction.

c. A safe student "pick-up/drop-off" area that does not interfere with local traffic shall be provided.

d. Retail sales at a gymnastic school shall be limited to gymnastic-related items, and the retail sales area shall not exceed 500 square feet.

Attachment A

NOTE – NEW DEFINITIONS PROPOSED ASSOCIATED WITH CHANGES ABOVE.

General service establishment. "General service establishment" refers to a category of uses whose primary activity is the provision of assistance, as opposed to products, to individuals, businesses, industry, government, and other enterprises. Specific uses in this category include but are not limited to postal and courier services, equipment rentals, repair shops, laundries, automobile fueling, veterinary clinics, and other services.

Heavy retail and service. "Heavy retail and service" includes retail and/or service activities that may have exterior service or storage areas. This use category includes, but is not limited to contractors, agricultural supplies, building materials, manufactured homes, heating fuels, truck stops, outdoor display/sales, and warehousing in buildings no larger than 50,000 gross square feet in area.

Office, medical. "Medical office" means an office or clinic used exclusively by physicians, dentists, and similar personnel for the treatment and examination of patients solely on an outpatient basis, provided that no overnight patients shall be kept on the premises. The term also includes veterinary clinics and such veterinary clinics may keep domestic animals overnight inside the clinics for short periods of time in association with and accessory to the treatment of such domestic animals.

Kennel. "Kennel" or shelter means any outdoor or indoor facility, which houses four or more small domestic animals (that number not including one unweaned litter) for periods longer than 24 hours as a commercial venture, as a nonprofit organization, or for a governmental purpose. The facility may be either a separate business or an accessory use. A kennel is to be distinguised from a veterinary clinic which houses animals for periods that may exceed 24 hours as a commercial venture that is accessory to the primary medical activity performed in a veterinary clinic – See definition of "Office, medical".

Attachment A

21.08.060 Institutional land uses.

A. Institutional land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Public agency or utility office	P[1, 9], C[2, 9]	P[1, 9], C[2, 9]	P[1, 9], C[2, 9]	P[1, 9], C[2, 9]			P[9]	P[9, 15]	P[15]		P[9]
Public agency or utility yard	P[3, 9]	P[3, 9]					P[9]	P[9, 13]		P[9]	P[9]
Public agency archives							P[9]	P[9, 13]		P[9]	P[9]
Court								P[9, 13]			P[9]
Police facility					P[5]		P[9]	P[9, 13]		P[9]	P[9]
Fire facility	C[4, 9]	C[4, 9]	C[4, 9]	C[4, 9]		P[9], C[4]	P[9]	P[9, 13]		P[9]	P[9]
Utility facility	P[9]	P[9]	P[9]	P[9]		P[9]	P[9]	P[9]		P[9]	P[9]
Minor communication facility (6)	C[9]	C[9]	C[9]	C[9]		C[9]	P[9]	P[9]	P	P[9]	C[9, 12]
Private storm water management facility	P[7, 9]	P[7, 9]	P[7, 9]	P[7, 9]		P[8, 9]	P[8, 9]	P[8, 9]	P[8]	P[8, 9]	P[9]
Interim recycling facility	P[9, 10, 11]	P[9, 10, 11]	P[9, 10, 11]	P[9, 10, 11]	P[10]		P[9]	P[9, 13]		P[9]	P[9, 12]

B. Development conditions:

1. Only as a re-use of a public school facility subject to the provisions of Chapter 21.32 WMC.
2. Only as a re-use of a surplus nonresidential facility subject to Chapter 21.32 WMC.
3. Limited to material storage for road maintenance facilities.
4. Fire facility conditions:
   a. All buildings and structures shall maintain a minimum distance of 20 feet from property lines adjoining Residential zones;
   b. Any buildings from which fire-fighting equipment emerges onto a street shall maintain a distance of 35 feet from such street; and
   c. No outdoor storage.
5. Limited to police substation facilities.
6. Minor communication facilities shall be regulated relative to setback and height pursuant to Chapter 21.12 WMC.
7. Such facilities shall be located on the same lot that they are designed to serve except in subdivisions that set aside a separate tract for such facilities.
8. Such facilities which are not located on the lot they are designed to serve shall be located on a lot with the same or more intensive zoning designation.
9. If use abuts an agriculturally zoned property, the following conditions apply:
   d. Buildings and parking areas must be set back 50 feet from the property line abutting a agriculturally zoned parcel;

e. Fifty feet of Type II landscaping is required in the setback; and

f. Nonemergency access through or to the agriculturally zoned parcel is prohibited.

10. Limited to drop box facilities accessory to a public or community use such as a school, fire station, or community center.
11. All processing and storage of material shall be within enclosed buildings and excluding yard waste processing.
12. Limited to publicly owned facilities.
13. Not permitted in the Pedestrian Core Design District; see WMC 21.14.310.
14. Not permitted on sites contiguous to property designated Low Density Residential or less by the City of Woodinville adopted Comprehensive Plan. This limitation also applies to sites in unincorporated King County with equivalent designations.
15. No outdoor storage or display. All activity associated with permitted use shall take place within an enclosed building. (Ord. 489 § 6 (Att. E), 2010; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 233 §§ 17, 18, 19, 1999; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997

21.08.060 Business services land uses.

A. Business services land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**AMU ~~O~~**	**I**	**P/I**
Construction and trade							P[17]	P[17]	P[29]	P	
Individual transportation and taxi base							P[29]	P[17, 20]			
Trucking and courier service							P	P[12, 20]	P[29]	P	
Warehousing (1) and wholesale trade									P[29]	P	
Self-service storage			C[14]	C[14]			P		P[29]	P	
Farm product warehousing, refrigeration and storage									P[29]	P	
Log storage									P[29]	P	
Transportation service							P[29]		P[29]	P	
Freight and cargo service							P[29]		P[29]	P	
Passenger transportation service							P	P[20]			

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Use	Zoning District										
	R 1-4	R 5-8	R 9-18	R 19+	NB	TB	GB	CBD	AMU ~~O~~	I	P/I
Communication offices							P	P	P	P	
Telegraph and other communications							P	P	P	P	
General business service					P[8]	P	P	P	P	P[16]	
Professional office					P	P[26, 27]	P	P	P	P[16]	P[3]
Outdoor advertising service							P	P[20]	P[29]	P	
Photocopying and duplicating service					P[15, 28]	P					
Miscellaneous equipment rental							P[17]	P[17]	P[29]	P	P[4]
Automotive rental and leasing							P	P[17]			
Automotive parking	P[19]	P[19]	P[19]	P[19]			P	P	P	P	P[5]
Professional sport teams/promoters							P	P[7]	P		
Research, development and testing							P[2]	P[2, 17]	P[2,17]	P[2]	P[6]
Heavy equipment and truck repair							P[29]		P[29]	P	
Commercial/industrial accessory uses		P[22]				P[22]	P	P	P	P	
Mailbox rental services					P[15, 28]						
Helistop					C[23]	C[23]	C[24]	C[24]	C[24]	C[24]	C[24]

B. Development conditions:

1. Except self-service storage.
2. Except NAICS Industry No. 54172 – Commercial, economic, sociological, and educational research. See general business services/office.
3. Only as a government, public agency, community service, or nonprofit use, or as an accessory to a permitted use.
4. Only as an accessory to a permitted use.
5. Only as an accessory to a permitted use and as a facility fully accessible to the public.
6. Only as a medical research and development facility associated with a hospital or other medical service provider.

7. Not permitted on sites contiguous to property designated Low Density Residential or less by the City of Woodinville adopted Comprehensive Plan. This limitation also applies to sites in unincorporated King County with equivalent designations.
8. Except for NAICS Major Group Nos. 541, 561 and 323.
9. No outdoor storage of materials.
10. Limited to office uses. No storage of nonoffice equipment, tools, machinery, supplies or commercial vehicles exceeding one-ton capacity.
11. Limited to current location. No new self-storage land uses are permitted in the Office zone as of January 1, 2003.
12. Limited to self-service household moving truck or trailer rental accessory to a gasoline service station and NAICS Industry No. 49211 – Courier services, except by air.
13. Limited to NAICS Industry No. 49211 – Courier services, except by air.
14. Accessory to an apartment development of at least 12 units, provided:
    a. The gross floor area in self-service storage shall not exceed 50 percent of the total gross floor area of the apartment dwellings on the site;
    b. All outdoor lights shall be deflected, shaded and focused away from all adjoining property;
    c. The use of the facility shall be limited to dead storage of household goods;
    d. No servicing or repair of motor vehicles, boats, trailers, lawn mowers or similar equipment;
    e. No outdoor storage or storage of flammable liquids, highly combustible or explosive materials or hazardous chemicals;
    f. No residential occupancy of the storage units;
    g. No business activity other than the rental of storage units to the apartment dwellings on the site; and
    h. A resident manager shall be required on the site and shall be responsible for maintaining the operation of the facility in conformance with the conditions of approval.
15. Service limited to the use of dry-ink toner copying only, and toxic chemical usage for any of the processing equipment, either as part of the process or for cleaning and maintenance of equipment, is prohibited.
16. Only as an accessory use to another permitted use, not to exceed 49 percent of gross floor area.
17. No outdoor storage or display. All activity associated with permitted use shall take place within an enclosed building.
18. Reserved.
19. Limited to commuter parking facilities for users of transit, carpools or ride-share programs, provided:
    a. They are located on existing parking lots for churches, schools, or other permitted non-residential uses which have excess capacity available during commuting hours; and
    b. The site is adjacent to a designated arterial that has been improved to a standard acceptable to the Public Works Department.
20. Not permitted in the Pedestrian Core Design District or Civic/Gateway Design District; see WMC 21.14.310.
21. Reserved.
22. Storage limited to accessory storage of commodities sold at retail on the premises or materials used in the fabrication of commodities sold on the premises.

23. Limited to emergency medical evacuation sites in conjunction with police, fire or health service facility.
24. Allowed as accessory to an allowed use; or limited to emergency evacuation sites in conjunction with police, fire or health service facility.
25. Reserved.
26. Permitted professional office uses shall be limited to the following NAICS Major Group and Industry Numbers:
    a. 5242 – Insurance agents, brokers and service;
    b. 53121 – Real estate agents and managers;
    c. 54111 – Legal services;
    d. 541330 – Engineering services;
    e. 541611 – Administrative management and general management consulting services; and
    f. 54182 – Public relations services.
27. A maximum of 20 percent of the gross square footage of the ground floor of any building may be used for professional office uses, and up to 40 percent of gross square footage of floors above the ground floor for the entire development may be used for professional office uses.
28. Services such as photographic processing, photo printing or other types of photo processing that employ wet chemical processes are prohibited. (Ord. 489 § 7 (Att. F), 2010; Ord. 481 § 10, 2009; Ord. 465 § 17, 2008; Ord. 448 §§ 12, 13, 2007; Ord. 426 §§ 7, 8, 2006; Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997)

~~28.~~29. Subject use is permitted only within a building and associated site improvements that were in existence at the (ADOPTION DATE OF THIS ORDINANCE). Expansion of a use in existence at the (ADOPTION DATE OF THIS ORDINANCE) shall be permitted.

21.08.070 Retail land uses.

A. Retail land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Building, hardware and garden materials					P[2]	P	P	P[4, 28]	P[29]		
Forest products sales										P	
Department and variety stores						P[5]	P	P	P[30]		
Food stores					P	P	P	P[29]	P[29]		
Agricultural crop sales	P[3, 7]										
Motor vehicle and boat dealers							P	P[8, 30, 31]			
Auto supply stores							P[9]				

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	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Gasoline service stations					P	P	P	P[12, 27]			
Apparel, jewelry and accessory stores					P	P	P[30]	P	P[30]		
Furniture and home furnishings stores						P[21]	P	P	P[30]		
Eating and drinking places					P[10, 16]	P[10, 16]	P	P[12]	P	P[6]	P[1]
Tasting room							P	P	P	P[26] C[25]	
Drug stores					P[23]	P	P	P	P[30]		P[13]
Liquor stores					P[24]		P	P	P		
Antique/Collectable shops					P	P[4]	P	P	P[30]		
Collectable shops					P		P	P	P[30]		
Secondhand/used merchandise shops					P			P			
Sporting goods and related stores					P	P	P	P	P[30]		
Book, stationery, video and art supply stores					P	P[11]	P	P[11]	P[30]		
Monuments, tombstones, and gravestones							P			P	
Hobby, toy, game shops					P	P	P[30]	P	P[30]		
Photographic and electronic shops					P	P	P[30]	P	P[30]		
Fabric shops					P	P	P[30]	P	P[30]		
Fuel dealers							P			P	
Florist shops					P	P	P	P	P[30]		P[13]
Personal medical supply stores					C			P			
Pet shops					P	P	P[30]	P	P[30]		
Bulk retail							P	P[12]			
Auction houses							P			P	

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Truck and motorhome dealers (14)							P			P	
Auto parts yard										P[20]	
Sexually oriented businesses (15)							P[11]			P[11]	
Gift shops					P	P		P	P[30]		P[13]

B. Development conditions:

1. Only as an accessory to a permitted use.
2. Only hardware and garden materials stores shall be permitted.
3. Special agricultural crop sales conditions:
   a. Limited to products produced on site; and
   b. Covered sales areas shall not exceed a total area of 500 square feet.
4. Excludes used building material stores and pawnshops.
5. Limited to NAICS Industry No. 45299 – Variety stores, and further limited to a maximum of 2,000 square feet of gross floor area.
6. Permitted in conjunction with an on-site food processing facility; otherwise permitted only in multi-tenant building and limited to a maximum of 2,000 square feet of gross floor area.
7. Special agricultural crop sales conditions:
   a. The floor area devoted to retail sales shall not exceed 2,500 square feet;
   b. Sales shall be limited to agricultural produce and plants;
   c. Storage areas for produce may be included in a farm store structure or in any accessory building;
   d. Hours of operation shall be limited to 7:00 a.m. to 9:00 p.m. during the months of May through September and 7:00 a.m. to 7:00 p.m. during the months of October through April. Outside lighting is permitted; provided, no off-site glare is allowed; and
   e. Noncontiguous lands within the City of Woodinville may be assembled by an individual farmer or group of farmers for the purposes of establishing a source of local products to be sold in a farm store on one of the properties.
8. Excluding retail sale of trucks exceeding one-ton capacity.
9. Only the sale of new or reconditioned automobile supplies is permitted.
10. Excluding NAICS Industry No. 72241 – Drinking places.
11. Sexually oriented businesses shall be prohibited within:
    f. Six hundred sixty feet of the perimeter of the building or point of access in which: any other sexually oriented business is located; or
    g. Three hundred thirty feet from any office zone or residential zone, except the single-family residential zoned areas to the west and east of the North Industrial Neighborhood Sexually Oriented Business Overlay District; or

h. Three hundred thirty feet of any school, licensed daycare, public park, community center, public library, sports club with children's activities, or church which conducts religious or educational classes for minors.

12. Subject to the City's adopted commercial design standards.
13. Only as an accessory to a hospital or other medical facility.
14. Includes wholesale and retail sale of trucks exceeding one-ton capacity.
15. See Chapter 17.19 WMC for regulations governing a sexually oriented business. See the zoning map for regulations governing the location of sexually oriented businesses.
16. No drive-through window restaurants, except drive-through kiosks with a footprint of less than 200 square feet that serve beverages and pre-prepared, pre-packaged food items to be consumed off site.
17. Permitted only on sites with a High Density Residential (R-48)/Office zone designation.
18. Except NAICS 453991 – Tobacco stores and stands, which are not permitted.
19. Drug stores are limited to 25 percent of total office building square footage.
20. The perimeter of all areas used for the storage of inoperable vehicles or vehicle parts must be screened with a six-foot sight-obscuring fence and a 10-foot width of Type I landscaping.
21. Limited to culinary-related uses under the following NAICS categories:
    a. 443111 – Household appliance stores; and
    b. 44229 – Other home furnishings stores.
22. These uses are only permitted as part of a development that integrates residential with tourist-oriented business development on the property and is conditioned through a development agreement with the City that ensures the proposed mixed use development meets the vision and goals of the Tourist District Master Plan.
23. Reserved.
24. Gross floor area of drug stores shall not exceed 3,500 square feet.
25. Beverage sales limited to beer and wine.
26. Tasting rooms are only permitted on those properties that have sufficient parking, vehicular access to the site, and pedestrian access to the business entrance as determined by the Director. Tasting rooms are required to undergo review for traffic impacts pursuant to Chapter 3.39 WMC and the Infrastructure Standards as adopted under Chapter 12.09 WMC. A parking study will be required to determine the number of spaces needed to meet the needs of a tasting room. All facilities shall provide or obtain: ADA compliant facilities; current State liquor license as a tasting room; direct pedestrian access from the business entrance to a public street or other public trail.
27. Permitted as an accessory to an on-site wine, beer or spirits production facility.
28. Not permitted in the Pedestrian Core Design District or Civic/Gateway Design District; see WMC 21.14.310.
29. Limited to a maximum of 24,000 square feet of gross floor area in the Pedestrian Core, General Business District, and Amenity Mixed-Use Districts; see WMC 21.14.310.
30. Limited to a maximum of 10,000 square feet of gross floor area in the Pedestrian Core Design District, ~~or~~ Civic/Gateway Design District, General Business District, or Amenity Mixed-Use District; see WMC 21.14.310.
31. No outdoor storage or display. All activity associated with permitted use shall take place

within an enclosed building.

32. No direct vehicle access to a public right-of-way. (Ord. 511 § 6, 2010; Ord. 489 § 8 (Att. G), 2010; Ord. 481 §§ 8 (Att. D), 10, 2009; Ord. 465 § 18, 2008; Ord. 426 § 9, 2006; Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 267 § 18, 2000; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997)

21.08.080 Manufacturing land uses.

A. Manufacturing land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Food and kindred products							C		P[15]	P[2]	
Winery/brewery/distillery							C		P	P	
Textile mill products									P[15]	P	
Apparel and other textile products							C		P[15]	P	
Wood products, except furniture							C[6]		P[15]	P	
Furniture and fixtures							C		P[15]	P	
Paper and allied products									P[15]	P	
Printing and publishing					P[7]	P[7]	P[7]	P[7]	P[15]	P	
Chemicals and allied products									P[15]	P	
Petroleum refining and related industries										C	
Plastics and rubber products manufacturing									P[15]	P	
Tire retreading										C	
Leather and leather goods							C		P[15]	P	
Stone, clay, glass and concrete products							P[9]		P[15]	P	
Primary metal industries										C	
Fabricated metal products									P[15]	P	

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Industrial and commercial machinery, heavy machinery and equipment									P[15]	P, C	
Computer and office equipment, measuring and controlling instruments							C		P[15]	P	
Electronic and other electric equipment and appliances							C		P[15]	P	
Transportation equipment manufactur-ing										C	
Miscellaneous light manufacturing									P[15]	P	
Motor vehicle and bicycle manufacturing										C	
Aircraft, ship and boat building										P[10,] C	
Movie production/distribution							P		P	P	
Accessory use, commercial/industrial									P	P[12, 13]	

B. Development conditions:

1. Reserved.
2. Except slaughterhouses.
3. Reserved.
4. Reserved.
5. Reserved.
6. Limited to uses found in NAICS Industry No. 33711 – Wood kitchen cabinets, and No.
7. 32191 – Millwork (excluding planing mills).
8. Limited to photocopying and printing services offered to the general public.
9. Reserved.
10. Only within enclosed buildings.
11. Limited to boat building of craft not exceeding 48 feet in length and aircraft parts.
12. Reserved.
13. Retail activity is limited to items manufactured or assembled on-site.

14. Retail area is limited to 10 percent of the gross floor area not to exceed 3,000 square feet regardless of gross floor area of the principal manufacturing use. (Ord. 481 § 9 (Att. E), 2009; Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997)

~~14.~~15. Subject use is permitted only within a building and associated site improvements that were in existence at the (ADOPTION DATE OF THIS ORDINANCE). Expansion of a use in existence at the (ADOPTION DATE OF THIS ORDINANCE) shall be permitted.

21.08.090 Resource land uses.

A. Resource land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
AGRICULTURAL:											
Growing and harvesting crops	P								P	P	
Raising livestock and small animals	P[6]								P	P	
FORESTRY:											
Growing and harvesting forest products	P								P	P	
Forest research									P[2, 3]	P	
FISH AND WILDLIFE MANAGEMENT:											
Hatchery/fish preserve and aquaculture (1)	C								P	P	
Wildlife shelters	C								P	P	
MINERAL:											
Mineral extraction											
Processing of minerals									P[7]	P	
Asphalt paving, roofing and saturated materials manufacturing									P[7]	P	

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
RESOURCE ACCESSORY USES:											
Resource accessory uses									P[4]	P[4]	

B. Development conditions:

1. May be further subject to the provisions of City of Woodinville Shoreline Management Program.
2. Only forest research conducted within an enclosed building.
3. Not permitted on sites contiguous to property designated Low Density Residential or less by the City of Woodinville adopted Comprehensive Plan. This limitation also applies to sites in unincorporated King County with equivalent designations.
4. Excluding housing for agricultural workers.
5. Reserved.
6. Only allowed in the R-1 zone. (Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 324 § 1, 2002; Ord. 304 § 1, 2001; Ord. 295 § 2, 2001; Ord. 194 § 3, 1997; Ord. 175 § 1, 1997
7. ~~6.~~ Subject use is permitted only within a building and associated site improvements that were in existence at the (ADOPTION DATE OF THIS ORDINANCE). Expansion of a use in existence at the (ADOPTION DATE OF THIS ORDINANCE) shall be permitted.

21.08.100 Regional land uses.

A. Regional land use table.

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Jail							S[11]				S[11]
Secure community transition facility							S[16]				
Work release facility							S[11]				
Public agency animal control facility							S[11]		P[25]	P[11]	S[11]
Public agency training facility							S[3, 11]			C[4, 11]	S[11]
Hydroelectric generation facility	C[11, 13], S[11]									S[11]	
Nonhydroelectric generation facility	C[11, 12], S[11]						C[11, 12], S[11]	C[8, 18]	C[8, 18]	P[11, 12], S[11]	

Attachment A

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Major communication facility										S[6] C[11]	
Personal wireless facilities (14)	14	14	14	14	14	14	14	14	14	14	14
Electric vehicle (EV) charging station (20)	P[19, 21, 23]	P[19, 21, 23]	P[19, 21, 23]	P[19, 21, 23]	P	P	P	P	P	P	P
Rapid charging station (22)	P[23]	P[23]	P[23]	P[23]	P	P	P	P	P	P	P
Battery exchange station									P[24,25]	P[24]	
Earth station	P[6a]	P[6a]	P[6a]	P[6a]		P[6b, 11]	P[6b, 11]	P[6b, 11]	P[6b, 11]	P[6b, 11]	P[6b, 11]
Oil and gas extraction	S[11]	S[11]	S[11]	S[11]			S[11]			C[11]	
Energy resource recovery facility										S[11]	
Soil recycling/incineration facility										C[11]	
Landfill										S[11]	S[8, 11]
Transfer station										S[17]	
Wastewater treatment facility							S[11]			C[11]	S[11]
Municipal water production	S[11]	S[11]	S[11]	S[11]			S[11]			S[11]	S[11]
Airport/Heliport	S[11]	S[11]	S[11]	S[11]			S[11]			S[11]	S[8, 11]
Landing field	S[11]	S[11]	S[11]	S[11]			S[11]			S[11]	S[8, 11]
Transit bus base							S[11]			P[11]	S[11]
Transit park and ride lot	S[11]	S[11]	S[11]	S[11]			P[11]	P[11, 5]	P[5]	P[11]	S[11]
School bus base							S[11]	S[11, 5]		P[11]	S[8, 11]
Racetrack	S[7, 11]	S[11]	S[7, 11]	S[7, 11]			S[11]	S[7, 11, 5]			
Fairground							S[11]	S[11, 5]			S[8, 11]
Zoo/Wildlife exhibit (2)						S	S[11]	S[11, 5]			S[8, 11]
Stadium/Arena							S[11]	S[11]	S	P[11]	S[8, 11]

Attachment A

	Zoning District										
Use	**R 1-4**	**R 5-8**	**R 9-18**	**R 19+**	**NB**	**TB**	**GB**	**CBD**	**~~O~~ AMU**	**I**	**P/I**
Junior college College/University	P[9,11], C[10,11], S[11]	P[9,11], C[10,11], S[11]	P[9,11], C[10,11], S[11]	P[9,11], C[10,11], S[11]				P[11]	P	P[11]	P[11]

B. Development conditions:

1. Except technical institutions. See vocational schools on general services land use table, WMC 21.08.050.
2. Except arboretum. See WMC 21.08.040, recreation/cultural land use table.
3. Except weapons armories and outdoor shooting ranges.
4. Except outdoor shooting range.
5. Not permitted in the Pedestrian Core District or Civic/Gateway District; see WMC 21.14.310.
6. Special use conditions:
   a. Limited to one receive-only satellite parabolic antenna not exceeding one meter in diameter in a residential zone and not exceeding two meters in diameter in all other zones.
   b. Limited to no more than three satellite parabolic antennas not exceeding one meter in diameter in a residential zone and not exceeding two meters in diameter in all other zones.
   c. Limited to tower consolidations.
7. Except racing of motorized vehicles.
8. Only as an accessory to a permitted use or if operated by a public agency.
9. Only as a reuse of a public school facility subject to the provisions of Chapter 21.32 WMC.
10. Only as a reuse of surplus nonresidential facility subject to the provisions of Chapter 21.32 WMC.
11. If use abuts an agriculturally zoned property, the following conditions apply:
    a. Buildings and parking areas must be set back 50 feet from the property line abutting a agriculturally zoned parcel;
    b. Fifty feet of Type II landscaping is required in the setback; and
    c. Nonemergency access through or to the agriculturally zoned parcel is prohibited.
12. Excluding impoundment of water using a dam.
13. Limited to facilities that comply with the following provisions:
    a. Any new diversion structure shall not:
       i. Exceed a height of eight feet as measured from the streambed; or
       ii. Impound more than three surface acres of water at the normal maximum surface level.
    b. There shall be no active storage.
    c. The maximum water surface area at any existing dam or diversion shall not be increased.
    d. An exceedance flow of no greater than 50 percent in mainstream reach shall be maintained.
    e. Any transmission line shall be limited to a:
       i. Right-of-way of five miles or less; and
       ii. Capacity of 230 KV or less.
    f. Any new, permanent access road shall be limited to five miles or less.
    g. The facility shall be located above an anadromous fish barrier.

14. Personal wireless service facilities shall be regulated pursuant to Chapter 21.26 WMC.
15. Not permitted on sites contiguous to property designated Low Density Residential or less by the City of Woodinville adopted Comprehensive Plan. This limitation also applies to sites in unincorporated King County with equivalent designations.
16. Secure community transition facilities (SCTF) shall in no case be sited adjacent to, immediately across a street or parking lot from, or within the line of sight of risk potential facilities defined in the law as schools, school bus stops, preschool facilities, daycare facilities, public parks, publicly dedicated trails, sports fields, recreational and community centers, churches, synagogues, temples, mosques or public libraries.
17. Permitted only (i) within the North Industrial Neighborhood as illustrated by Figure 1-2 of the Woodinville Comprehensive Plan, (ii) upon approval of a special use permit, and (iii) upon the Hearing Examiner's determination that appropriate measures have been or, prior to operation of the transfer station, will be implemented sufficient to mitigate the anticipated impacts of the transfer station. Such mitigation measures may include, but are not necessarily limited to, the following:
    a. Odor control.
    b. Vector control.
    c. Waste residency durational limitations.
    d. Containment and/or covering of waste transport vehicles.
    e. Operating hour limitations.
    f. Facility size limitations.
    g. Maximum weight limitations for waste transport vehicles.
    h. Noise control.
    i. Truck tip limitations.
18. Fuel source limited to a renewable resource (i.e., solar or wind).
19. Level 1 and Level 2 charging stations only.
20. Level 1 and Level 2 charging stations are permitted in critical aquifer recharge areas and in other critical areas when serving an existing use.
21. Allowed only as an accessory use to a primary permitted use or permitted conditional use.
22. The term rapid is used interchangeable with Level 3 and rapid charging.
23. Only as an electrical vehicle charging station – restricted.
24. The battery exchange station work or service shall only be performed in an enclosed building, and no outdoor storage of materials. (Ord. 523 § 4 (Att. C), 2011; Ord. 489 § 9 (Att. H), 2010; Ord. 428 § 8, 2006; Ord. 414 §§ 2, 3, 2006; Ord. 379 § 14, 2004; Ord. 347 § 9, 2003; Ord. 326 § 7, 2002; Ord. 325 § 1, 2002; Ord. 324

~~24.~~25. Subject use is permitted only within a building and associated site improvements that were in existence at the (ADOPTION DATE OF THIS ORDINANCE). Expansion of a use in existence at the (ADOPTION DATE OF THIS ORDINANCE) shall be permitted.

21.12 Development Standards - Density and Dimensions

21.12.010 Purpose.
21.12.020 Interpretation of tables.
21.12.030 Densities and dimensions – Residential zones.
21.12.040 Densities and dimensions – Public and commercial/industrial zones.
21.12.050 Measurement methods.
21.12.060 Minimum urban residential density.
21.12.070 Calculations – Allowable dwelling units or floor area.
21.12.080 Calculations – Site area used for density calculations.
21.12.090 Lot area – Prohibited reduction.
21.12.100 Lot area – Minimum lot area for construction.
21.12.110 Setbacks – Specific building or use.
21.12.120 Setbacks – Modifications.
21.12.130 Reserved.
21.12.140 Setbacks – From alley.
21.12.150 Setbacks – Adjoining half-street or designated arterial.
21.12.160 Setbacks – Projections allowed.
21.12.170 Height – Exceptions to limits.
21.12.180 Lot size averaging.
21.12.190 Lot divided by zone boundary.
21.12.200 Sight distance requirements.
21.12.210 Nonresidential land uses in residential zones.

21.12.010 Purpose.

The purpose of this chapter is to establish requirements for development relative to residential density and basic dimensional standards as well as specific rules for general application. The standards and rules are established to provide flexibility in project design, provide solar access, and maintain privacy between adjacent uses. (Ord. 175 § 1, 1997)

21.12.020 Interpretation of tables.

(1) WMC 21.12.030 and 21.12.040 contain general density and dimension standards for the various zones and limitations specific to a particular zone(s). Additional rules, exceptions, and methodology are set forth in WMC 21.12.050 through 21.12.210, and WMC21.38.010 through 21.38.080.

(2) The density and dimension tables are arranged in a matrix format on two separate tables and are delineated into two general land use categories:

  (a) Residential; and

  (b) Resource and commercial/industrial.

(3) Development standards are listed down the left side of both tables, and the zones are listed across the top. Each cell contains the minimum or maximum requirement of the zone. Numbers in parentheses identify specific requirements found in the development conditions that follow the matrix. A blank box indicates that there are no specific requirements. If more than one standard appears in a cell, each standard will be subject to any applicable development condition as noted.

~~(3)~~(4) Where an WMC reference/link appears after the density and dimensional topic, then the use is subject to the standards set forth in the applicable section or chapter.

(5) Property-specific development standards may be applied to specific properties or areas containing several properties through a development agreement consistent with Chapter 36.70B RCW, and approved by the City Council. (Ord. 390 § 3, 2005; Ord. 175 § 1, 1997)

21.12.030 Density and dimensions – Residential zones.

A. Density and dimensions – Residential zone standards.

Topic	R-1	R-4	R-6	R-8	R-12	R-18	R-24	R-48
DENSITY & LOT SIZE								
Base Density: Dwelling Unit/Acre	1 du/ac	4 du/ac	6 du/ac	8 du/ac	12 du/ac	18 du/ac	24 du/ac	48 du/ac
Minimum Density: % of Base Density (2)		75%	75%	85%	80%	75%	70%	65%
Minimum Lot Area (1)	35,000 sf	9,000 sf	6,000 sf	5,000 sf				
Minimum Lot Width (3)	100 ft/75 ft (7) (12)	60 ft	50 ft	30 ft	30 ft	30 ft	30 ft	30 ft
Minimum Lot Width at Street (9)	100 ft/75 ft (12)	60 ft	50 ft	30 ft				
SETBACKS								
Minimum Street Setback (3)	10 ft (8)	10 ft (8)	10 ft (8)	10 ft (8)	10 ft (8)(17)	10 ft (8)	10 ft (8)	10 ft (8)
Minimum Interior Setback (3)	10 ft (7)	5 ft (10)	5 ft (10)	5 ft (10)	5 ft (10)(17)	5 ft (10)	5 ft (10)	5 ft (10)
HEIGHT, BUILDING COVERAGE & IMPERVIOUS AREA								
Base Height	35 ft	35 ft	35 ft	35 ft	35 ft (17)	45 ft	45 ft	45 ft (18)
Maximum Building Coverage: Percentage (5) (16)	15% (11) (14)	35%	50%	55%	60%	60%	70%	70%
Maximum Impervious Surface: Percentage (5) (16) (19)	20% (15)	45%	70%	75%	85% (17)	85%	85%	90% (18)

B. Development conditions:

(1) Except as modified by WMC 21.12.180 and WMC 21.24.085.

(2) Also see WMC 21.12.060.

(3) These standards may be modified under the provisions for zero-lot-line and townhome developments.

(4) Reserved.

(5) Applies to each individual lot. Building coverage and impervious surface area standards for:

(a) Regional uses shall be established at the time of permit review; or

(b) Nonresidential uses in Residential zones shall comply with WMC 21.12.210.

(6) Reserved.

(7) The standards of the R-4 zone shall apply if a lot is less than 15,000 square feet in area.

(8) At least 20 linear feet of driveway shall be provided between any garage, carport, or other fenced parking area and the street property line. The linear distance shall be measured along the centerline of the driveway from the access point to such garage, carport or fenced area to the street property line or pedestrian walkway, sidewalk, or easement access road(s), whichever is closest to the garage, carport or fenced parking area.

(9) Panhandle Lots. Panhandle lots shall be allowed subject to the following requirements:

(a) Panhandle lots shall be allowed in cul-de-sacs, where critical areas do not allow the normal frontage required by the underlying zone, and/or where a private road is not practical.

(b) The width of the access corridor shall be 20 feet between the street and the main body of the lot.

(c) The other density and dimension standards in this section shall be determined using only the main body of the lot, and excluding the access corridor, including: minimum lot area, minimum lot width, setbacks, maximum building coverage and maximum impervious surface.

(d) The access corridor shall maintain a minimum height clearance of 12 feet, and shall be designed to meet the driveway requirements in the City's infrastructure standards.

(e) There shall not be two or more contiguous panhandle lots. In cases where multiple contiguous panhandle lots are proposed, a private road shall be required instead.

(f) The access corridor shall provide direct access to a paved public or private street.

(g) The access corridor must be part of the lot, and be under the same ownership as the main body of the lot.

(h) All requirements of the fire code shall be met, including access and sprinkler requirements.

(10) For townhomes or apartment development, the setback shall be the greater of:

(a) Twenty feet along any property line abutting R-4 through R-8 zones; or

(b) The average setback of the R-4 through R-8 zoned single-family detached dwelling units from the common property line separating said dwelling units from the adjacent townhome or apartment development, provided the required setback applied to said development shall not exceed 60 feet. The setback shall be measured from said property line to the closest point of each single-family detached dwelling unit, excluding projections allowed per WMC 21.12.160 and accessory structures existing at the time the townhome or apartment development receives conditional use permit approval by the City.

(c) (See also landscaping requirements under WMC 21.16.060(2).

(11) On any lot over one acre in area, an additional five percent may be used for buildings related to agricultural or forestry practices.

(12) For the R-1 zone only, the minimum lot width at street shall be 100 feet at the street;

except that the minimum lot width at street on cul-de-sacs shall be 75 feet at the street.

(13) Reserved.

(14) Maximum Building Coverage Percentage.

Lot Size	Max. Percentage Allowed
<15,000 SF	35% (Permitted for R-4 zone)
15,000 to 25,000 SF	28%
25,000 to 35,000 SF	22%
Over 35,000 SF	15%

(15) Maximum Impervious Surface Percentage.

Lot Size	Max. Percentage Allowed
<15,000 SF	45% (Permitted in R-4 zone)
15,000 to 25,000 SF	37%
25,000 to 35,000 SF	28%
Over 35,000 SF	20%

(16) New mobile home parks are exempt from this requirement.

(17) If located in the Tourist District Overlay, see WMC 21.38.065.

(18) If located in the R-48/O district, see WMC 21.38.030(5).

(19) A maximum impervious credit of up to 50 percent for the use of pervious concrete materials as a recognized engineered all-weather surface used for walkways, patios, off-street parking lots, private easement access roads and similar hard surface areas. (Ord. 532 § 6, 2012; Ord. 448 §§ 14, 15, 2007; Ord. 426 §§ 10, 11, 2006; Ord. 400 § 11, 2005; Ord. 175 § 1, 1997)

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21.12.040 Density and dimensions – Public and commercial/industrial zones.

A. Density and dimensions – Residential zone standards.

Topic	P/I	NB	TB	GB	CBD (27)	~~O~~AMU	I
DENSITY							
Base Density: Dwelling Unit/Acre		12 du/ac	12 du/ac	36 du/ac	36 du/ac	36 du/ac	
Residential Maximum Floor/Lot Ratio: Square Feet				2/1 (26)	2/1 ~~(1)~~ (26)	2/1 (26)	
Commercial/Industrial Maximum Floor/Lot Ratio: Square Feet	4/1	1/1	1/1	2/1 (19)	2.5/1	~~4~~3/1	3/1
~~Maximum Building Coverage: Percentage~~							
Maximum Building Square Footage			10,000	(21)	(21)		
BUILDING SETBACKS AND FAÇADE STEP-BACKS							
Minimum Building Step-Back				10 ft (2)	10 ft (2)		
Minimum Street Setback (17)	10 ft	10 ft (3) 20 ft (4)	10 ft (5)	(28)~~10 ft~~ 25 ft (15)	(28)~~10 ft~~ (5)	(28)~~10 ft~~ (5)	25 ft 10 ft (6)
Minimum Interior Setback (13)	20 ft (7) (16)	10 ft	20 ft (7) (14)	25 ft (7) (15)	20 ft (7)	20 ft (7)	20 ft (7) (14) (15) 50 ft (8) (14)
BUILDING HEIGHT							
Base~~(10~~ Height	45 ft	35 ft (10)	35 ft (10) (14) ~~(20)~~	39 ft (26)	35 ft (12)	Residential Mixed use: 35 ft. Industrial:45 ft. (14)	45 ft (14)
~~Maximum Height with Structured Parking~~				~~60 ft (25)~~	~~57 ft (25)~~		
Maximum Height			45 ft (20)	60 ft ~~(25)~~ (26)	57 ft ~~(25)~~ (26)	57 ft (26)	
IMPERVIOUS AREA LIMITS							
Maximum Impervious Surface: Percentage	85%	75%	85% (14)	85%	90%	~~75%~~90% (14)	90% (14)

Comment [b12]: Under proposed GB policies, this zone would allow residential in conjunction with some non-residential development where within ¼ mile of a park or transit stop. Density provisions closely follow that of the CBD.

Comment [LG13]: As part of Comp Plan Update, AMU is a new proposed zone in southern industrial area allowing for mixed use but retaining industrial until such time as redevelopment occurs. This column closely follows CBD or I zone for standards depending on topic.

B. Development conditions:

(1) Reserved.~~A transit-oriented housing development, as defined in WMC 21.06.662 and~~

~~meeting the criteria contained in WMC 21.38.090(2), may use alternative development standards in WMC 21.38.090(3) as a method of calculating allowable dwelling units.~~

(2) Ten-foot setback may not be required on those sites abutting a designated pedestrian-oriented street pursuant to City of Woodinville Design Standards, or as may hereafter be amended.

(3) Reserved.

(4) Height is limited to 35 feet when development abuts a Low or Moderate Residential zoned property.

(5) Gas station pump islands shall be placed no closer than 25 feet to street front lines.

(6) Reserved.~~Mixed use developments that include a minimum of 25 percent of the total area as office space may increase height limits to a maximum of 45 feet.~~

(7) A 20-foot Type I landscaped setback only required along property lines adjoining single-family residential zones, otherwise no specific setback requirement. Developments are also subject to the interior yard compatibility provisions of WMC 21.14.380.

(8) Fifty-foot setback only required along property lines adjoining Residential zones for industrial uses established by conditional use permits, otherwise no specific interior setback requirement.

(9) Ten-foot setback permitted only on those sites not abutting a designated arterial street.

(10) Height limits may be increased when portions of the structure or building which exceed the base height limit provide one additional foot of street and interior setback beyond the required setback for each foot above the base height limit, provided the maximum height may not exceed 45 feet.

(11) Twenty-foot setback required only along property lines adjoining the Woodinville-Duvall Road right-of-way.

(12) Height is limited to 35 feet in the Civic Gateway Design District only when development abuts a low or moderate residentially zoned property.

(13) See WMC 21.16.060, Landscaping – Interior lot lines.

(14) If located in the Tourist District, see WMC 21.38.065.

(15) Twenty-five-foot setback only required along property lines adjoining the SR 202 and Woodinville-Snohomish Road rights-of-way. See WMC 21.16.080(2) for landscaping requirements.

(16) Fifty-foot setback required along property lines abutting agriculturally zoned parcels.

(17) Does not apply to signage. For applicable sign setbacks, see Chapter 21.20 WMC.

(18) ~~Height limit may be increased to a maximum of 45 feet when a multi-story building is designed and used entirely for either office or mixed office and retail uses.~~Reserved.

(19) Maximum floor/lot area ratio percentage may be increased to 4/1 when a multi-story building is designed and used entirely for office or mixed office and retail uses.

(20) Height may be increased to 49 feet when authorized by a development agreement.

(21) In the design districts pursuant to WMC 21.14.310 and in the CBD zoned area west of the Sammamish River hereby designated as the Old Town District, a retail establishment in a single building may not exceed the gross square footage (GSF) in the aggregate as follows:

(d) Little Bear Creek Corridor Design District retail GSF limit: 80,000 square feet;

(e) Civic/Gateway Design District retail GSF limit: 25,000 square feet;

(f) Pedestrian Core Design District retail GSF limit: 30,000 square feet;

(g) East Frame Design District retail GSF limit: 150,000 square feet;

(h) Transition Area Design District retail GSF limit: 75,000 square feet;

(i) Old Town District retail GSF limit: 35,000 square feet.

"Gross square footage (GSF)" is measured according to WMC 21.06.297. "Retail establishment" means a business engaged in the selling of goods or merchandise from a fixed location for direct purchase by the consumer, including services incidental to the sale of such goods. The GSF of abutting retail establishments shall be aggregated in cases where the establishments: (i) are engaged in the selling of similar or related goods, wares, or merchandise and operate under common ownership or management; or (ii) share checkout stands, a warehouse, or a distribution facility; or (iii) otherwise operate as associated, integrated or cooperative business enterprises.

(22) Building elevation fronting a street shall step back a minimum of 10 feet after the first 30 feet of building height. "Street" does not include SR 522.

(23) Building elevation fronting a street shall step back a minimum of 10 feet after the first 28 feet of building height or other building modulations as approved through design review approval pursuant to Chapter 21.14 WMC.

(24) Reserved.~~A maximum height of 51 feet with no more than four floors may be obtained through the provision of City-approved public open space and at least two or more City-approved incentives intended to mitigate the impacts of taller buildings and/or provide a public benefit pursuant to WMC 21.14.910(2)(c).~~

(25) Reserved.~~Developments that provide structured parking for all required on-site parking may exceed the height limit by one story for every level of parking provided, to a maximum of 57 feet, with no more than five floors, in the CBD zone and 60 feet, with no more than five floors, in the GB zone. Developments that provide said parking and five floors shall also include City-approved public open space and at least two or more City-approved incentives, intended to mitigate the impacts of taller buildings and/or provide a public benefit pursuant to WMC 21.14.910(2)(c).~~

(26) Building Height and Density Incentives:

(a) Subject to requirements, mitigation and public benefits in subsection (b)(ii), height may be increased to 57 feet maximum in the CBD or AMU zone or to 60 feet in the GB zone and/or r~~R~~esidential density for residential developments and residential/commercial mixed use developments ~~located in the CBD zone~~ may be determined by the use of a floor area ratio of 2.0 ~~that provides for mitigation or public benefits that exceed those required under standard regulations~~ rather than by units per acre in the GB, CBD or AMU zones.

~~(i)~~(b) ~~Said mitigation and public benefits shall include individual exceptional design in architectural features of structure and/or site design which features shall include at least two items from each category as listed below and as may be further defined~~Developments may earn greater height or apply a floor area ratio subject to the following requirements, mitigation, and provision of public benefits:

Attachment A

Mitigation and Public Benefits for Increased Height or Increased Residential FAR	
~~Category I~~Mitigation for Added Height and Density	**~~Category II~~Public Benefits**
All developments shall provide a minimum of two of the following features not otherwise required by the Woodinville Municipal Code: • Transit Facilities • LEED Certified Structures (minimum silver) or equivalent • Courtyards • Water Features • Pedestrian and Bicycle Facilities • Kiosks limited to one per 300 feet of street frontage • Street Furniture • Enhanced Weather Canopies • Public Art	All developments may earn a share of floor area ratio or increased height up to the maximum maximums below: ~~Courtyards~~ ~~Public Open Space~~ ~~Transit Facilities~~ ~~LEED Certified Structures (minimum silver) or equivalent~~ Up to 45 feet in height in CBD zone: • Exceptional Design as defined in WMC 21.14.960 • Public open space of XX size • Include a minimum of 25 percent of the total area as office space Up to 51 feet in height in GB zone: • Exceptional Design as defined in WMC 21.14.960 • Public open space of XX size • Provide a multi-story building designed and used entirely for either office or mixed office and retail uses Up to 2.0 FAR and/or 57 feet in height in CBD or AMU zone, or 2.0 FAR and/or 60 feet in GB zone: • Affordable Housing (10% of the total units to be affordable subject to WMC 21.14.XXX Standards for Affordable Housing) [Option: Allow fee in lieu.] • Transit Oriented Development as defined in WMC 21.06.662 and subject to WMC 21.14.XXX Standards for Affordable Housing.

(27) For all new residential development within the CBD zone, individual unit clothes washer and dryer hook ups, fireplaces, and storage spaces are required for each new residential unit.

~~(27)~~(28)See WMC 21.14.371 for design provisions relating to building setbacks.

Comment [LG14]: This is an evolution of the City's present approach and would give credit for the more difficult or costly benefits, which would be affordable housing or TOD development and would apply to the CBD and GB zones. Potential Implications: If market is more supportive of commercial or mixed use at 36 units per acre, then most will choose the extra one story benefit over two story/FAR benefit associated with affordable housing. If achieving greater density through FAR or if greatest height is desired affordable housing is the proposed benefit, it is recommended that fee in lieu be an option for the development.

Another benefit incentive option is to do as the Bel-Red Subarea Plan– the first increment of FAR above base goes to affordable housing and the next increment to other benefits.

Another benefit incentive option is prioritize similar to Mercer Island – after public open space is provided at specific locations then only benefit is affordable housing.

In the proposed AMU zone, only the Affordable Housing or TOD options would be applied. It is a new zone with new housing opportunities and would be applied a priority for affordable housing.

Comment [LG15]: Includes affordable housing by definition

21.14.xxx Accessory Dwelling Units – Design Standards

(1) Purpose.

(a) To provide infill housing opportunities throughout residential and mixed-use zones in Woodinville;

(b) To provide affordable housing options; and

(c) To provide an opportunity for rental income for property owners.

(2) Standards.

(a) Only one accessory dwelling per lot; The accessory dwelling unit may be added to or included within the primary unit, or located in a detached structure;

(b) The primary residence or the accessory dwelling unit shall be ~~owner~~ occupied by an owner of the property or an immediate family member of the property owner;

(c) If the accessory dwelling unit is a separate structure, the accessory dwelling unit shall not be larger than 50 percent of the living area of the primary residence, but in no event shall exceed [800 /1,000] square feet. If the accessory dwelling unit is within the same structure as the primary residence, the total square footage of the accessory dwelling unit shall not exceed 40 percent of the total square footage of the primary dwelling unit and the accessory dwelling unit combined excluding any garage area, and in no case shall it exceed 1,000 square feet. If the accessory dwelling unit is completely located on a single floor of a multistory structure, the Planning Director may allow increased size in order to efficiently use all floor area;

(d) One additional off-street parking space is provided~~;~~ in addition to the parking required for the primary dwelling unit; and

(e) The property owner shall apply for an accessory dwelling unit permit with the Building Department. The application shall include an affidavit signed by the property owner agreeing to all the general requirements outlined in this section. Approval of the accessory dwelling unit shall be subject to the applicant recording a document with the King County department of records and elections which runs with the land and identifies the address of the property, states that the owner(s) resides in either the principal dwelling unit or the accessory dwelling unit, includes a statement that the owner(s) will notify any prospective purchasers of the limitations of this section, and provides for the removal of the accessory dwelling unit if any of the requirements of this chapter are violated.

NOTE: Following are several sections addressing issues that are commonly covered in local ADU ordinances. They may not be critical, but provide clarification on issues that are commonly raised.

(a) The primary entrance to the accessory dwelling unit shall be located in such a manner as to be clearly secondary to the main entrance to the principal unit and shall not detract from or alter the single-family character of the principal unit. [OR One accessory dwelling unit door may be constructed on the front or street side of the residence; provided, that it is screened from the street or the visual impact is otherwise mitigated.]

(b) Additions to an existing structure or newly constructed detached structures created for the purpose of developing an accessory dwelling unit, shall be designed consistent with

Comment [b16]: NOTE – The following content is updated material formerly located in the permitted use chapter as footnote 3 to the residential permitted use table. The Track Changes include ARCH suggestions.

Comment [AJS17]: Clarifies that one more than required by code, and not one more from what is currently provided on site. E.g. if a house has 4 parking spaces, but only 3 required by code, then no additional parking is required.

the existing roof pitch, siding, and windows of the principal dwelling unit

(c) The portion of a single-family dwelling in which an accessory dwelling unit is proposed must comply with all standards for health and safety contained in all applicable codes, with the following exception for ceiling height. Space need not meet current International Building Code (IBC) ceiling height requirements if it was legally constructed as habitable space.

Comment [AJS18]: This allows some relaxation of code for non-safety item.

(d) That portion of a single family residence which meets the definition of accessory dwelling unit, may be legally established, and not subject to zoning violation fines, if the following requirements are met: (1) An application for an ADU permit is filed within two (2) years of the effective date of the ordinance codified in this section; (2) The ADU is determined to meet the requirements of this section as well as any other applicable Code requirements. An ADU inspection will be required for issuance of an ADU permit. The ADU inspection fee will cover a physical inspection of the ADU. This fee will be waived if the ADU existed on the effective date of the ordinance codified in this section, and the ADU permit is applied for [within two years of the effective date of the ordinance codified in this section] OR [specified date]. Existing legally nonconforming structures may be used for the locating of an ADU if the Building Official determines that the structure is sound, will not pose a hazard to people or property, and meets the requirements of this section and building code requirements. Portions of buildings that undergo a change of use are required to meet building codes for new construction in compliance with the current building code.

21.14.xxx Cottage Housing – Design Standards

(1) Purpose.

(a) To provide an opportunity for small, detached housing types clustered around a common open space;

(b) To ensure that cottage developments contribute to the overall character of residential areas;

(c) To provide for centrally located and functional common open space that fosters a sense of community;

(d) To provide for semi-private area around individual cottages to enable diversity in landscape design and foster a sense of ownership;

(e) To minimize visual impacts of parking areas on the street and adjacent properties and the visual setting for the development; and

(f) To promote conservation of resources by providing for clusters of small dwelling units on a property.

(2) Description.

Cottage housing refers to clusters of small detached dwelling units arranged around a common open space.

(3) Lot configuration.

Cottages may be configured as condominiums or fee-simple lots provided they meet the standards herein.

(4) Density bonus.

Due to the smaller relative size of cottage units, each cottage shall be counted as one-half a dwelling unit for the purpose of calculating density. For example, a cluster of 6 cottages would be equivalent to 3 dwelling units.

Comment [b19]: The density bonus is a critical factor – without it, the economics don't work and they simply will not be built. Consider that these cottage houses are less than half the size of average new detached single family homes constructed in the region – and they come with very stringent design and open space standards.

(5) Dimensional standards.

Table 21.14.xxx Dimensional standards for cottages:

Standard	Requirement
Maximum floor area	1,200SF
Minimum common space (See subsection (I) below for more info)	400 SF/unit
Minimum private open space (See subsection (J) below for more info)	200 SF/unit
Maximum height for cottages	26 ft. (all parts of the roof above 18 ft. shall be pitched with a minimum roof slope of 6:12)
Maximum height for cottages accessory structures	18 ft.
Setbacks (to exterior property lines)	See (ADD CROSS REFERENCE TO DIMENSIONAL STANDARDS CHART)
Minimum distance between structures (Including accessory structures)	10 ft.

Comment [b20]: This is a typical maximum size in many other cities' cottage housing ordinances.

Standard	Requirement
Minimum parking spaces per cottage:	ADD CROSS REFERENCE TO PARKING STANDARDS – SUGGEST 1.5/UNIT – CERTAINLY LESS THEN 2, MORE THAN 1.0.

(6) Units in each cluster.

Cottage housing developments shall contain a minimum of 4 and a maximum of 12 cottages located in a cluster to encourage a sense of community among the residents. A development site may contain more than one cottage housing development.

(7) Windows on the street.

Transparent windows and/or doors are required on at least 10 percent of the facades (all vertical surfaces) of all cottages facing the street and common open space. For facades facing north, at least 8 percent of the facade shall include transparent windows or doors. DEPARTURES will be considered pursuant to (ADD CROSS REFERENCE FOR STANDARDS RELATED TO DEPARTURES) for cottages where that standard applies to 2 or more facades, provided the design meets the purpose of the standards.

Comment [b21]: Consider departure provisions – similar to what's provided for other commercial design standards in 21.14.

(8) Parking and driveway location and design.

(a) Parking shall be located on the same property as the cottage development;

(b) Where lots abut an alley, the garage or off-street parking area is encouraged to take access from the alley;

(c) Parking areas shall be located to the side or rear of cottage clusters and not between the street and cottages. Parking is prohibited in the front and interior setback areas;

(d) Parking and vehicular areas shall be screened from public street and adjacent residential uses by landscaping or architectural screens. For parking lots adjacent to the street, at least 10 feet of Type C landscaping (ADD CROSS-REFERENCE) shall be provided between the sidewalk and the parking area. For parking lots along adjacent residential uses, at least 5 feet of Type A, B, or C landscaping (ADD CROSS-REFERENCE) shall be required. The city will consider alternative landscaping techniques provided they effectively mitigate views into the parking area from the street or adjacent residential uses and enhance the visual setting for the development;

(e) Parking shall be located in clusters of not more than 5 adjoining uncovered spaces (except where adjacent to an alley). DEPARTURES will be considered pursuant to (ADD CROSS-REFERENCE)provided alternative configurations improve the visual setting for development;

(f) Garages may be attached to individual cottages provided all other standards herein are met and the footprint of the ground floor, including garage, does not exceed 1,000 square feet. Such garages shall be located away from the common open spaces; and

(g) No more than one driveway per cottage cluster shall be permitted, except where clusters front onto more than one street.

(9) Common open space requirements.

(a) Open space shall abut at least 50 percent of the cottages in a cottage housing development;

(b) Open space shall have cottages abutting on at least 2 sides;

(c) Cottages shall be oriented around and have the main entry from the common open space;

(d) Cottages shall be within 60 feet walking distance of the common open space; and

(e) Open space shall include at least 1 courtyard, plaza, garden, or other central open space, with access to all units. The minimum dimensions of this open space are 15 feet by 20 feet.

(10) Required private open space.

Private open space shall be required adjacent to each dwelling unit, for the exclusive use of the cottage resident(s). The space shall be usable (not on a steep slope) and oriented toward the common open space as much as possible, with no dimension less than 10 feet.

(11) Porches.

Cottage facades facing the common open space or common pathway shall feature a roofed porch at least 80 square feet in size with a minimum dimension of 8 feet on any side.

(12) Covered entry and visual interest. Cottages located facing a public street shall provide:

(a) A covered entry feature (with a minimum dimension of 6 feet by 6 feet) visible from the street;

(b) At least 10 feet of landscaped open space between the residence and the street; and

(c) At least 2 architectural details, such as:

(i) Decorative lighting;

(ii) Decorative trim;

(iii) Special door;

(iv) Trellis or decorative building element; and/or

(v) Bay window.

Alternative design treatments will be considered as DEPARTURES pursuant to pursuant to (ADD CROSS-REFERENCE) provided the design treatments provide visual interest to the pedestrian.

(13) Character and diversity.

Cottages and accessory buildings within a particular cluster shall be designed within the same "family" of architectural styles. Examples elements include:

(a) Similar building/roof form and pitch;

(b) Similar siding materials;

(c) Similar porch detailing; and/or

(d) Similar window trim;

A diversity of cottages can be achieved within a "family" of styles by:

(a) Alternating porch styles (such as roof forms);

(b) Alternating siding details on facades and/or roof gables; and/or

(c) Different siding color.

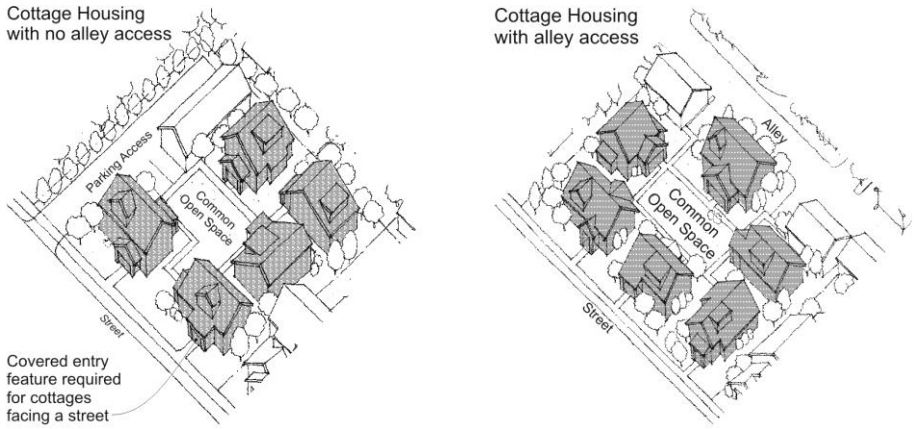

Figure . Typical cottage housing layouts.

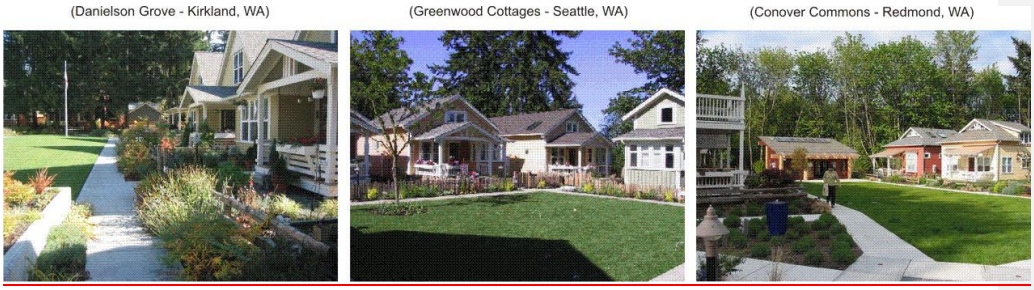

Figure . Cottage housing examples.

21.14.XXX Standards for Affordable Housing.

Comment [LG22]: Based on ARCH material.

We suggest adding fee in lieu similar to other Eastside Communities.

Where a developer chooses to provide affordable housing to achieve a height, density, or floor area ratio incentive pursuant to WMC 12.12.040, the following provisions shall apply:

(1) Locations. The affordable housing units shall be intermingled with all other dwelling units in the development.

(2) Tenure. The type of ownership (owner vs. rental) of the affordable housing units shall be the same as the type of ownership for the rest of the dwelling units in the development.

(3) Unit mix. The affordable housing units should consist of a range of number of bedrooms or studios that are comparable to units in the overall development.

(4) Timing. The affordable housing units shall be available for occupancy in a time frame comparable to the availability of the rest of the dwelling units in the development.

(5) Affordability Agreement. Prior to any building permit , an agreement in form and substance acceptable to the City shall be executed providing price restrictions, homebuyer or tenant qualifications and long-term affordability. The agreement shall be recorded with King County Department of Records and Elections and shall constitute a covenant running with the land. The City reserves the right to establish in the affordability agreement monitoring fees for the affordable housing unit, which can be adjusted over time to account for inflation. The purpose of any monitoring fee is for the review and processing of documents to maintain compliance with income and affordability restrictions of the affordability agreement.

(6) Duration of Affordability. Affordable housing units shall remain as affordable housing for a minimum of 30 years from the date of initial owner occupancy for owner affordable units and for the life of the project for rental affordable housing units.

(7) Alternative Compliance. (Add fee in lieu option similar to other Eastside King County Communities; see overview accompanying code).

NOTE – NEW DEFINITIONS PROPOSED ASSOCIATED WITH CHANGES ABOVE:

Affordable housing unit means:

- Owner Affordable Housing Unit. An owner-occupied dwelling unit affordable to households with household income not exceeding ninety percent (90%) of the King County median income, adjusted for household size.
- Rental Affordable Housing Unit. A renter-occupied dwelling unit affordable to households whose income does not exceed sixty percent (60%) of the King County median income, adjusted for household size.

King County Median Income: The median yearly income for the average sized family in the Seattle Metropolitan Statistical Area as published by the United States Department of Housing and Urban Development from time to time. In the event such income determination is no longer published, or has not been updated for a period of at least eighteen (18) months, the City may use or develop such other reasonable method as it may choose in order to determine the income for families in King County at the median yearly income for King County.

21.14.310 Applicability

(1) All new construction within the CBD, O, TB, GB, AMU and NB zones shall be subject to all chapters of the design standards as determined by the Director. The Downtown and Little Bear Creek Corridor study area has some additional specific design standards that are incorporated into the commercial design standards.

21.14.910 Architectural scale.

~~(c) Building Height Incentive Potential. Buildings exceeding the allowed base height, pursuant to WMC 21.12.040, with an additional floor (maximum of four, with a height not to exceed 51 feet) can be obtained through the provision of City-approved public open space and at least two of the following:~~

~~(i) Exceptional design (see WMC 21.14.960) in architectural features of structures and/or site layout;~~

~~(ii) Leadership in Energy and Environmental Design (LEED) Certification for all structures pursuant to the U.S. Building Council rating system;~~

~~(iii) Structured parking for all required parking; or~~

~~(iv) Private open space. (Ord. 489 § 11 (Att. J), 2010; Ord. 400 § 12, 2005)~~

Chapter 21.38

PROPERTY-SPECIFIC DEVELOPMENT STANDARDS AND SPECIAL DISTRICT OVERLAYS

~~21.38.030 Specific development standards – High Density Residential (R-48)/ Office.~~

~~(1) Permitted uses on properties designated High Density Residential (R-48)/Office shall include all uses permitted in the Urban Residential (R-19+) and Office zones as set forth in Chapter 21.08 WMC, excluding the following:~~

~~(a) Theater;~~
~~(b) Funeral home;~~
~~(c) Cemetery;~~
~~(d) Hospital;~~
~~(e) Self-service storage; and~~
~~(f) Miscellaneous rental equipment.~~

~~(2) Total floor area for retail sales and services permitted pursuant to subsection (1) of this section shall be limited to 2,000 square feet per individual use.~~

~~(3) Residential densities shall be developed as follows:~~

~~(a) The base residential density is 48 dwelling units per acre;~~

~~(b) The maximum residential density is 72 dwelling units per acre;~~

~~(c) The minimum number of dwelling units that may be allowed is 31 units per acre;~~

~~(d) Units may be developed as townhomes, apartments, or senior-assisted.~~

~~(4) Office space, while not required, is permitted if the proposed office use is integrated with the residential uses to the extent feasible.~~

~~(5) The following development standards apply:~~

~~(a) Setbacks:~~

~~(i) Street setbacks shall be 10 feet.~~

~~(ii) Interior lot line setbacks shall be five feet, unless the property line abuts a single-family detached dwelling or zone, in which case the setback shall be 20 feet.~~

~~(b) Building Heights. A maximum building height of 55 feet is permitted.~~

~~(c) Impervious Surface. The maximum percentage of impervious surface permitted is 75 percent.~~

~~(d) Design Standards. See WMC 21.14.050, 21.14.070, 21.14.080, 21.14.090, 21.14.250 and 21.14.260.~~

~~(e) On-Site Recreation. See WMC 21.14.180 through 21.14.240 and 21.14.270 through 21.14.290.~~

~~(f) Landscaping.~~

~~(i) Street Frontage. A 10-foot width of Type III landscaping shall be required.~~

~~(ii) Street trees shall be required pursuant to the City's street tree plan or as determined by the Development Services Director.~~

~~(iii) Interior Lot Lines. A 10-foot width of Type II landscaping shall be required, except where the development abuts a single-family dwelling or zone or industrial development or zone, in which case a 20-foot width of Type II landscaping shall be required.~~

~~(iv) Parking lot landscaping shall be required per WMC 21.16.070.~~

~~(g) Parking. The number of parking spaces required shall be determined by a parking study and approved by the Development Services Director. Shared parking is permissible per WMC 21.18.040. With the exception of WMC 21.18.030, all other provisions of Chapter 21.18 WMC apply.~~

~~(h) Signs. The provisions of Chapter 21.20 WMC shall apply, except for the following:~~

~~(i) To the extent possible, residential views shall not be disturbed by office signs.~~

~~(ii) Except for mixed-use buildings, no office signs shall be permitted in solely residential areas.~~

~~(iii) Signs for offices must be located within 300 feet of the structure containing the offices.~~

~~(i) Environmentally Sensitive Areas. All provisions of Chapter 21.24 WMC apply. (Ord. 465 § 27, 2008; Ord. 448 § 22, 2007; Ord. 400 § 19, 2005; Ord. 390 § 6, 2005; Ord. 175 § 1, 1997)~~

21.38.055 Special district overlay – Regional Retail.

(1) The purpose of the regional retail special district overlay is to establish an area for regional retail development to occur in a manner compatible with adjacent industrial uses and featuring generous landscaping and buffering treatment, and coordinated auto and pedestrian circulation plans. Regional Retail districts shall only be established in areas zoned I. Permitted uses shall include all uses permitted in the I zones, as set forth in Chapter 21.08 WMC, regardless of the classification used as the underlying zone on a particular parcel of land.

(2) The following additional uses are permitted in the Regional Retail Overlay:

(a) Individual retail uses featuring at least 100,000 square feet of gross floor area. This

could include general merchandise, building, hardware and garden materials stores, food stores, electronics stores, furniture and home furnishings stores, and sporting goods stores; and

(b) Other retail uses permitted in the CBD zone per WMC 21.08.070 provided they are within the same development and supportive of the regional scale retail use described in paragraph (a) above.

(3) Development standards and design criteria:

(a) Developments shall be subject to the Commercial Design Standards set forth in Chapter 21.14.

(b) Site design and the associated vehicular access network shall be designed to minimize impacts to surrounding industrial uses.

(c) Site design shall emphasize Low Impact Development techniques to the extent feasible based on soil types.

~~21.38.060 Special district overlay – Office/Research Park Development.~~

~~(1) The purpose of the office/research park special district overlay is to establish an area for development to occur in a campus setting with integrated building designs, flexible grouping of commercial and industrial uses, generous landscaping and buffering treatment, and coordinated auto and pedestrian circulation plans. Office/research park districts shall only be established in areas zoned GB, O, or I zones. Permitted uses shall include all uses permitted in the GB, O, and I zones, as set forth in Chapter 21.08 WMC, regardless of the classification used as the underlying zone on a particular parcel of land.~~

~~(2) The following development standards shall apply to uses locating in office/research park overlay districts:~~

~~(a) All uses shall be conducted inside an entirely enclosed building, except that outdoor storage and loading areas may be permitted if screened from public view with Type I landscaping;~~

~~(b) An internal circulation plan shall be developed to facilitate pedestrian and vehicular traffic flow between major project phases and individual developments;~~

~~(c) The standards set forth in this section shall be applied to the development as a unified site, notwithstanding any division of the development site under a binding site plan or subdivision;~~

~~(d) All buildings shall maintain a 50-foot setback from perimeter streets and from Residential zoned areas;~~

~~(e) The total permitted impervious lot coverage shall be 80 percent. The remaining 20 percent shall be devoted to open space. Open space may include all required landscaping, and any unbuildable environmentally sensitive areas and their associated buffers;~~

~~(f) The landscaping standards set forth in Chapter 21.16 WMC are modified as follows:~~

~~(i) Twenty-foot-wide Type II landscaping shall be provided along exterior streets, and 20-foot-wide Type III landscaping shall be provided along interior streets;~~

~~(ii) Twenty-foot-wide Type I landscaping shall be provided along property lines adjacent to Residential zoned areas;~~

~~(iii) Fifteen-foot-wide Type II landscaping shall be provided along lines adjacent to Non-residential zoned areas; and~~

~~(iv) Type IV landscaping shall be provided within all surface parking lots as follows:~~

~~(A) Fifteen percent of the parking area, excluding required perimeter landscaping, shall be landscaped in parking lots with more than 30 parking stalls;~~

~~(B) At least one tree for every four parking stalls shall be provided, to be reasonably distributed throughout the parking lot; and~~

~~(C) No parking stall shall be more than 40 feet from some landscaping;~~

~~(v) An inventory of existing site vegetation shall be conducted pursuant to the procedures set forth in Chapter 21.15 WMC. Significant trees identified in the inventory shall be retained as set forth in Chapter 21.15 WMC for commercial and industrial developments; and~~

~~(vi) An overall landscaping plan which conforms to the requirements of this subsection shall be submitted for the entire district or each major development phase prior to the issuance of any site development, grading, or building permits;~~

~~(g) Lighting within an office/industrial park shall shield the light source from the direct view of surrounding residential areas;~~

~~(h) Refuse collection/recycling areas and loading or delivery areas shall be located at least 100 feet from residential areas and screened with a solid view-obscuring barrier;~~

~~(i) Off-street parking standards as set forth in Chapter 21.18 WMC are modified as follows:~~

~~(i) One space for every 300 square feet of floor area shall be provided for all uses, except on-site daycare, exercise facilities, eating areas for employees, archive space for tenants, and retail/service uses;~~

~~(ii) Parking for on-site daycare, exercise facilities, eating areas for employees, archive space for tenants, and retail/service uses shall be no less than one space for every 1,000 square feet of floor area and no greater than one space for every 500 square feet of floor area; and~~

~~(iii) At least 25 percent of required parking is encouraged to locate in a parking structure; and~~

~~(j) Sign standards as set forth in Chapter 21.20 WMC are modified as follows:~~

~~(i) Signs visible from the exterior of the park shall be limited to one monument office/research park identification sign at each entrance. Such signs shall not exceed an area of 64 square feet per sign;~~

~~(ii) No pole signs shall be permitted; and~~

~~(iii) All other signs shall be visible only from within the park. (Ord. 478 § 10, 2009; Ord. 426 § 20, 2006; Ord. 400 § 19, 2005; Ord. 175 § 1, 1997)~~

~~21.38.080 Special district overlay – Mixed Use.~~

~~The provisions of the underlying zone shall apply, until regulations are adopted. (Ord. 400 § 19, 2005; Ord. 175 § 1, 1997)~~

GENERAL USE ISSUES

Owner Occupancy

- Either the primary residence or the accessory dwelling unit must be occupied by an owner of the property. (Bel.)

- Either the principal dwelling unit or the accessory dwelling unit must be occupied by an owner of the property or an immediate family member of the property owner. (MI)

- Owners shall sign an affidavit attesting to their occupancy every five years. (Tac.)

Definition

- Property owner, as reflected in the title records, makes his or her legal residence at the site, as evidenced by voter registration, vehicle registration, or similar means, and actually resides at the site more than six months out of any given year, [and at no time receives rent for the owner-occupied unit.] (Bel)

Limitation on occupancy

- The total number of occupants in both the primary residence and accessory dwelling unit combined may not exceed the maximum number established by the definition of family in Section (Bel)

  (Note: Bellevue debated the tradeoffs of limiting the scale of individual units by either limiting the size, or limiting the number of occupants. They eventually decided that they were essentially controlling the number of occupants by controlling the size of accessory units, and therefore did not need to explicitly address limiting the number of residents in ADUs.)

- * Resident must be an immediate family member of the owner of the primary home.

Limitation on size

- The ADU shall contain not less than 300 sq. ft. and not more than 800 sq. ft., excluding any related garage area.

  (Note: the minimum was based on using minimum room sizes outlined by the Code.)

- The square footage of the accessory dwelling unit shall be a minimum of 220 square feet and a maximum of 900 square feet, excluding any garage area; provided, the square footage of the accessory dwelling unit shall not exceed 40 percent of the total square footage of the primary dwelling unit, excluding the garage area, as it exists or as it may be modified. (MI)

- The square footage of the ADU, excluding garage area, shall not exceed 40% of the primary residence and adu combined, excluding garage area. (Bel)

- The total square footage of a detached ADU shall not exceed 40 percent of the total square footage of the primary dwelling unit and the accessory dwelling unit combined excluding any garage area, and in no case shall it exceed 1,000 square feet.

- o The square footage of the ADU shall not exceed forty (40) percent of the total square footage of the primary residence and ADU combined, excluding any non-living areas such as garage area, storage sheds, or decks, unless the excluded area is the location of the proposed ADU. (Issaq)

- o If the accessory unit is completely located on a single floor [of a multistory structure], the Planning Director may allow increased size in order to efficiently use all floor area. (Kirk)
  reason for discretion, is the presumption that for daylight basements, sq. ft. limitation could be arbitrary

- o The square footage shall not be less than 300 sq. ft. nor more than 800 sq. ft. The maximum square footage for the ADU may be exceeded for two story structures provided other criteria are met and the intent of the ordinance is maintained. (Tac)

- o ADU does not exceed 50% of the combined total area of the principal residence and the ADU. (K.C.)
  (Note: This may not be appropriate if want to ensure that the ADU is'secondary' to primary residence, unless include some other types of restrictions. The King County ordinance does not do that.)

- o Detached accessory dwelling units shall not exceed 800 square feet of gross floor area. The gross floor area shall not include area with less than five (5) feet of ceiling height, as measured between the finished floor and the supporting members for the roof. When calculating the square footage of the ADU (see KZC 5.10.340, definition of "gross floor area"), covered exterior elements such as decks and porches will not be included; provided, the total size of all such covered exterior elements does not exceed 200 square feet. (Kirk)

- o No ADU may have more than one bedroom, nor be more than 700 sq. ft.
  No ADU shall be more than 30% of the total floor area, excluding garage. (WC)

- o * Must have at least 1,400 sq. ft. of floor area exclusively for the primary unit.
  (Note: Portland has revised this provision. There are probably more appropriate, and less arbitrary means to accomplish the underlying objective of this provision.).

<u>New or Existing</u>

- o Silent on issue which would imply allowed in new or existing homes.

- o An ADU may be developed in either an existing or new residence.

- o Only permitted in existing units defined as construction of the principal dwelling was completed (occupancy approved) at least three years prior to application for accessory dwelling unit. (Bel)

<u>Density of accessory units? {</u>e.g. #of accessory units allowed in a community)

- o Do not address. (Bel.)

- o * The number of accessory units shall not exceed 3% of total units within a Census Tract. (WC)

(Note: Cities that have permitted ADU's have not had a problem with an overabundance, or an over concentration of units.)

Home Occupation and Accessory units

(Note: To appropriately address this issue, should first evaluate in what circumstances Home Occupation Permits are required.)

- A site may not contain both an accessory dwelling unit and a business subject to the regulations in 20.30N for a Class A or Class B Home Occupation Permit (Bel)
  (Note: These are businesses that generally have customer traffic.)

- "No home occupations, day care home or mini child care facility shall be allowed in an ADU." (Tac.)
  (Note. Different from Bellevue in that it appears to only limit the ADU, not the primary residence.)

Miscellaneous

- An ADU shall not be subdivided or otherwise segregated in ownership from the primary dwelling unit. (Red)

- There shall be no more than 1 accessory unit per parcel. (Evt)

DESIGN ISSUES

The first step is to develop a sense of your community's existing housing.

For example, what physical forms of housing exist in your community, and which ones might best lend themselves to accommodating ADUs such as houses with:

Detached garages,
daylight
basements, larger
homes,
2-story homes,
access off of
alleys,
traditional basements.

If your housing does not easily lend itself to adding ADU's then it is more likely that ADUs would be done through additions. If so, does this lead to concerns with privacy?

Entrances

- Shall have only one entrance on the front of the house. Additional entrances permitted on the side and rear of the house. (Bel.)

- The primary entrance to the accessory dwelling unit shall be located in such a manner as to be clearly secondary to the main entrance to the principal unit and shall not detract from or alter the single-family character of the principal unit. (Kirk)

- The single-family dwelling containing the accessory dwelling unit shall have only one entrance on each front or street side of the residence except where more than one entrance existed on or before January 17, 1995. (MI)

- One ADU door may be constructed on the front or street side of the residence; provided, that it is screened from the street or the visual impact is otherwise mitigated (Issaq)

- * Unit can only be accessed through the main unit. (No separate entrance) (Not really a fully separate unit)

Additions

- Silent on issue, which means must meet setbacks etc. of single family zoning. (Bel) (Note: Bellevue Commission concluded that it would be ineffective or appropriate to have design criteria more stringent than that used for normal additions. What would prevent someone from getting a permit for an addition, and then afterward come back for a permit for an ADU?)

- Additions to an existing structure or newly constructed detached structures created for

the purpose of developing an accessory dwelling unit, shall be designed consistent with the existing roof pitch, siding, and windows of the principal dwelling unit. (MI)

Garages

- Silent on issue. Implies that can convert garage, so long as meet building code and provide necessary amount of parking. City has no provision that required parking for the primary residence or ADU be covered. (Bel)

- * Garage space may be converted only if the same number of covered parking spaces are provided elsewhere on the property. (KC)

Privacy

- The location and orientation of a ADU shall not materially reduce the privacy of residents of adjoining properties. The Zoning Administrator shall consider placement of windows, decks and balconies, landscape screening, and height/number of stories, in determining if privacy will be materially reduced. (WC)

  (Note; This may apply only to attached structures. Reason to apply on to detached structures is that detached structures would normally not be used for living quarters other than as an ADU, whereas, for the primary residence additions, etc could occur without an ADU.)

Parking

- One off-street space for the ADU, which is in addition to any off-street spaces required for the primary residence. (Bel)

  (Note: Bellevue used this language instead of requiring 3 off-street spaces. This is because some older houses are required to provide only one off-street space, and they did not want to trigger a requirement for 2 additional spaces. Also, if a house already has 3 parking spaces, it does not need to provide an additional spot. Therefore most houses can meet this requirement with existing parking areas (garages and driveways).)

- One off-street parking space is required for an ADU in addition to the parking required for the primary dwelling unit. [Parking spaces must be paved and may include private driveways, garages, carports, or off-street areas reserved for vehicles.] (Red)

- Total of 3 off-street spaces.

- Parking must be provided in the rear of the lot when alley access is available. (Tac)

- All single-family dwellings with an accessory dwelling unit shall meet the parking requirements applicable to the dwelling if it did not have such an accessory dwelling unit. (MI).

  NOTE: City already required so much parking did not feel needed extra, and requirement varied in a few areas.

- Tandem parking can be used to fulfill this requirement. (Issaq)

- Do not require additional off street parking. (Ptl)

(Using this approach would be dependent on evaluating current parking situation in a community.)

Attached vs. Detached

- Only in the same building as the principal residence unless the lot is at least 10,000 sq. ft. [and the allowable density of the zone is not exceeded]. (KC)

- ADU shall not be permitted in structures detached from the primary residence. (Bel)

- ADU permitted as a second dwelling added to, created within, or detached from the main building. Detached ADUs should be located in the rear of the lot. (Tac)

- An accessory dwelling unit will be considered to be "detached" from the principal unit if it has any of the following characteristics (Kirk):

  a. It does not share a common roof structure with the principal unit.

  b. It is not integrated into the footprint of the principal unit.

  c. The design is inconsistent with the existing roof pitch, siding treatment, and window style of the principal unit.

Abbreviations for Referenced Ordinances

*	Provisions not recommended to be incorporated into local ordinances.
Bel.	Bellevue
EC	El Cerrito, California
Evt.	Everett
KC	King County
Ptl.	Portland, Oregon
Red.	Redmond
Tac.	Tacoma
WA	Washington DCD Ordinance recommendations
WC	Walnut Creek, California

PERMITTING/ENFORCEMENT

Permitting process

- o Allow as outright permitted use. No special permit or application or covenant. (KC) (Note: Doesn't allow for ability to track units/may be harder to enforce owner occupancy)

- o Building permit process with requirement to sign a covenant. Do an inspection of the unit to ensure meet accessory unit requirements. (Tac)

- o The property owner shall apply for an accessory dwelling unit permit with the Building Department. The application shall include an affidavit signed by the property owner agreeing to all the general requirements outlined in this section. (Kirk)

- o After receipt of a complete application and prior to approval of an accessory dwelling unit, the city shall inspect the property to confirm that all applicable requirements of this code and other codes are met. (MI)

- o The registration form as required by the City shall include a property covenant. The covenant must be filed by the property owner with the City for recording with the King County Department of Records and Elections to indicate the presence of the accessory dwelling unit, and reference to other standards outlined in this section. The covenant shall run with the land as long as the accessory dwelling unit is maintained on the property. (Kirk)

- o Approval of the accessory dwelling unit shall be subject to the applicant recording a document with the King County department of records and elections which runs with the land and identifies the address of the property, states that the owner(s) resides in either the principal dwelling unit or the accessory dwelling unit, includes a statement that the owner(s) will notify any prospective purchasers of the limitations of this section, and provides for the removal of the accessory dwelling unit if any of the requirements of this chapter are violated. (MI)

- o File a registration application (includes mailing labels for residents w/in 200') Property inspection to ensure meets standards. Separate building permit if necessary. Covenant recorded against the property. After approval notice to neighbors informing of enforcement procedures. (Bel)

- o Permit process which requires a public hearing prior to permitting. (WC)

- o The fee for an application for an ADU shall be the same as the fee required in a Home Occupation Level 1 Review. (Issaq)

- o * Permit is only good for x years, or is voided upon sale of the property. (Note: Places a severe restriction on the use of accessory units. Also, eliminates ability for accessory unit to be considered by a lender.)

- o * Applicant must have lived in house for 2 years, and permit cannot be assumed at time of sale.

Meeting Building Code(s)

- The ADU shall meet all technical code standards including building, electrical, fire and plumbing code requirements). (Bel)

- In order to encourage the development of housing for people with disabilities, the (building official) may allow reasonable deviation from the stated requirements to install features that facilitate accessibility. Such facilities shall be in conformance with the UBC. (WA.)

  (To what extent is this a moot point because ADU's are not required to meet accessibility requirements (less than 4 units)?)

- The portion of a single-family dwelling in which an accessory dwelling unit is proposed must comply with all standards for health and safety contained in all applicable codes, with the following exception for ceiling height. Space need not meet current International Building Code (IBC) ceiling height requirements if it was legally constructed as habitable space. (Kirk)

- The accessory dwelling unit shall comply with all standards for health and safety in the Uniform Building Code, Uniform Plumbing Code, Uniform Electrical Code, Uniform Mechanical Code, Uniform Fire Code and any other applicable codes, except as provided in this chapter. The ADU shall comply with all development code provisions for single-family dwellings including height and setbacks, and the ADU shall be included as part of the impervious surface and floor area limitations for a building site. (MI)

- All existing accessory dwelling units that are located within a single-family dwelling which was legally constructed but does not now comply with current ceiling height requirements of the Uniform Building Code, shall be allowed to continue in their present form. (MI)

- Vancouver B.C. has special codes to ensure meeting safety standards without exorbitant costs to bring to full code.

<u>Administrative Discretion</u>

- The Land Use Administrator may allow variances to the stated general requirements pursuant to Section 13.06.408 of Tacoma's Land Use Regulatory Code. (Tac)

<u>Tracking Process</u>

- Annual report to Council re: ADU applications, distribution, complaints, etc. (Tac)

<u>What to do about existing 'illegal' units</u>

- ADU's existing prior to enactment of these general requirements may be found to be legal, if the property owner applies for a building permit for the ADU and complies with all required standards and provisions. (Tac)

- Silent on issue, which implies same as Tacoma. (Bel)

- If an ADU was or is created without being part of a project for which a building permit was or is finaled, an ADU inspection will be required for issuance of an ADU permit. The ADU inspection fee will cover a physical inspection of the ADU. This fee will be waived if the ADU existed on January 1, 1995, and the ADU permit is applied for by December 31, 1995. (Kirk)

- If an ADU was created without being part of a project for which a building permit was finalized, the City shall require a building inspection to determine if the structure is sound, will not pose a hazard to people or property, and meets the requirements of this section and building code. The ADU inspection fee will cover the building inspection of the ADU. This fee will be waived if the ADU permit is applied for within two years of the effective date of the ordinance codified in this section. (Issaq)

- That portion of a single family residence which meets the definition of accessory dwelling unit, may be legally established, and not subject to zoning violation fines, if the following requirements are met: (1) An application for an ADU permit is filed within two (2) years of the effective date of the ordinance codified in this section; (2) The ADU is determined to meet the requirements of this section as well as any other applicable Code requirements. (Issaq)

- Existing legally nonconforming structures may be used for the locating of an ADU if the Building Official determines that the structure is sound, will not pose a hazard to people or property, and meets the requirements of this section and building code requirements. Portions of buildings that undergo a change of use are required to meet building codes for new construction in compliance with the current building code. (Issaq)

- Those created prior to 1953 shall be permitted upon registration and evidence of date of establishment, evidence of use of the unit for the 6 month period prior to registration.

  Those created after 1953 can be permitted through administrative use permit if the unit does not otherwise conform with requirements. Must apply within 180 days of adoption of the ordinance. Those that do not meet requirements for size and parking will be referred to the Planning Commission. (EC)

<u>Enforcement</u>

- Cancellation of the covenant.
  Civil violation, for which a monetary penalty may be assessed and abatement may be required. (Bel.)

- The city retains the right with reasonable notice to inspect the ADU for compliance with the provisions of this section. (MI)

- The owner shall file an Owner's Certificate of Occupancy in a form acceptable to the City Attorney no later than April 1st of each year. (Evt.)

- In addition to all other penalties provided in the Redmond Municipal Code...owner shall be subject to a civil penalty of $100 per day, for each day the violation is allowed to persist after receiving notice thereof from the Code Administrator. (Red.)
  (Note: If the solution is to move out a renter, may place an undo hardship on the renter to move out immediately. May want a phased penalty to give renter a reasonable time to move out.)

<u>Utility hook-ups</u>

- Do not require separate utility hook-ups.

- Only one electric and one water meter shall be allowed for the entire building, serving both the principal and accessory dwelling unit. (Evt.)
  (Note: may want to leave some discretion for administrator to waive this requirement).

- * Require separate metering
  (This could place a large cost burden on creating ADUs and appears contrary to the general concept of the ADU being a secondary use.)

<u>How to deal with local CC&R's</u>

- CC&R's are a private contract, and do not need to be considered by cities when issuing permits. Cities evaluate permits based on their codes. Enforcement of CC&R's done outside of city procedures.

Zoning Information: Summary Matrix

(Please refer to individual city's pages for detail on the requirements)

ADU Regulatory Provisions	Bellevue	Kirkland	Redmond	Mercer Island	Issaquah	Newcastle	Wood.
General							
Allowed ADU Location							
inside main house	Yes	Yes	Yes	Yes	Yes	Yes	Yes
attached to main house	Yes	Yes	Yes	Yes	Yes	Yes	Yes
detached from main house	No	Yes	Yes	Yes	Yes	Yes	Yes
Owner occupancy required	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Off-st.parking requirement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unit							
Size Limits							
minimum sq. ft.	Yes	No	No	Yes	No	Yes	No
maximum sq. ft	Yes	Yes	Yes	Yes	Yes	Yes	Yes
cap limit	No	Yes	No	No	No	No	No
Allowed location of entrance							
front	No	Yes	Yes******	Yes *****	Yes **	Yes	Maybe****
side	Yes	Yes	Yes	Yes	Yes **	Yes	Maybe****
facing same street as house entrance	Yes*****	Yes	Yes	Yes *****	Yes **	Yes **	Maybe****
Process							
Separate ADU application	$25	$200	$264	$103	$100	$100	No
Building permit application	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neighborhood notification required	Yes	No	Yes	Yes	No	No	No
Administrative design review							
architectual elements	No	No	Yes	Yes	No	No	No
exterior appearance	No	No	Yes	Yes	No	Yes	No
entrance	Yes	No	Yes	No	No	No	No
square footage	No	No	No	No	No	No	No
Is covenant recorded on property	Yes	Yes	No	Yes	Yes	Yes	No

* Only existing ADUs are allowed in these cities--New ADU's not currently allowed
** locations require screening
*** Allowed in garage only
**** Consistency with ex. Neighborhood development required
*****Must be pre-existing, and may have other conditions
******Requires approval by Technical Committee

Zoning Information: Summary Matrix

(Please refer to individual city's pages for detail on the requirements)

ADU Regulatory Provisions	Bothell	Medina	Yarrow Pt.	Hunts Pt. *	Clyde Hill	Beaux Arts *	King County
General							
Allowed ADU Location							
inside main house	Yes	Yes	Yes	n/a	Yes	n/a	Yes
attached to main house	Yes	Yes	Yes	n/a	Yes	n/a	Yes
detached from main house	No	No	Yes	n/a	Yes ***	n/a	Yes
Owner occupancy required	Yes	Yes	Yes	n/a	Yes	n/a	Yes
Off-st.parking requirement	Yes	Yes	Yes	n/a	Yes	n/a	Yes
Unit							
Size Limits							
minimum sq. ft.	No	Yes	Yes	n/a	Yes	n/a	No
maximum sq. ft	Yes	Yes	Yes	n/a	Yes	n/a	Yes
cap limit	Yes	No	Yes	n/a	Yes	n/a	No, if all inside SF
Allowed location of entrance							
front	Yes**	Yes **	Yes	n/a	Yes	n/a	Yes**
side	Yes**	Yes **	Yes	n/a	Yes	n/a	Yes
facing same street as house entrance	Yes **	Yes **	No	n/a	No	n/a	Yes*****
Process							
Separate ADU application	No	$100	No	n/a	$150	n/a	No
Building permit application	Yes	Yes	Yes	n/a	Yes	n/a	Yes
Neighborhood notification required	No	No	No	n/a	No	n/a	No
Administrative design review							
architectual elements	No	No	No	n/a	No	n/a	No
exterior appearance	Yes	Yes	No	n/a	Yes	n/a	No
entrance	Yes	No	Yes	n/a	Yes	n/a	No
square footage	Yes	No	No	n/a	No	n/a	No
Is covenant recorded on property	No	Yes	No	n/a	Yes	n/a	Yes

* Only existing ADUs are allowed in these cities--New ADU's not currently allowed
** Locations require screening
*** Allowed in garage only
**** Standard building permit fees formula
***** If in a detached unit (only)

ATTACHMENT B. ACCESSORY DWELLING UNIT

Comparison of Fees September 2014

The Table below compares whether other Eastside King County cities collect impact fees or require utility fees for Accessory Dwelling Units. "No indications" means that the code doesn't appear to require or prohibit separate utility hookups or metering for ADUs (but standard fees would apply).

	Impact Fees	**Utility Fees**
Bellevue	Permit Tech says no impact fees; however, not clearly exempted by BCC 22.16.070.B. No Transportation Review Fee for ADUs. Impact fees not required for additions or remodels.	No indications. (Handout P-3: "A water service application is required if a separate water meter is needed.")
Bothell	$1,194 per dwelling.	No indications.
Issaquah	"Affordable housing" is exempt, but ADUs not defined as affordable. Checking with city.	No indications, other than, "The review of utility connections (water, gas, and electric) shall be done by the Public Works Department."
Kenmore	These may provide means of exemption; checking with city: "A change in use where the increase in trip generation is less than five percent or 10 peak hour trips." "The director shall be authorized to determine whether a particular development activity falls within an exemption identified in this section, in any other section, or under other applicable law. Determinations of the director shall be in writing and shall be subject to the appeals procedures set forth in KMC 20.47.070."	No indications.
Kirkland	Exempt.	No indications.
Mercer Island	City has no impact fees.	Not addressed specifically, but "Subdivision. An ADU shall not be subdivided or otherwise segregated in ownership from the primary dwelling unit."
Newcastle	Not clear, but this may provide means of exemption: "The director shall be authorized to determine whether a particular development for a proposed building permit, or certificate of occupancy if no building permit is required, falls within an exemption of	The city shall not require that an accessory dwelling unit have a separate connection to any utility service facilities; provided, that the owner shall comply with any rules or regulations of the utility service provider regarding the connection of an accessory

	Impact Fees	Utility Fees
	this chapter. Determinations of the director shall be subject to the appeals procedures set forth in NMC 16.15.130."	dwelling unit to the service provider's facilities.
Redmond	Exempt.	Not addressed specifically, but "Subdivision. An ADU shall not be subdivided or otherwise segregated in ownership from the primary dwelling unit."
Sammamish	Exempt.	No indications.

ATTACHMENT C. DOWNTOWN RESIDENTIAL INCENTIVES

Potential Code Amendments associated with Woodinville Comprehensive Plan Update

OVERVIEW

In 2012, as the City was considering residential development standards, the City removed density incentives in all zones except for the Central Business District (CBD). In response to public and agency comments, the code analysis at that time discussed ensuring density incentives in the CBD were functioning to attract residential development, particularly affordable housing. With the Comprehensive Plan Update proposal underway, there is an opportunity to consider the CBD density incentive system. Further since the General Business (GB) zone was part of the City's downtown planning efforts and it is studied in the Comprehensive Plan Update for mixed uses, incentives for this zone are also addressed. Further an Amenity Mixed Use (AMU) zone is under consideration for the Comprehensive Plan Update along the Sammamish River, and could be considered an appropriate zone for incentives.

The Woodinville Zoning Code provides density (floor area ratio or FAR) and height incentives for the CBD zone in WMC 21.12.040, footnotes 24- 26. Affordable housing is one of several incentives that can be utilized to achieve the FAR incentives, but there does not appear to be any explicit definition of levels or amounts of affordable housing required to have access to the incentives. The code also appears to allow increases in FAR for transit oriented development, which by definition includes below market rate housing as well as public transit and commercial features. Height may be increased if structured parking or a percentage of office is provided, and these sections are linked to a set of public benefits that include some but not all of the benefits indicated in WMC 21.14.910(2)(c); affordable housing is not one of the public benefits in this alternative system.

Bellevue and Mercer Island are two communities that also used a similar approach with incentives and their experience was few developers selected the affordable housing option among the list of public benefits. There are potentially several explanations for this. First, is that it is less expensive to provide the other incentives. Second, the affordable housing requirement results in a long term requirement that a developer needs to directly monitor and impacts value; whereas as many of the other incentives (e.g. water feature, courtyard, exceptional design) once provided can enhance the marketability and value of a property.

The multiple paths of achieving height and FAR bonuses in Woodinville's CBD zone is problematic in its complexity and inconsistency – e.g. pointing to two different lists of public benefits desired. As well the public benefits are not given a priority or weight indicting which are more costly to provide and therefore should earn greater height or density.

The purposes of proposed code amendments under separate cover are to:

- Simplify the densities and dimensions table and footnotes,
- Treat height and FAR bonuses in a coordinated manner rather than as separate systems,
- Add needed definitions, e.g. affordable housing, and
- Weight the cost of providing the public benefit more closely to greater achievement of height or FAR.

EXAMPLE BONUS SYSTEMS

Bellevue Approach

Following is an excerpt of a case study on the Bellevue Bel-Red Subarea Plan approach from Puget Sound Regional Council's Housing Toolkit (http://www.psrc.org/growth/hip/case-studies/bel-red/):

> *The new Bel-Red development regulations create base floor area ratios of 1.0. Maximum floor area ratios (FAR) must be "earned" by providing amenities. The maximum FARs within designated nodes are 4.0 and 2.0 in the surrounding areas. The FAR amenity incentive system awards developers bonus density up to the maximum FAR, provided that certain amenities are included in a project–or paid as a fee-in-lieu. Affordable housing is a major component of this system. Other amenities that qualify for bonus density include: parks and recreation, environmental protection, transfer of development rights, child care or non-profit space, public restrooms, public art, and LEED gold or platinum certification. The affordable housing bonus is stated as follows:*
>
> - *Rental: 4.6 square feet of bonus building area for every square foot of affordable rental housing affordable at the 80% of area median income.*
> - *Owner: 7.2 square feet of bonus building area per square feet of ownership housing affordable at 100% of median income level.*
>
> *The bonus system was developed based on an analysis prepared by the Urban Land Institute.*

Mercer Island Approach

After achievement of specific connections or plazas in specific areas of the Town Center, Mercer Island requires developers to utilize the affordable housing incentive to receive additional height/density. Following is some of the key language from the Mercer Island code as compiled by A Regional Coalition for Housing:

> *b. Eligibility for Maximum Building Height. Every lot in the Town Center is eligible for the maximum building height described in the above chart by providing a significant public amenity. The intent of this developer incentive is to obtain three significant public plazas in the Town Center, provide a single mid-block pedestrian connection across each large City block in the Town Center and provide affordable housing in the Town Center. The type of significant public amenity that an applicant must provide is described in Exhibit 3 and in MICC 19.11.050(B)(1)*
>
> *(b) If an applicant owns a lot that is not highlighted on Exhibit 3 as eligible for a connection or plaza, then the applicant must provide significant affordable housing to qualify for the maximum building height. (c) Once a significant public plaza has been approved by the Design Commission on Site 1, 2 or 3 shown on Exhibit 3, no subsequent development may use a significant public plaza with respect to that Site to qualify for the maximum building height but will still be eligible for the maximum building height by providing significant affordable housing.*
>
> *5. Significant Affordable Housing. a. Affordable Housing Ratio. A development shall be granted additional building height based upon one of the two following ratios: (i) 3 additional square feet of market building area for every 1 square feet of affordable housing area provided on the highest story; or (ii) 3 additional market residential units*

for every 1 affordable housing unit provided on the highest story. In no event shall there be less than two affordable housing units. (Note: See Definitions below for required level of affordability)

d. Permit Fees. The city shall waive that portion of the building permit and plan review fees and reimburse that portion of the design review fees allocable to the highest story of the development based on the relative square footage of the highest story compared to the overall square footage of the building.

Additional Provisions to Consider

Alternative Compliance

The City may wish to incorporate an alternative to providing the affordable housing onsite, if a developer requests greater density or height for a residential or mixed use development; this could be accomplished by allowing the units to be developed offsite or through a fee in lieu. For example, the City could deposit the fee-in-lieu in the ARCH trust fund for later expenditure by the City.

In Kenmore, in exchange for upzoning a portion of downtown, the City required a certain percentage of units be affordable, and allowed the required affordable housing to be located in offsite elsewhere in downtown:

18.77.010 Affordable housing – Purpose and intent.

The purpose of this chapter is to implement, through regulations, the responsibility of the City under the Washington State Growth Management Act to consider the housing needs of all economic segments of the community, and to assure an adequate affordable housing supply in the City. The City recognizes that the marketplace is the primary supplier of adequate housing for those in the upper economic groups, but that some combination of appropriately zoned land, regulatory incentives, innovative planning techniques, and requirements will be necessary to make adequate provisions for the needs of households whose incomes are at or below median income.

18.77.020 Applicability.

The provisions of this chapter shall apply to multifamily residential developments proposed on property four acres or greater in size within the downtown residential or downtown commercial zones that lie west of 68th Avenue NE, and which are providing for more than 20 multiple-family dwelling units.

18.77.030 Requirements.

A. Affordable housing units amounting to 25 percent of the total number of units in the development shall be provided. Housing shall be affordable to those who make equal to or less than 85 percent of the King County median household income adjusted for household size.

B. Unit size mix shall be comparable to the market mix, units shall be integrated into the whole development, and affordable units shall match the tenure of the whole development, unless otherwise authorized by the City.

C. Subject to City authorization, the affordable units need not be provided within the development, but must be provided within the downtown commercial, downtown residential, or regional business zone. Units may be either rented or sold. Off-site affordable housing may be provided if the City finds that:

1. The location chosen does not lead to undue concentration of affordable housing in any particular area of the City; and

2. The site is within close proximity to employment opportunities and/or transit services; and

3. Adequate infrastructure and municipal services can be provided.

D. Monthly rents, including utilities where applicable, shall be no greater than 30 percent of the monthly income for households earning up to 85 percent of the King County median household income adjusted for household size. Home prices considered affordable for buyers earning up to 85 percent of the King County median household income adjusted for household size shall be determined by the City. Covenants shall be established which guarantee the fulfillment of this obligation.

Other cities allowing for fee in lieu include Kirkland, Redmond, and Seattle. Kirkland's fee in lieu process is as follows:

112.30 Alternative Compliance

1. Approval Process for Alternative Compliance – As an alternative to providing some or all of the required affordable housing units on the subject property, the Planning Director may approve a request for alternative compliance. Alternative compliance may include providing affordable housing units at another location within the City of Kirkland, payment to the City in lieu of constructing partial affordable housing units to be used to create affordable housing units, or such other means proposed by the applicant and approved at the discretion of the Planning Director, consistent with the following criteria for alternative compliance.

2. Criteria for Alternative Compliance – The City may approve a request for alternative compliance if both of the following requirements are met:

a. The applicant demonstrates that the proposed alternative compliance method achieves an affordable housing benefit to the City equal to or better than providing the affordable housing units on site.

b. The affordable housing units provided through the alternative compliance will be based on providing the same type of ownership of units as would have been provided on site.

3. Requirements for Off-Site Alternative Compliance – Off-site affordable housing units are subject to the following requirements:

a. The off-site location chosen for the affordable housing units shall not lead to an undue concentration of affordable housing either at the off-site location or in any particular area of the City.

b. Any building permits required for off-site affordable housing units shall be submitted prior to submittal of building permits for the subject property. Certificates of occupancy for off-site affordable housing units shall be issued prior to issuance of the final certificate of occupancy for the subject property.

4. Requirements for Payment in Lieu Alternative Compliance – Payments in lieu of constructing affordable housing units are subject to the following requirements:

a. To encourage "pioneer developments" subject to these regulations, payments in lieu are allowed for one (1) whole required affordable housing unit and portions of required affordable housing units that are less than 0.66 units during the five (5) years immediately following the effective date of the ordinance codified in this chapter (until April 1, 2015). After that time period, payments in lieu are allowed only for portions of required affordable housing units that are less than 0.66 units. Rounding up to the next whole number of units and actual construction of the affordable units is required when the calculated number of required affordable units results in a fraction of 0.66 or more.

b. Payments in lieu shall be based on the difference between the cost of construction for a prototype affordable housing unit on the subject property, including land costs and development fees, and the revenue generated by an affordable housing unit. The formula for payments shall be established by the Planning Director.

c. The payment obligation shall be established prior to issuance of any building permits for the project and shall be due prior to issuance of any certificate of occupancy for the project. Collected payments shall be deposited in the City's Housing Trust Fund account.

Other Requirements

In addition to the basis amount and level of affordable housing, more cities are including several more administrative items directly within their zoning regulations. Several of these are based on guidelines within state legislation authorizing local incentive programs. Following is a list of topics addressed, and some sample language:

- Locations. The affordable housing units shall be intermingled with all other dwelling units in the development and are not required to be on located on the top floor or bonus story.
- Tenure. The type of ownership (owner vs. rental) of the affordable housing units shall be the same as the type of ownership for the rest of the dwelling units in the development.
- Unit mix. The affordable housing units should consist of a range of number of bedrooms or studios that are comparable to units in the overall development.
- Timing. The affordable housing units shall be available for occupancy in a time frame comparable to the availability of the rest of the dwelling units in the development.
- Design. The exterior design of the affordable housing units must be compatible and comparable with the rest of the dwelling units in the development. (Note: May not be as applicable in downtown Woodinville given type of buildings anticipated.)
- Affordability Agreement. An agreement in form and substance acceptable to the City shall be executed providing price restrictions, homebuyer or tenant qualifications and long-term affordability. The agreement shall be recorded with King County Department of Records and Elections and shall constitute a covenant running with the land.
- Duration of Affordability. Affordable housing units shall remain as affordable housing for a minimum of 30 years from the date of initial owner occupancy for owner affordable units and for the life of the project for rental affordable housing units.
- Alternative Compliance. The Director may approve a request for all or a portion of the affordable housing required by this Chapter with alternative compliance methods if they meet the following requirements (see Kirkland for details).

- Monitoring and Fee. The reserves the right to establish in the Affordability Agreement monitoring fees for the Affordable Units which can be adjusted over time to account for inflation. The purpose of any monitoring fee is for the review and processing of the Affordability Agreement (Newcastle provision. A couple cities have done this as a future precaution).

BEST AVAILABLE SCIENCE REVIEW

City of Woodinville Comprehensive Plan Update

Prepared for:

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APPENDICES

Appendix A: Woodinville Comprehensive Plan Update – Existing Conditions Report, Section 1.3
Appendix B: Wetlands & CAO Updates: Guidance for Small Cities

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1 INTRODUCTION

The Washington State Growth Management Act (GMA) and implementing rules require cities and counties to " include the 'best available science' [BAS] when developing policies and development regulations to protect the functions and values of critical areas and must give "special consideration" to conservation or protection measures necessary to preserve or enhance anadromous fisheries." (WAC 365-195-900) Critical areas include geologically hazardous areas, frequently flooded areas, critical aquifer recharge areas used for potable water, wetlands, and fish and wildlife habitat conservation areas (RCW 36.70A.030(5)). Inclusion of BAS in the development of locally appropriate policies and regulations must be balanced with the many other substantive goals and mandates of the GMA. Use of non-scientific information (e.g., social, legal, cultural, economic, or political) that results in departures from scientifically valid critical areas recommendations must be identified and justified, and potential consequential impacts must also be identified.

This report provides BAS for the Woodinville Comprehensive Plan and Municipal Code Update. The 2015 Comprehensive Plan Update Study Area includes the Woodinville city limits; the King County designated Potential Annexation Area, the Woodinville-proposed Urban Growth Area (UGA) in Snohomish County, and the City-King County Joint Study Area (see Figure 1 below).

BAS documents are prepared by qualified scientific experts and follow a valid scientific process. The scientific process, which produces reliable information, is generally characterized by peer review, standardized methods, logical conclusions and reasonable inferences, quantitative analysis, proper context, and references. Common sources of scientific information include research, monitoring, inventory, modeling, assessment and synthesis (WAC 365-195-905).

The report authors compiled BAS references for each section or discipline. BAS documents were selected based on their significance to the Woodinville Comprehensive Plan Update Study Area, common use in each discipline, and relevance to current scientific practices or principals.

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The scientific body of knowledge evolves as new studies are conducted and new technologies are employed. While the BAS information provided here is intended to provide a framework for critical area protections, it may not provide definitive criteria for all regulatory decisions. Ecologic systems, including urban environments, are complex and based on both landscape-scale and local processes, comprised of many variables. Where definite guidance is lacking or studies in the scientific literature show variable methods and results, a range of values is commonly provided here. In accord with WAC 365-195-920, where scientific information is incomplete with regard to a land use, a precautionary or no risk approach should be taken.

This BAS review is intended to guide the development or revisions of policy in the Comprehensive Plan and any necessary revisions to the City's existing Critical Areas Ordinance (CAO) language in the City of Woodinville Municipal Code (WMC, Chapter 21.24, Critical Areas). Local factors, including projected growth, the nature and intensity of land uses within the City, natural resources at risk, and the ability of the City to implement its CAO, should be considered during the update process (WDOE 2010a). Further, City staff has identified the following topics for review in the Comprehensive Plan and Municipal Code Update relevant to the CAO and other development regulations:

- Stream typing
- Grading ordinance
- Other topics that may result from the BAS and associated Gap Analysis

This BAS review will be referenced as the City moves forward with their Comprehensive Plan Update, including a CAO update. The next step in that process will be a gap analysis report, which identifies where current BAS can and should be incorporated into critical area regulations.

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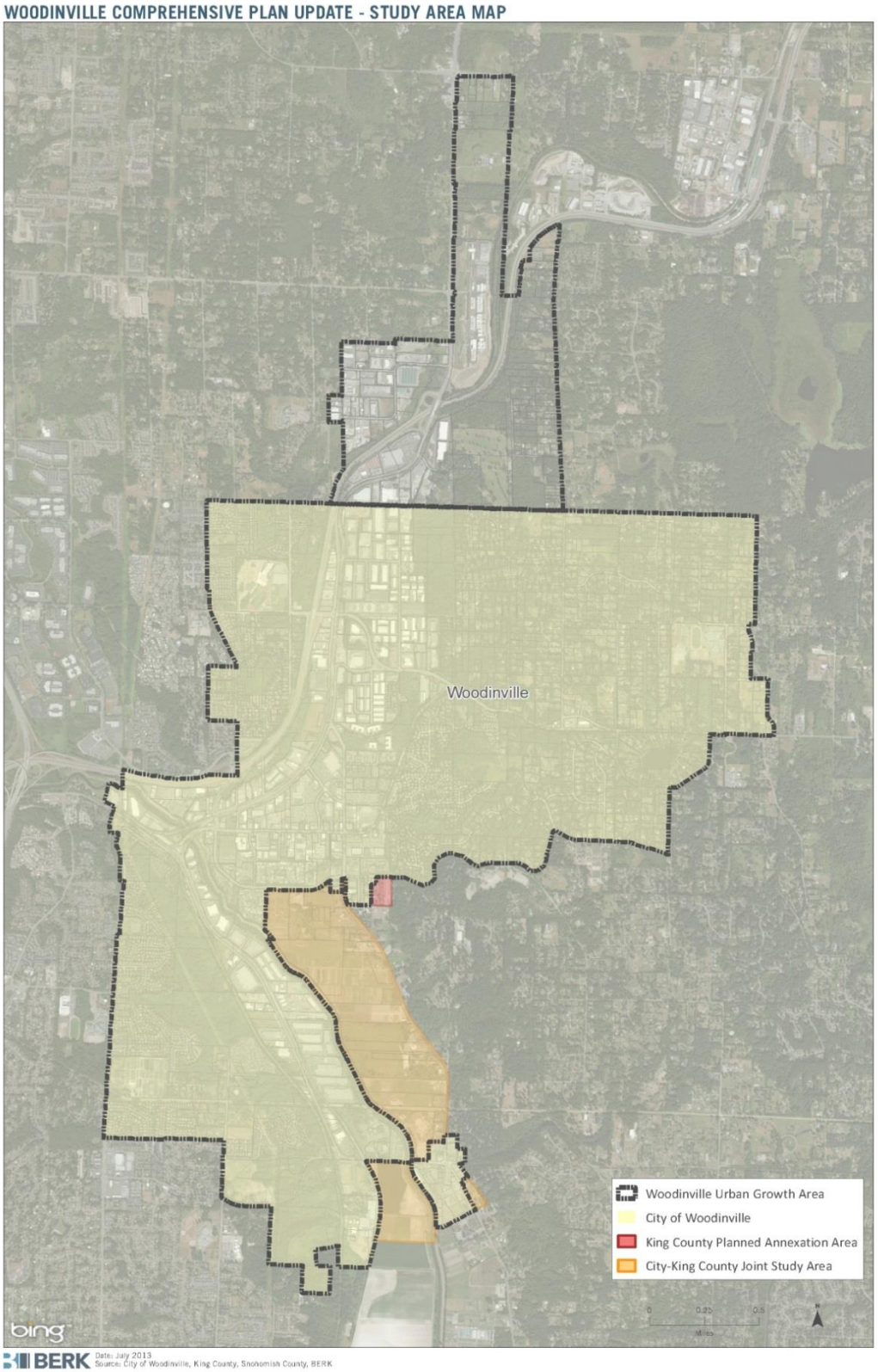

Figure 1-1. Woodinville Comprehensive Plan Update Study Area map.

2 CRITICAL AQUIFER RECHARGE AREAS

Washington State's Growth Management Act (RCW 36.70A) requires local government to designate and protect "Critical Areas" to protect natural resources, including those areas that have a "critical recharging effect on aquifers used for potable water" (RCW 36.70A.030(5)). Such areas are called Critical Aquifer Recharge Areas (CARAs), and the goal of establishing and protecting CARAs is to protect the functions and values of a community's drinking water by both preventing the supply from being contaminated, and by maintaining the supply of water in the aquifer.

The Washington Administrative Code (WAC 365-190) further defines CARAs as;

> *Areas with a critical recharging effect on aquifers used for potable water are areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water.*

An aquifer is a geologic formation that readily transmits water to wells or springs. Aquifer recharge occurs when water flows into the ground to an aquifer. An aquifer can be confined or unconfined. An unconfined aquifer is one in which the upper boundary is the water table, with no aquitard (a geologic formation that does not readily transmit water) between the water and the ground surface. A confined aquifer is a deeper aquifer that is separated from the surface by an aquitard, and is often under pressure. Groundwater recharge areas are characterized by decreasing hydraulic head with depth (direction of groundwater movement is downward). Groundwater discharge areas are characterized by increasing hydraulic head with depth (direction of groundwater movement is upward, towards the surface) (Driscoll 1986, Winter et al. 1998).

Several CARAs are mapped within the Woodinville Comprehensive Plan Update study area, including the Cross Valley sole-source aquifer (in the Woodinville-proposed UGA in Snohomish County north and east of the Woodinville city limits) (EPA 2008). These CARAs are described in the *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A). About seven wells were mapped in eastern Woodinville in February 2007 (Golder Associates Inc.).

2.1 CARA Functions and Potential Impacts

The functions and values of a CARA are to provide clean drinking water and to contribute water to streams and wetlands that support wildlife. Potential impacts to CARAs can take two forms – impacts to water quality and impacts to water quantity.

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An aquifer is considered to be used for potable water if it has existing wells, or is in the identified protection area for an existing well; if it is a sole-source aquifer (i.e. supplies at least 50% of the drinking water for the region above the aquifer); is planned to be used for potable water in the future; or is otherwise identified as an important supply. The Woodinville Comprehensive Plan Update Study Area contains a sole-source aquifer and numerous wells (Appendix A). To maintain potable water uses and potential uses of existing aquifers, both water quality and quantity must be managed.

Surface water and groundwater are frequently interacting. Streams can contribute to groundwater levels, and groundwater can contribute to stream flow. Often a stream will recharge an aquifer during wetter periods, and serve as a discharge during drier season. Likewise, wetlands can also serve to recharge or discharge aquifers, with the function varying seasonally in some cases. Streams, wetlands, springs and seeps all provide critical habitat and resources for vegetation and wildlife, both aquatic and terrestrial. These functions and values are dependent on both the quantity and quality of the water in the aquifer (Alley et al. 1999, Dunne and Leopold 1978, King County 2004).

2.1.1 Water Quality

While aquifer recharge areas serve to replenish groundwater supplies, they can also serve as a conduit for the introduction of contaminants to groundwater. The risk of groundwater contamination (impacts to water quality) is related to two main parameters: The susceptibility of the aquifer and the contamination loading potential or source loading (EPA 1989, EPA 1995).

Aquifer Susceptibility

Aquifer susceptibility refers to how easily water and pollutants can move through the ground to reach the underlying aquifer. A shallow, unconfined aquifer in a gravel rich basin would be more susceptible to contamination than a deep, confined aquifer overlain by dense glacial till. Contamination loading refers to the quantity and types of pollutants present in the area, and how they are handled. Unmanaged open space would have a low contamination loading potential, while a light industrial area would likely have a higher loading potential, and an older industrial site with multiple leaking storage containers would have a high loading potential. Together, susceptibility and loading potential determine the vulnerability of an aquifer. A highly susceptible aquifer may have a low vulnerability if the land use within the area is primarily open space. Likewise, an industrial site with multiple leaking storage containers may not create significant vulnerability if it is separated from the nearest aquifer by several hundred feet of dense glacially-compressed clay.

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The susceptibility of an aquifer can be assessed by looking at three critical factors (Morgan 2005):

1. The overall permeability of the vadose zone (the unsaturated material between the aquifer and the ground surface, through which any contaminants would need to pass to reach the aquifer)
2. The thickness of the vadose zone or depth to the aquifer,
3. The amount of recharge available.

Permeability of the vadose zone can be estimated from soil and geologic mapping. The Washington Department of Natural Resources has an interactive web-based geologic map of the state which provides some insight into the permeability of the vadose zone (Washington State DNR/Geology; https://fortress.wa.gov/dnr/geology/?Site=wigm).

Depth to an aquifer can be determined by examining well logs in the vicinity. As mentioned above, well logs are available at the Department of Ecology (WDOE) website (see Washington State Department of Ecology Well Log in Section 7 for web address; http://apps.ecy.wa.gov/welllog/mapsearch.asp). In many cases, there may be several moderate to deep aquifers underlying a given location, and different wells in a given vicinity may be at widely varying depths if they are drawing from different aquifers.

The amount of water recharge available to an aquifer can also be estimated from soil permeability and rainfall data. This dynamic is discussed in greater detail in the water quantity section below.

Contamination Loading Potential

While hydrogeologic conditions determine the overall susceptibility of an aquifer, the level of urbanization in a watershed determines contamination loading potential (Fetter 1980). Common pollutants in urban environments that may contaminate groundwater are nitrate, sewage effluent, and hazardous chemicals (Driscoll 1986).

Nitrate

Nitrate is a soluble form of nitrogen, which is stable, is not filtered by passing through soil, and which can cause health risks when it contaminates drinking water. Too much nitrate in drinking water can lead to, among other conditions, methemoglobinemia, or blue baby syndrome, in infants. This condition robs blood cells of their ability to carry oxygen, resulting in a bluish discoloration of the body. If not diagnosed and treated, this condition can lead to slow suffocation and possible death. To prevent this illness, the U.S. Environmental Protection Agency set the maximum contaminant level for nitrate at 10 mg/l.

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Because of its solubility and stability, nearly all groundwater contains low levels of nitrate. Concentrations above 1mg/l are generally associated with anthropogenic sources, including sewage, fertilizers, livestock and pet waste.

Sewage Effluent

On-site sewage treatment can be an effective method for treating and disposing of sewage, if properly designed and maintained. As an additional benefit, such systems can be a source of aquifer recharge. Enhancing groundwater supplies through aquifer recharge and recovery are recommended approaches to maintaining sustainable groundwater sources as global warming occurs (Binder et al. 2010). However, on-site treatment does not typically remove nitrate, pharmaceuticals and many other chemical contaminants. Dilution usually reduces the concentrations of such contaminants, but is not always effective. In areas where the use of on-site sewage treatment is concentrated, groundwater contamination can result (Dunne and Leopold 1978, Godfrey et al. 2007).

Chemicals and contaminants of concern

Chemicals and products that are used every day in an urbanized area have the potential to contaminate groundwater if improperly used. The activities and facilities that are likely to use such materials include, but are not limited to, the following: (King County 2004)

Above/ underground storage tanks & lines
Airports
Automobile repair and body shops
Boat repair facilities
Construction
Food Processing
Funeral services/ taxidermy
Furniture repair/ refinishing
Gas stations
Golf courses
Hardware/ farm/ auto parts stores
Landfills
Machine/ metal fabricating shops
Marinas
Medical/ vet offices
Mines/ gravel pits
Office buildings/ strip malls
Pesticide operators
Photo processing facilities
Research laboratories
RV parks and facilities
Retail stores
Septage lagoons
Waste transfer/ recycling areas

The Department of Ecology requires pollution prevention plans for facilities that generate more than 2,640 pounds of hazardous waste per year, but these requirements apply only to waste products, and not necessarily to those products that are used as part of a process (WAC 173-307). Smaller businesses and homeowners are not required to provide prevention plans, and while larger farms and businesses may use potential contaminants more frequently or in greater quantity, groundwater is also subject to contamination by materials used

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by small businesses and households, especially those on septic systems or that store materials on the ground.

2.1.2 Water Quantity

Maintaining water quantity within an aquifer supports both potable water uses and landscape-scale habitat functions, which are groundwater-dependent. As noted above, surface water and groundwater are cyclic and frequently interacting.

An aquifer recharge area is an area where water from rainfall, snowmelt, lakes, rivers, streams or wetlands, flows into the ground to an aquifer. Aquifer discharge areas are where water flows away from an aquifer to the ground surface. Such areas can include seeps, springs, wetlands, streams, lakes, estuaries, and shorelines. Wells are also considered an aquifer discharge. Since groundwater movement is driven by gravity, an aquifers' recharge is typically at a higher elevation than its discharge area. Therefore, higher elevations tend to be recharge areas and lower elevations tend to be discharge areas. However, in some cases subsurface conditions may result in groundwater flow that does not reflect surficial topography (Discroll 1986).

The quantity of water available in an aquifer is a balance between recharge, storage, and discharge. Land use and development typically alters water conveyance within a basin. For example, replacing forests with buildings, roads, driveways, lawns, and even pastures typically reduces the recharge to underlying aquifers to varying extents, while simultaneously increasing the peak runoff rates to streams. In rare instances, however, some land uses can increase recharge rates. For example, if homes in an area receive water from a river or lake and discharge that water into septic systems, the result can be an increase in recharge to the underlying aquifer, and one that has potential for introducing contaminants (Dunne and Leopold 1978, Winter et al. 1998).

Recharge to an aquifer is dependent on precipitation and infiltration into the soil below the root zone. Infiltration below the root zone is controlled by a number of factors, including temperature, wind, soil type, geology, vegetation type, and land surface slope. The root zone is an important factor to consider, since evaporation and transpiration of water by plants reduces the water available for groundwater recharge, and can account for much or most of the rainfall during some months (SJC 2004).

Identifying the recharge area of an unconfined aquifer can be relatively simple. Since there is no barrier between the ground surface and the aquifer, the recharge area is typically the land area contributing infiltration to the aquifer. Surface water, in lakes, streams, and wetlands, may play a large role in both recharge to

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and discharge from unconfined aquifers, and the function may vary from season to season (Dunne and Leopold 1978, Winter et al. 1998).

For a confined aquifer, more involved studies must be undertaken to understand the movement of subsurface water. Well logs from a given area can be used to map aquifers, and water elevations in the wells can be mapped to define a hydraulic gradient, which can then be used to determine flow direction in the aquifer (Golder Associates 2007).

Changes in groundwater recharge and withdrawal of water by wells is the primary means of reducing groundwater quantity.

2.2 Potential Protection Measures

Protecting CARA functions and values requires the following: (Morgan 2005)

- Identifying where groundwater resources occur
- Classifying the risk potential by area
    - Determining how susceptible the groundwater resource is to potential contamination
    - Identifying and quantifying the potential sources of contamination (contamination loading)
    - Assessing the vulnerability of the water resources
- Planning Oversight
    - Protect those areas and land use and activities that pose risks to the resource
    - Ensure that protections are enforced
    - Manage withdrawals to maintain future supply for both drinking water and for streams and wetlands

2.2.1 CARA Identification

Identifying CARAs involves 1) identify aquifers used for potable water, and 2) identifying the areas that recharge those aquifers.

For public water supply wells, much of this work has already been done under the Safe Drinking Water Acts Source Water Protection Program, which identifies wellhead protection zones, determines the susceptibility of the well to contamination, and inventories contamination sources within the protection zone. Public water supply wells and their protection zones are identified by both the Washington State Department of Health Source Water Assessment Maps and Department of Ecology Facility/Site Atlas (see References for websites). WDOE requires well logs to be filed for all wells drilled in the state, and maintains a map of the location of each well logged (see WDOE, Well Logs in Section 7 for web address). While well logs are required for all wells in the state, there are undoubtedly some that have not been properly logged. In some instances, the

well log may not reflect the proper well location. Well logs are mapped as a point in the center of the reported quarter section (A quarter-section is a 40-acre square). Assuming that the well driller reported the correct quarter section for the well, the actual well location may be anywhere within that 40-acre area.

The most reliable way to map recharge areas is to examine water levels in wells and use that data to map regional water levels or piezometric surfaces. Extensive CARAs are already mapped within the Woodinville Comprehensive Plan Update Study Area (Appendix A).

2.2.2 Classification of Potential Risk

Classification of CARAs is typically achieved by combining the susceptibility of the aquifer with the contaminant load in the recharge area. Susceptibility refers to how easily a contaminant can make its way to the aquifer, while contaminant load refers to the quantity and type of contaminants in the CARA and how likely it is for such contaminants to enter the ground.

Wellhead protection zones are defined as areas where a spill incident could result in contamination of the well within a specified time period, ranging from 6 months to 10 years. These time-of-travel zones are mapped, though with varying levels of accuracy. Some are mapped using groundwater modeling programs, while others are mapped by simply drawing circles of varying size around the wellhead.

The City of Woodinville has adopted the King County Critical Recharge Areas map pursuant to WMC 21.24.190. King County has mapped groundwater susceptibility to contamination. Areas within the County are mapped as one of three categories:

1) *Category I critical aquifer recharge areas include those mapped areas that King County has determined are highly susceptible to groundwater contamination and that are located within a sole source aquifer or a wellhead protection area.*
2) *Category II critical aquifer recharge areas include those mapped areas that King County has determined:*
   - *have a medium susceptibility to ground water contamination and are located in a sole source aquifer or a wellhead protection area; or*
   - *are highly susceptible to ground water contamination and are not located in a sole source aquifer or wellhead protection area.*
3) *Category III critical aquifer recharge areas include those mapped areas that King County has determined have low susceptibility to groundwater contamination and are located over an aquifer underlying an island that is surrounded by saltwater.*

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This mapping can be viewed on King County's iMap system at the website listed in Section 7 (King County iMap/Groundwater): http://www5.kingcounty.gov/iMAP/viewer.htm?mapset=GroundWater.

King County mapping classifies the susceptibility of groundwater, as well as the location of wells. City of Woodinville categorizes CARAs as Category I or II following the same criteria as King County; omission from their code implies that Woodinville does not contain Category III CARAs. This information, when supplemented with well location data from WDOE and the Department of Health can help to identify where nonpublic wells are and how susceptible they might be to contamination. Zoning, business licenses, and WDOE data on existing pollution prevention plans can provide estimates of contamination loading. The Woodinville Comprehensive Plan Update Study Area includes a sole-source aquifer (in the Woodinville-proposed UGA in Snohomish County north and east of the Woodinville city limits) as documented in the *City of Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A).

Classifying the vulnerability of CARAs can be done in several different ways. For example, two methods suggested by WDOE (2005) include categorization by susceptibility alone and categorization by priorities and risk.

Categorization by susceptibility has the advantage that it can be accomplished through use of geologic mapping, soil mapping and well data, all of which are publically available. Once classified, decisions can be made to determine what activities should be allowed and what protections should be put in place for each category, regardless of the contaminant loading of the area. Such a categorization system might include the following categories, in order of decreasing susceptibility:

1. Water table sand and gravel aquifers
2. Deeper, less susceptible aquifers
3. Confined aquifers

A more targeted categorization system based on priorities and risk would assess what wells are the most important and provide the best protection for aquifers; travel time for contaminants could be used as a basis for the protection area. For example, such a prioritized list might include the following categories:

- Large public water supply systems one-year time of travel protection zone
- Densely populated areas that rely on ground water
- Medium public water supply system protection zones
- Rural areas with high dependence on groundwater

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- Discontinuous local drinking water of limited extent
- Sole source aquifers.

2.2.3 Planning and Regulatory Oversight

WDOE (2005) recommends that local jurisdiction consider prohibiting certain high risk uses in high-priority CARAs. Such uses may include landfills, wood treatment facilities, metal plating facilities, tank farms, and any other facilities that treat, store, use, or transfer large quantities of chemicals. Moderate to low risk facilities may be acceptable in high-priority CARA's, provided that adequate pollution prevention plans and practices are in place and properly maintained, with appropriate contingency plans for emergency situations.

Water rights require regulation of the amount of water withdrawn from an aquifer, but several exemptions exist (RCW 90.44.050), including;

- Water for livestock
- Water for non-commercial lawn or garden one-half acre or less
- Water for a single or group of homes, up to 5,000 gallons per day
- Water for industrial purposes, including irrigation, up to 5,000 gallons per day

2.3 Summary

Groundwater is a valuable source of drinking water as well as fresh water for stream, lakes, estuaries, wetlands and springs, and the habitat that such areas provide. Critical Aquifer Recharge Areas are meant to protect this resource by:

1. identifying aquifers that provide potable water, and
2. protecting those areas that provide water to such aquifers so that water quality and water quantity in the aquifer can be maintained.

The vulnerability of an aquifer is the product of its susceptibility to contamination and the contaminant loading. Susceptibility is determined primarily by how easily water passes from the ground surface to the aquifer. An aquifer that easily receives water is also highly susceptible to contamination. Contaminant loading is a measure of the quantity of contaminants in the recharge area. Contamination may include any number of chemicals used for a variety of industrial or household uses, as well as some natural sources, such as salt water intrusion.

A highly vulnerable aquifer is one with high susceptibility and high contaminant loading. A moderately vulnerable CARA may combine high susceptibility with low contaminant loading, or may combine low to moderate susceptibility with low to moderate contaminant loading.

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Water quantity must also be considered when protecting CARA's. Water quantity is a function of the amount of water being taken into the aquifer (recharge) and the amount of water being taken out of the aquifer (discharge). Discharge can include both natural releases to streams, springs, lakes, wetlands, estuaries, and shorelines, as well as human withdrawals via wells. Development and associated increased impervious surfaces can decrease the amount of water reaching the aquifer by generating increased surface water runoff volumes.

Protecting CARA's involves identifying where they are, classifying them based on their vulnerability or some other rational method, and making appropriate land use decisions based on that classification. State and Federal laws regulate a number of activities and wellhead protection areas, but local jurisdictions may benefit from additional CARA protections.

3 FLOOD HAZARD AREAS

Frequently flooded areas are regulated to manage potential risks to public safety. Such areas also provide valuable fish and wildlife habitat benefits in-streams and downstream as well.

Criteria for identification and classification of frequently flooded areas are provided in the Washington Administrative Code, WAC 365-190-110:

"Frequently flooded areas. Flood plains and other areas subject to flooding perform important hydrologic functions and may present a risk to persons and property.

(1) Classifications of frequently flooded areas should include, at a minimum, the 100-year flood plain designations of the Federal Emergency Management Agency and the National Flood Insurance Program.

(2) Counties and cities should consider the following when designating and classifying frequently flooded areas:

(a) Effects of flooding on human health and safety, and to public facilities and services;

(b) Available documentation including federal, state, and local laws, regulations, and programs, local studies and maps, and federal flood insurance programs, including the provisions for urban growth areas in RCW 36.70A.110;

(c) The future flow flood plain, defined as the channel of the stream and that portion of the adjoining flood plain that is necessary to contain and discharge the base flood flow at build out;

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(d) *The potential effects of tsunami, high tides with strong winds, sea level rise, and extreme weather events, including those potentially resulting from global climate change;*
(e) *Greater surface runoff caused by increasing impervious surfaces."*

Flooding within the Woodinville Comprehensive Plan Update Study Area is most often triggered by heavy rains, and exacerbated by runoff from impervious surfaces related to development. Mapped flood areas are documented in the *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A) and typically occur along the Sammamish River, Little Bear Creek, Woodin Creek, and in the vicinity of Lake Leota.

3.1 Functions and Potential Effects of Development

3.1.1 Floodplain Processes

Floods are natural events, and the process by which floodplains are created. As a rule of thumb, a typical stream in equilibrium with its surroundings will tend to be sized so that it fills to the top of the banks about once per year (Leopold 1994). As a result, when the stream flow is greater than the annual event, water will spill over the top of the banks. Streams carry sediment along with water, especially during flood events, and the amount of sediment that can be carried is a function of the quantity and velocity of the water. When water overflows the banks, its velocity slows compared to the water in the channel. As a result, the overbank flow drops its sediment load, which, over time, forms a flood plain (Dunn and Leopold 1978, Knighton 1998).

Floodplains are dynamic and highly productive environments. Dynamic hydrologic processes, including mobilization of large woody debris and other allocthonous inputs, can be critical to the maintenance of fish and wildlife habitat (Naiman and Decamps 1997, Gurnell 2005). High flow channels carved into floodplains provide important habitat for a variety of fish species, particularly in creating areas of refuge from the high flows. Overbank flow serves as a short-term storage area for streams, helping to reduce the peak flood flows downstream of the flooding location. Some of the water on the floodplain infiltrates into the soil and contributes to aquifer recharge. According to the Washington State Department of Ecology such storage and infiltration may be a more cost effective way to address flooding problems than other structural solutions (WDOE 1991).

3.1.2 Effects of Development

As development occurs, stream channels are often straightened and armored to accommodate development within the urban grid (Booth 1990). Flood protection measures, such as levees and dikes, may be built or maintained to protect

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structures and property in the floodplain from flooding events. These alterations impact floodplains and in some cases, disconnect them entirely from the stream they once served.

Increased impervious surfaces from buildings, driveways, roads, and the conversion of forest to lawn cause increases in peak flow magnitude and frequency (Booth 2002). These increases in surface water flow tend to scour or down-cut stream channels, which reduces floodplain connectivity and functions. (Bolton and Shellberg 2001). Such downcutting can, in some areas, lead to bank over-steepening, exacerbate erosion problems, and even increase the risk of landslide hazard. The stress on the bed of a stream caused by flow is a function of the flow velocity and the weight of the water pressing down on the bed, so as flow depths increase, the stress on the bed of the channel increases, and the channel downcuts. As the channel downcuts, the depth of the flow before it spills over the bank increases, which in turn increases the stress on the bed of the creek, setting up a negative feedback mechanism in which the more a stream downcuts, the more able it is to erode the bed. As a result, downcutting often continues until some other factor comes into play to stop it, such as the channel cuts down to a less erosive material (dense clay or rock), or is halted by woody debris, or some gradient control like a downstream culvert prevents further downcutting. Such downcutting can lead to bank over-steepening. This can exacerbate erosion problems in erosion hazard areas, and may also increase the risk of landslide hazard on a marginally stable slope (Booth 1990).

Total impervious surface area is commonly used as a measure of urbanization in a basin, which impacts stream and floodplain ecology. Increased impervious area is correlated with decreased stream health. As noted by Booth et al. (2004), streams environments are complex and integrated management of these resources requires more detail than total impervious area figures alone provide. A study of the impact of urban patterns on aquatic ecosystems in the Puget lowland sub-basins found statistically significant relationships between landscape patterns and stream health. In that study, the mean patch size of urban land cover and the number of road crossings were found to explain variability in stream health better than total impervious area alone. Patterns of urban development are relevant to watershed functions and both increased impervious surface area and its aggregation or patch size directly impact stream ecosystems (Alberti et al. 2006). Hydrology of urban streams is often typified by run-off driven increases to peak flows and higher recurrence of flood intervals (Booth 1990).

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3.1.3 Climate Change

It is now generally accepted that anthropogenic global climate change is occurring. Climate models project annual temperature increases totaling 2.0 degrees Fahrenheit by 2020 and 3.2 degrees Fahrenheit by the 2040s (Mote and Salathe 2010). Global climate change is projected to impact climatic variation and natural resources in the Pacific Northwest. A reduction in regional snowpack, a subsequent reduction in summer water supply, and hardships for salmon and forests are expected to pose a challenge to natural resource management (Mote et al. 2003). Seasonal changes in the Pacific Northwest are projected to entail wetter autumns and winters and drier summers (Mote and Salathe 2010). Increased precipitation in autumn and winter may result in more frequent flood events.

3.2 Potential Protection Measures

Frequently flooded areas are often regulated to reduce the risk to people and property, typically by limiting development, requiring that structures be raised above flood levels, and requiring compensatory storage for any fill within the frequently flooded area (FEMA 2013, King County 2004, ASFPM 2003). However, such areas often coincide with other critical areas, such as streams, wetlands, and aquifer recharge areas. Protecting frequently flooded areas therefore produces secondary benefits for habitat protection, especially when habitat is considered in locating, designing, installing, and maintaining flood control facilities (Bolton and Shellberg 2001).

The first step to protecting flood prone areas, or conversely to protect people and structures from flooding, is to identify such areas. Woodinville defines flood hazard areas as "those areas in City of Woodinville subject to inundation by the base flood including, but not limited to, streams, lakes, wetlands and closed depressions" (WMC 21.06.245).The City has already mapped flood prone areas within the City limits, including those areas identified by FEMA as Zone A and Zone X flood areas, as well as other areas not identified by FEMA, such as riverine wetlands. The next step is to reduce the impact of, or to, the built environment.

Most current floodplain management strategies are premised on "no net impact" or "no adverse impact" (ASFPM 2003). Under such a strategy, the actions of one floodplain property owner does not adversely affect the flood risk of other property owners in terms of flood stage, flood velocities, increased flow volumes, or increased erosion risk. Regulatory actions to help achieve this goal include compensating for lost floodplain storage due to development and requiring no net increase in flood elevations. These strategies can be most effective at protecting not only development, but the natural processes of floodplains when they are combined with structural solutions such as setting back existing levees and reconnecting disconnected side channels.

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The City can reduce hazards associated with frequently flooded areas by restricting development in mapped floodplains. Requiring compliance with stormwater design standards as specified in the Stormwater Management Manual for Western Washington (WDOE 2005) is another tool to help protect floodplains from the impacts of urbanization. Additionally, some mapped floodplains overlap with other critical areas, such as wetlands and steep slopes and are therefore afforded some protection under those regulations.

The City may either develop specific floodplain regulations or require habitat assessments for development in the floodway or floodplain through what is commonly called the FEMA BiOp process. This requirement stems from the 2008 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp), which found that the implementation of the National Flood Insurance Program (NFIP) in the Puget Sound region jeopardizes the continued existence of federally threatened salmonids and resident killer whales. As a result, NMFS established Reasonable and Prudent Alternatives to ensure that development within the Special Flood Hazard Area (100 year floodplain), floodway, channel migration zone (CMZ), and riparian buffer zone do not adversely affect water quality, water quantity, flood volumes, flood velocities, spawning substrate, or floodplain refugia for listed salmonids. Because the NFIP is implemented by FEMA through participation by local jurisdictions that adopt and enforce floodplain management ordinances, FEMA has delegated responsibility to the local jurisdictions to ensure that development does not adversely affect listed species. Habitat assessments must evaluate impacts to stormwater, floodplain capacity, and vegetative habitat.

The NFIP standards apply to the Special Flood Hazard Area (SFHA), which covers the mapped 1 percent chance (100 year) floodplain. However, in its biological opinion, NMFS identified the "Protected Area" as the 100 year floodplain plus the riparian buffer zone (RBZ), which extends 250 feet from the ordinary high water mark, and the CMZ, plus 50 feet. In many areas, the "Protected Area" will extend far beyond the 100 year floodplain. To comply with NFIP, only the 100 year floodplain must be protected. Cities and counties also have an independent responsibility to protect floodplain functions and processes that may extend beyond the 100 year floodplain in order avoid take of ESA listed species.

3.3 Summary

Frequently flooded areas are important to identify and protect both because they present flood hazards and because they perform valuable hydrologic and habitat functions.

Stream health, floodplain functions, and patterns of urban development are all inter-related. Development in and upstream of frequently flooded areas can

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have a negative impact on floodplain functions, both to the area itself and to the development in and around the area. Total impervious surface within a basin, patch size of impervious surfaces and forest land, and the number of road crossings all affect watershed-scale processes. Urban environments are characterized by increased runoff to streams, as undetained flow from impervious surfaces increase the magnitude and frequency of peak flow event. This increase in flow often causes streams to downcut, which can separate the channel from the floodplain, making it more difficult for high flows to overtop the bank. This can lead to a negative feedback mechanism by which the downcutting worsens progressively until the channel can no longer downcut.

Development in frequently flooded areas generally needs to be protected from flooding by some means and can lead to increased flooding problems downstream. Natural floodplains store water during high flow events, releasing it back into the channel as the flow recedes. If the floodplain is blocked by a structure or a levee built to protect a structure, that storage capacity is lost, and downstream flooding is worsened.

Development in frequently flooded areas should be allowed only with no net loss, or no adverse impact, to both reduce the potential for damage to the resource and to prevent a worsening of flood impact. Development upstream of frequently flooded areas should employ mechanisms that ensure that peak flows to the creek are not increased. Again, such measures will not only help protect the resource of frequently flooded area, but will help protect people and structures from the hazard associated with flooding.

4 GEOLOGICALLY HAZARDOUS AREAS

According to RCW 36.70A.030(9) and WAC 365-190-120, Geologically Hazardous Areas are "those areas that are susceptible to erosion, sliding, earthquake, or other geological events and are not suited to the citing of commercial, residential, or industrial development consistent with public health and safety concerns". The four main types of geologically hazardous areas recognized in the GMA are 1) erosion hazard areas; 2) landslide hazard areas; 3) seismic hazard areas, and 4) areas subject to other geologic evens such as coal mine hazards and volcanic hazards.

Whereas the goal with most other GMA mandated critical areas is to protect a valued ecological resource, the purpose of regulating activities in geologically hazardous areas is to protect the public from the hazard. These areas are subject to periodic events that can result in property damage, injury and the loss of life. Human activity in these areas can pose a safety concern, and, in some cases, may

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actually increase the potential for a hazardous event. Such hazard events have the potential to affect not just one property, but also the neighboring properties. For example, improperly clearing a parcel in a sloping landslide area may increase the potential for a landslide that could damage not only the cleared property, but also the neighboring properties above and below it. Therefore, it is important to identify where such hazard areas are, and to ensure that activities and development in those areas is appropriate.

GMA Guidelines indicate that "Some geological hazards can be mitigated by engineering, design, or modified construction or mining practices so that risks to health and safety are acceptable" [WAC 365-190-080(4)]. However, the same section of the code also states that "When technology cannot reduce risks to acceptable levels, building in geologically hazardous areas is best avoided."

Steep slopes and other geologically hazardous sites that pose an erosion, landslide or seismic hazard should be included in critical area regulations to reduce potential risks to public health and safety. Mass wasting events can also be detrimental to habitat, particularly in-stream habitat. Landslide hazards include areas with all three of the following characteristics: slopes steeper than 15 percent, hillsides intersecting geologic contacts with relatively permeable sediment over relatively impermeable sediment or bedrock, and springs or groundwater seeps. Any areas where the slope is "40 percent or steeper and with a vertical relief of ten or more feet except areas composed of consolidated rock" is also deemed a steep slope which poses a landslide hazard (WDC 2003 and WAC 365-190-120).

4.1 Functions and Potential Effects of Development

4.1.1 Erosion

Erosion is part of the natural dynamic that builds floodplains and beaches, enables channel migration on rivers and streams, and facilitates the recruitment of woody debris into streams and other bodies of water. Erosion occurs when wind, streamflow, waves or even ice move particles from where they had previously rested. Material that is transported via erosion is carried with the flow of the medium that caused the erosion until that medium no longer has sufficient energy to carry the material, at which point the material is deposited.

Erosion and deposition are natural processes for both streams and beaches, and the flora and fauna that use such areas are generally adapted to a certain level of erosion and deposition. However, excessive erosion, and resulting excessive deposition, can be harmful to stream channels, shorelines, and the plants and animals that use them. Erosion is one of the primary mechanisms for recruiting large woody debris to streams, and in Western Washington, such debris is highly beneficial to salmonids and other aquatic species. However, erosion also

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produces fine sediment, which can deposit in the gravels that many fish species use to spawn, causing eggs to suffocate and die (Nelson and Booth 2002).

In an urban setting, erosion can become a hazard when structures are placed in areas susceptible to erosion, or land use actions cause formerly stable areas to begin eroding. Urban development such as parking lots, roads and buildings, prevent rain from infiltrating into the soil, generating more rapid runoff from the land into nearby streams and rivers. This results in an increase in peak flow volumes in the streams, which in turn produces higher energy and increases the potential for streambank erosion (Booth 1990, Booth 1991, Nelson and Booth 2002).

Erosion Hazard is the susceptibility of the land to the prevailing agents of erosion (Houghton and Charman 1986). The magnitude of the hazard is determined by a variety of factors, including the soil type, topography, vegetation, rainfall patterns, and basin-wide land use and development patterns. Erosion hazard areas include areas likely to become unstable, such as bluffs, steep slopes, and areas with unconsolidated soils (WAC 365-190-120).

The hazard from erosion-prone areas includes direct damage as a result of the erosion as well as increased risk from landslide as a result of erosion. During storm events and under other extreme conditions, erosion can happen very rapidly, putting at risk any structures located in the area being eroded, and potentially risking injury or death to people using such structures at the time of erosion (Booth 1991).

Removal of vegetation can also contribute to increased erosion potential in susceptible areas. Vegetation intercepts rainfall, preventing a significant portion of rainfall from reaching the ground where it can cause erosion (Watson and Burnett, 1995). In cleared areas, the impact of rain drops can initiate the erosion process, freeing small particles to be carried downslope. As water accumulated on the ground, it tends to concentrate in small channels, and as the water gains in depth and volume, larger particles can be mobilized by the flow. In this way, small channels or rills can eventually develop into gullies.

Significant erosion in the region is typically limited to those areas where runoff has been concentrated by human activity or where vegetation has been removed from erodible soils. Vegetation reduces erosion by preventing a significant amount of rainfall from reaching the soil and physically binds the soil together with root materials (Booth et al. 2002, Niaman and Decamps 1997).

Erosion hazards in the Woodinville Comprehensive Update Study Area are commonly associated with steep slopes and are located along the Sammamish River, West Ridge and East Valley. Erosion hazard areas are mapped in the

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Woodinville Comprehensive Plan Update -Existing Conditions Report, Section 1.3 (Appendix A).

4.1.2 Landslides

Landslides include a wide variety of processes that involve the downward and outward movement of slope-forming material by sliding, toppling, falling, or spreading (USGS, 2004). In most cases, landslides deliver material from the hillslopes into streams and rivers. Trees that are involved in the landslide often end up being delivered to these streams, rivers, and beaches, where they become important habitat. Such large woody debris (LWD) provides nutrients, shelter and shade, while helping to stabilize stream channels, and ultimately beaches.

Areas prone to landslides are commonly slopes comprised of relatively permeable materials, such as sand and gravel, over a less permeable material, such as bedrock or clay. Water that infiltrates through the upper soil layer, but cannot penetrate the lower layer as quickly, it builds up at the interface between the two layers (Menashe 1993). This water adds weight to the slope and causes a loss of cohesion, which allows the slope to fail.

Landslide hazard areas are well described in the WAC (365-190-120):

Landslide hazard areas include areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

1) *Areas of historic failures, such as:*
    a. *Those areas delineated by the United States Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development;*
    b. *Those coastal areas mapped as class u (unstable), uos (unstable old slides), and urs (unstable recent slides) in the department of ecology Washington coastal atlas; or*
    c. *Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington department of natural resources.*
2) *Areas with all three of the following characteristics:*
    a. *Slopes steeper than fifteen percent;*
    b. *Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and*
    c. *Springs or groundwater seepage.*

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3) *Areas that have shown movement during the holocene epoch (from ten thousand years ago to the present) or which are underlain or covered by mass wastage debris of this epoch;*
4) *Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;*
5) *Slopes having gradients steeper than eighty percent subject to rockfall during seismic shaking;*
6) *Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones;*
7) *Areas that show evidence of, or are at risk from snow avalanches;*
8) *Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and*
9) *Any area with a slope of forty percent or steeper and with a vertical relief of ten or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least ten feet of vertical relief.*

Landslides can occur in a variety of different ways, from fast to slow, and deep to shallow, originating from the bottom of a slope or the top of a slope, or somewhere in between. A variety of classification schemes have been used to describe landslides. The classification by Varnes (1978) is likely the most widely used, and classifies slides by the type of movement and the material involve. A more simple classification, uses three basic types of landslides common to this area: 1) Rapid-Shallow, 2) Block Fall, and 3) Deep-Seated (King County 2004). As the names imply, a rapid-shallow landslide is one that does not extend deeply into the ground, and usually moves quickly down a slope. This is the most common type of landslide in the Puget Sound region, where the glacial deposits often result in surface layers that are more permeable then the deeper layers, causing water to build up on the interface between the two layers. The weight and pressure from the water causes the upper layer to fail, and slide over the deeper, more resistant layer. Block falls are common where erosion is occurring at the toe of a slope, either through wave energy or streamflow. As the toe is over-steepened, at some point the slope above the toe becomes unstable and the entire slope collapses as more-or-less a single unit. Deep-seated landslides are generally larger than the other types of landslide, and involve one or more large blocks of both soil and the underlying substrate moving together. Such slides can move extremely slowly, taking years, decades or longer to reach equilibrium. However, even moving slowly, such deep-seated landslides can cause significant damage to structures.

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Activities associated with urban development, including vegetation removal, and increased impervious surfaces, can increase the landslide hazard of susceptible areas. Vegetation plays a significant role in landslide potential by intercepting a substantial amount of rainfall, preventing it from infiltrating into the soil. Roots from vegetation also take up and transpire some of the water that does reach the soil (Watson and Burnett 1995). This reduces the amount of water that rests on the interface between the permeable and impermeable layer. A dense matrix of roots can also lend considerable strength to the soil on a slope (Schmidt, et al. 2001), decreasing the likelihood of slope failure and shallow-rapid landslides.

The hazard associated with landslide prone areas includes damage to structures on the unstable slope, at the bottom of the slope where the material from a landslide deposits, and at the top of the slope that may be destabilized by the slide. During faster land sliding events, the danger of personal injury or death can be significant.

In addition to personal and property damage, landslides may have an adverse effect on plants and animals in the vicinity. Landslides, like erosion, are a natural phenomenon that is relatively common in the Pacific Northwest, and the flora and fauna of the region is adapted to landslides to a certain extent. However, persistent slides and an overabundance of slides can be harmful to a number of species. For example, landslides that produce abundant fine sediment can be damaging to fish that spawn in streams that receive the fine sediment.

Steep slopes in the Lake Leota, Woodin Creek, and Sammamish River West basins pose a potential landslide hazard (Woodinville 2009). Geologic features, including steep slopes and landslide hazard areas are mapped in the *Woodinville Comprehensive Plan Update -Existing Conditions Report, Section 1.3* (Appendix A).

4.1.3 Seismic Hazard Areas

Per WAC, Seismic Hazard areas includes areas subject to severe risk of damage as a result of ground shaking, slope failure, settlement or subsidence, soil liquefaction, surface faults or tsunamis that are caused by an earthquake. It goes on to stipulate that ground shaking is the primary cause of earthquake damage in Washington, and that such shaking can cause the ground to settle. The strength of ground shaking is primarily affected by the magnitude of the earthquake, the distance from the source of the earthquake, the type or thickness of the surface materials, and the type of geologic structure affected (WAC 365-190-120 (7).

Western Washington is part of the "Ring of Fire", a series of tectonic plate boundaries that more or less outlines the Pacific Ocean. Where tectonic plates meet, they do one of three things: converge, diverge, or slide past each other

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laterally. In Western Washington, the last remnant of the Juan de Fuca plate is converging with the North American plate. The Juan de Fuca plate is an oceanic plate, while the North American plate is a continental plate. Oceanic plates are made of more dense material than continental plates, and where the two types of plates converge, the oceanic plate is driven under the continental plate. Such is the case in Western Washington, part of the Cascadia Subduction Zone, defined as the area affected by the subduction of the Juan de Fuca plate under the North American plate. This subduction is the primary driver of seismic activity in the Pacific Northwest.

Subduction zones are responsible for most of the largest magnitude earthquakes, including the 2011 Tohoku earthquake in Japan, (9.0 magnitude), the Alaskan earthquake in 1965 (9.2 magnitude) and Great Chilean earthquake of 1964 (9.5 magnitude). In the book *The Orphan Tsunami of 1700*, Brian Atwater, et al. (2005) provides evidence that a Cascadia subduction zone earthquake occurred on January 26, 1700 and was, per his estimate, in the 8.7-9.2 magnitude range. The precision of the date stems from records of a tsunami in Japan that was caused by the quake. There is geologic evidence for 13 or more of these "great quakes" in the Cascadia subduction zone, occurring at intervals ranging from 300-900 years apart.

In addition to these "great quakes", lesser, but still potentially damaging quakes occur in the region on a more frequent basis, including the 2001 Nisqually quake and the 1965 Olympia quake. These and other, smaller earthquakes are associated with smaller faults that occur in the Puget Sound region. One such fault is the Southern Whidbey Island Fault Zone (SWIFZ). USGS mapping indicates the SWIFZ extends southeastward beneath the mainland and between Seattle and Everett. This feature includes a lineament across the Little Bear Creek basin in Woodinville. Paleoseismological evidence indicates that the SWIFZ has produced four earthquake events since deglaciation (approximately 16,400 years ago) (Sherrod et al. 2005). Smaller earthquakes and their shallower depth can produce a great deal of ground motion, especially on susceptible soils.

In an earthquake, all the ground can be expected to move, but ground shaking is typically worse in areas where unconsolidated sediment, either naturally deposited (i.e. river sediments) or artificial, is present (Gerstel et al. 1997). The thickness of such layers may also play a role in the amount of motion that the area experiences. In some cases, the frequency of the earthquake waves may create a resonance in a sediment layer of the proper thickness, creating greater ground motion in a localized area than in other nearby areas where the layer is more or less thick and resonance does not occur. Similarly, underlying geologic structures may serve to focus earthquake seismic waves, depending on depth and frequency (Langston and Lee 1983).

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Depending on the type of earthquake and the relative motion of the ground, movement along the faults can lead to subsidence and/or uplift along the fault line. During the 1964 Alaska earthquake, parts of the Gulf of Alaska were uplifted by 11 meters (36 feet) while other areas subsided by over 2 meters (Stover and Coffman 1993). Surface faulting is when movement along a fault causes a rupture in the ground surface. Such faulting can destroy buildings, make roads impassable, and sever underground utilities, including gas, electric, water, sewer, and communications. These utilities problems can lead to fires, flooding, sink holes, and contamination.

Ground shaking can also cause a number of different types of ground failure, including landslides, soil liquefaction, and settling (Keefer 1983). Landslides can be triggered when a marginally stable slope is subjected to ground shaking. Liquefaction occurs when saturated, loose, sandy soil is subjected to shaking. Shaking causes the loose, sandy soil to compress, and if it is saturated (i.e. water fills all the spaces between soil particles), the water is displaced by the compressing particles and forced upwards. Under normal conditions, soil particles are in direct contact with each other, and that contact is what makes the soil capable of supporting a load like a building. But when liquefaction occurs, the pressure from the upward-migrating water breaks the contact between the soil particles, and the strength of the soil is lost, such that it behaves more like a liquid than a solid. Any buildings that rely on the soil for support (as opposed to pilings or other engineered structure) can essentially sink into the soil like quicksand. Where soils are not saturated, the compression can still lead to settling, which can break utility lines and, if such settling occurs unevenly under a building, may cause the foundation to break, or in severe instance, may cause the building to fail.

Seismic hazards include both direct and indirect personal and property damage from earthquakes. Direct damage can vary from the relatively minor, such as broken glass, overturned furniture, and damage to brickwork (chimneys tend to be particularly vulnerable due to their height and narrow cross-section) and foundations to complete collapse of structures. Those areas where soils and underlying geology would increase the magnitude of ground shaking would experience more severe damage. Ground shaking may also increase the hazard of landslide hazard areas by destabilizing marginally stable slopes, especially if the quake hits during or after a winter storm even when soil saturation levels peak. Indirect damage can include fires triggered by broken gas and/or electric lines, loss of information from severed data lines, flooding from broken water lines, contamination and illness from leaking sewer lines, etc.

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4.1.4 Other Geologically Hazardous Areas

Other geologically hazardous areas include areas subject to potential volcanic hazards, and areas where old coal mines may pose a hazard, per WAC 365-190-120 (8).

Volcanoes

Volcanoes in Washington are the result of the subsidence of the Juan de Fuca plate under the North American continent. As the oceanic plate is forced under the continental crust, heat from the earth begins to melt the rock, starting with those minerals with the lowest melting point, such as quartz and feldspar. This melted material is less dense than the surrounding material and rises upward, and where it can reach the surface, a volcano is formed.

There are five Cascade volcanoes – Mt. Adams, Mt. St. Helens, Mt Rainer, Glacier Peak, and Mt. Baker. Of these, Glacier Peak is in closest proximity to Woodinville at approximately 55 miles. The next closest is Mt. Rainier, approximately 65 miles away. Lahars, which are mudflows or debris flows caused by the rapid melting of mountain snow from a volcanic eruption or other volcanic activity, have historically traveled similar distances – along the Green River from Mt. Rainier, and along the Sauk and Skagit rivers from Glacier Peak. However, lahars are driven by gravity, and flow along the lowest ground. Pyroclasitc flows and debris avalanches occur only within close proximity to their source, and are therefore not a hazard in Woodinville.

Volcanic hazards can include pyroclastic flows, debris avalanches, debris flows, tephra fall (fine tephra fall is commonly referred to as ash), and flooding associated with volcanoes. During the explosive eruptions typical of Cascade volcanoes, hot, pressurized volcanic gasses released by an eruption carry rock and ash into the air. As the energy that carried the material upward dissipates, the particles begin to fall back to the ground, with the larger particles falling first and closest to the volcano, and the smaller particle being carried farther with the wind before depositing; this material is called tephra fall. The result is a thick deposit of coarse material nearest the site of the eruption, grading to thinner and finer deposits as the distance from the volcano increases (Wolfe & Pierson, 1995).

The only volcanic hazard likely to be experienced within the Woodinville Comprehensive Plan Update Study Area is tephra fall or ash. The major hazard potential from tephra fall are the impact from falling material, burial of structures and pathways, and the presence of abrasive materials in the air and water. Given the distance between Woodinville and any Cascade volcanoes, the impact potential is negligible, since larger particles fall nearest the volcano, and burial of structure would require a very severe eruption, since the depth of tephra decreases with distance from the volcano. However, volcanic ash can be problematic up to several hundred miles downwind of its source, causing eye

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and respiratory irritation, damaging engines on airplanes, automobiles, trucks, and trains, reducing visibility, and potentially short-circuiting power transmission lines (WMD 2012). Such problems can occur during the initial ashfall, and later as wind and/or vehicles re-suspend ash particles. Additionally, wet ash on buildings can be heavy enough to cause roof damage or even collapse (Wolfe & Pierson, 1995). Ash suspended in water can also damage sewer treatment facilities.

4.2 Potential Protection Measures

Geologic hazard areas can potentially damage property and/or cause injury or death. Unlike other critical areas, where the potential impact is to a resource that is valued and being protected, with geologic hazards, the goal is to protect people and property from potential damage associated with the area.

A variety of measures can be taken to protect property and people from geologically hazardous areas. Careful planning and engineering can help to reduce the magnitude of, and maybe even prevent, certain erosion and landslide events from happening. Unfortunately, there is as yet no known way to prevent earthquakes or volcanic events, and even predicting such events is still a very imprecise endeavor. However, while such events cannot be prevented, the amount of damage that the events are likely to cause can be reduced or eliminated with proper planning and preparation. Identifying and mapping potential hazard areas is an important first step in developing protection measures.

4.2.1 Erosion Hazard Areas

Erosion Hazard Areas can be protected by promoting sound development practices. Temporary Erosion and Sedimentation Control (TESC) Plans and their associated Best Management Practices (BMPs) can be effective at preventing erosion associated with construction and grading activities in erosion hazard areas. According to WDOE, typical BMPs are temporary and permanent seeding, protecting areas of exposed soil, slowing down runoff velocity, and trapping sediment through the use of straw bales, temporary ponds or silt fences.

Vegetation management is also an important component, since vegetation provides a good deal or protection against erosion (Fredricksen and Harr 1981, Gray and Sotir 1996, Menashe 1993). Vegetation protects soil on slopes from falling water, while the roots provide mechanical strength to the soil. On stream banks and shorelines, this root strength can protect against shear stress from waves and flow.

Development that concentrates flows or creates higher peak flows than in the pre-developed condition are likely to make erosion hazards more severe. This

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can be a localized effect (e.g. a homeowner that drains footings to a steep slope, causing erosion) or can be more drainage-basin in scale (e.g. parking lots in the upper basin causing higher peak flows downstream, increasing the potential for erosion from the parking lot outfall to all points downstream).

Erosion Hazard Areas should be mapped and classified based on their potential for erosion. Erosion hazard mapping includes the following five categories of hazard (King County 2004):

Slight. Indicates no appreciable erosion damage is likely to occur during and after the development or continuation of a particular land use under consideration. Soil conservation management should include simple practices such as rapid establishment of ground cover as soon as possible.

Moderate. Implies significant erosion may occur during development of a particular land use. Provided appropriate soil conservation measures are adopted during development, both short-term and long-term erosion problems may be avoided.

High. Implies significant erosion may occur. Intensive soil conservation measures are required to control erosion that will occur during development or continuation of a particular land use. Short-term measures are required in the initial stages of development. Long-term erosion control would involve intensive measures being implemented.

Very High. Implies that significant erosion will occur both during and after development of a particular land use is established, even with intensive soil conservation measures. Planning will need to carefully consider the balance between long-term erosion damage and the maintenance and repair needed to ensure the viability of the land use.

Extreme. Implies soil erosion will occur to such an extent that erosion control is impractical. These areas are best retained as green timber and not used. Where urban development proceeds in spite of this recommendation, detailed engineering, geotechnical and other studies will be necessary.

4.2.2 Landslide Hazard Areas

Buffers or setbacks around landslide hazard areas, including the tops and toes of steep slopes, can be an effective way of preventing or limiting damage (Gerstel et al., 1997). If development is proposed within the buffer or slide area, rigorous design and construction standards should be adhered to in order to prevent the development from causing slope instability, either at the site or elsewhere on the slope. Any such development in the hazard area or its buffer should be evaluated on a site-specific basis by a licensed geotechnical engineer or

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engineering geologist. Data used in such analyses should be site-specific, and include subsurface exploration and testing of soils at an appropriate frequency across the site.

4.2.3 Seismic Hazard Areas

Given the difficulty in predicting where, when, and how large an earthquake will be, the safest course of action is to assume that a structure will at some point in its useful life be subjected to an earthquake. The Washington State Building Code (WAC 51-50) offers guidance from the 2009 International Existing Building Code with amendments specific to the State, including several directly related to seismic standards. Adherence to such guidance is an effective way to mitigate seismic hazards.

4.2.4 Other Geologically Hazardous Areas

Volcanoes

Areas at risk from lahars and associated phenomena from a volcanic eruption at Glacier Peak and Mount Rainier are documented in the Washington State Enhanced Hazard Mitigation Plan (WMD 2012). The Woodinville Comprehensive Plan Update Study Area is outside of identified lahar paths. Tephra fall or ash is essentially the only volcanic hazard that might face Woodinville. Hazard mapping of such areas is unnecessary, since the entire Woodinville Comprehensive Plan Update Study Area would be equally prone to such a hazard.

Mines

No coal mines are mapped within the Woodinville Comprehensive Plan Update Study Area. Therefore, mine-specific protection measures are not warranted.

4.3 Summary

Geologically Hazardous Areas within the Woodinville Comprehensive Plan Update Study Area include areas of erosion hazard, landslide hazard, seismic hazard, and volcanic hazard. Unlike most other critical areas, the goal of regulating geologically hazardous areas is to reduce the risk of harm to people or property that are associated with such areas, rather than to protect those areas from being harmed or degraded.

As documented in the *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A), the City has already identified slope, landslide and seismic hazard areas. Detailed geologic mapping is also included in the Golder Associates report (2007).

Because the goal of identifying geologically hazardous areas is to protect human life and property, avoidance is often the best option. However, structural and

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engineering solutions can help to mitigate such hazards, if done appropriately and if properly maintained. Thorough geotechnical analysis and engineering design is critical to achieve such mitigation. Such analysis should include an assessment of the property in question as well as the properties surrounding the site. Also, since geologically hazardous areas are often interconnected, such analysis should include all the hazards likely to affect the site. For example, in a landslide hazard area on a slope above a creek, a proper analysis should include an assessment of the neighboring properties, as well as all the properties above and below the site on the slope, and should include an assessment of the potential for erosion from the creek at the bottom of the slope, as well as an assessment of the seismic stability of the site and the proposed structure.

It should also be mentioned that, unlike some other critical areas, off-site mitigation with respect to geologically hazardous areas is not feasible.

5 WETLANDS

Wetlands were historically drained or filled to accommodate agriculture or development. However, today they are recognized as high functioning ecosystems that provide a wide range of valuable services, including flood control, aquifer recharge/discharge, and wildlife habitat.

Wetlands exhibit a diversity of characteristics, such as permanent or seasonal inundation, organic or mineral soils. Wetlands are distinguished from adjacent areas by anaerobic wet soil conditions within the root zone during the growing season, unique soil profiles, and water dependent or water tolerant plant species. Transitions between wetland and non-wetland or upland areas may be gradual or plainly defined, often by topographic breaks. Since interest in managing and protecting wetland resources began in the mid-fifties, ecologists have struggled to develop a wetland definition based on scientifically defensible criteria. Implementation of the 1977 Clean Water Act requires a scientifically based legally defensible wetland definition (Mitsch and Gosselink 2000).

The commonly used wetland definition as issued by the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (Corps), Shoreline Management Act (SMA), Growth Management Act (GMA) and recorded in the Washington Administrative Code (WAC 173-22-030(10)) is:

> "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps,

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marshes, bogs, and similar areas. Wetlands do not include artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from non-wetland areas to mitigate the conversion of wetlands."

Major wetlands within the Woodinville Comprehensive Plan Update Study Area include Lake Leota and associated fringe wetlands, wetlands along the Sammamish River and Little Bear Creek, and wetland pockets across the landscape. Known wetland areas are mapped in the *Woodinville Comprehensive Plan Update – Existing Conditions Report, Section 1.3* (Appendix A).

5.1 Functions and Potential Effects of Development

Physical, chemical, and biological processes that occur within a wetland and the surrounding landscape are commonly referred to as wetland functions. Wetland scientists generally acknowledge that wetlands perform the following eight functions:

1) flood/storm water control,
2) base stream flow/groundwater support,
3) erosion/shoreline protection,
4) water quality improvement,
5) natural biological support,
6) general habitat functions,
7) specific habitat functions, and
8) cultural and socioeconomic values (Cooke Scientific Services 2000).

The capacity of an individual wetland to perform functions is dependent upon climate, geomorphic or topographic location, the hydrology source and hydrodynamics. Wetland functions also vary, both positively and negatively, due to processes or changes occurring at the watershed scale. The Bedford "process-structure-function" model is a tool for evaluating wetland functions and values at a greater landscape scale. This model assumes that land use choices affect processes key to wetland and other aquatic system functions (Sheldon et al. 2005). Additionally, a study conducted by Poiani et al. (1996) demonstrates that regional land uses, corresponding pollutant inputs, and watershed characteristics, such as soils and topography, affect wetland processes, particularly in regard to nitrogen cycling.

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While wetlands perform many ecological functions, scientific literature acknowledges that the value assigned to any given wetland function is subjective. Wetlands naturally perform several functions at low cost relative to engineered solutions, such as water storage, flood protection, water reserve, pollutant and nutrient retention, and provisional fisheries habitat; these are valued as human services (Hattermann et al. 2008). For practical applications, such as the WDOE rating system, wetland functional values are broadly grouped into three categories: 1) water quality functions, 2) flood storage or hydrologic functions, and 3) habitat functions (Sheldon et al. 2005).

5.1.1 Wetland Hydrology

Primary hydrologic functions wetlands provide are peak flow reduction and flood-flow desynchronization, reduced downstream erosion, and groundwater recharge (Sheldon et al. 2005). As described by Hruby et al. 1991 and Adamus et al. 1991, flood-flow desynchronization is a landscape-scale process whereby stormwater is stored in wetlands across the watershed and slowly released down-gradient. Cumulatively this reduces the magnitude and intensity of peak flows (Sheldon et al. 2005). In turn, reducing the velocity of water flow across the watershed reduces downstream erosion (Reinelt and Horner 1995, Adamus et al. 1991). Wetlands also recharge groundwater to varying degrees based on site-specific conditions including groundwater flow rates, wetland storage capacity, landscape position or hydrogeomorphic class, and evapotranspiration rates (Adamus et al. 1991, Hunt et al. 1996).

Urbanization typically alters wetland hydrology by increasing or decreasing flows that enter the wetland from the surrounding landscape (Sheldon et al. 2005). A Puget Sound wetland study found that even 4% urbanization can measurably alter wetlands and severe wetland degradation correlates with impervious cover in excess of 20% (Schueler 2000).

High impervious surface cover characteristic of urban areas leads to greater peak flows. In an urban setting, peak flow rates for a single storm event increase as much as five-fold relative to less developed areas (Booth 1991). Under these conditions, McMillan (2000) concludes that buffers are not likely to protect a wetland's hydroperiod if they are located in a basin with impervious surface exceeding 15 percent. Changes to flow conditions associated with urbanization are known to increase erosion, down-cut stream channels, bury vegetation, increase depth of ponding, and alter seasonal water regimes (Sheldon et al. 2005).

Modified drainage patterns in urban areas are found to increase water level fluctuations in wetlands by a foot or more; this stresses many native plant species and tends to result in more invasive or aggressive plant species establishment (Schueler 2000).

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Other improvements typical of urban areas may reduce the amount of water entering a wetland. For example, stormwater management may have unintended consequences for wetland hydrology. When road ditches, drainage tiles or other stormwater features are installed down-slope wetlands may become drier (Wigington et al. 2005, Hogan and Walbridge 2007). As is typical of ecosystem processes, hydrologic maintenance is linked to many other wetland and buffer functions.

5.1.2 Water Quality

Wetlands improve water quality by intercepting runoff, retaining inorganic nutrients, converting organic wastes, settling sediment and removing contaminants (Sheldon et al. 2005). While wetlands are known to provide water quality functions, research indicates that household chemicals, pharmaceuticals and personal care products are entering aquatic systems and negatively impacting fish and wildlife populations (Staples et al. 2004, Klaschka 2008, Fent 2008, Caliman & Garvilescu 2009); the ability of wetlands to neutralize these pollutants is unknown at this time.

The water quality functions provided by an individual wetland vary by site-specific characteristics including hydrogeomorphic class and basin condition. Water quality functions are also dependent on several factors including residence time of polluted waters, vegetation structure and density, and soil composition. A longer residence time allows sediment and other solids to settle. Ungrazed vegetation acts as a filter to capture sediment particles entering the wetland (Hruby 2004). Research has shown that a vegetated wetlands and riparian buffers can be expected to capture more than 90% of sediment and other non-point source pollutants in runoff (Gilliam 1994). Due to the absorption properties of heavy metals, phosphorus, and some toxic compounds, sediment capture in wetlands also reduces these pollutants in downstream environments. According to Kerr et al. 2008, low oxygen concentrations that are common to wetland environments make them particularly good sinks for copper. The major processes by which wetlands reduce runoff pollutants are both biotic and abiotic and include sedimentation, adsorption, precipitation, oxidation, bio-degradation, and plant uptake (Adamus el al. 1991, ITRC 2003).

Nutrient uptake in wetland systems also protects down-gradient waters by preventing nutrient spikes that can disrupt trophic indices; such disruptions can cause eutrophication. The primary nutrients wetlands remove are nitrogen and phosphorus. Wetland plants and microorganisms are known to uptake or remove nitrogen through the biochemical processes of nitrification and denitrification, which occur in aerobic and anaerobic conditions, respectively (Sheldon et al. 2005). As noted above, phosphorus is captured in settled sediments; wetlands also remove phosphorus through adsorption, particularly to

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clay soils, and precipitation with calcium (Sheldon et al. 2005). However, phosphorus retention in wetlands is not permanent and seasonal fluctuations in phosphorus release have been documented in some studies (Aldous et al. 2005).

Negative correlations between urbanization and wetland water quality have been documented in the Puget Sound region (Schueler 2000, Azous and Horner 2010). For example, increased water volumes within a wetland can alter plant communities and anaerobic soil processes thus diminishing water quality functions (Schueler 2000, Sheldon et al. 2005). A decrease in water entering wetlands results in less opportunity to provide water quality functions (Wigington et al. 2005, Hogan and Walbridge 2007). Urbanized watersheds also release more nutrients, sediment and toxins into wetlands (Sheldon et al. 2005), further straining systems that are already compromised. When excess nutrients are transported via runoff into lakes and ponds, eutrophication may occur; a process that reduces levels of dissolved oxygen and causes aquatic fauna mortality. Eutrophication in Lake Leota has been linked to urbanization within that watershed (Falter 2007).

5.1.3 Wildlife Habitat

Wetlands provide important wildlife habitat within the landscape due to the presence of unique structures and processes. Ecological features that are linked to species richness and abundance in a landscape include structural complexity, connectivity to other ecosystems, plentiful sources of food and water, and a moist moderate microclimate (Knutson and Naef 1997). Wetlands, depending on site-specific conditions, landscape position, and surrounding land use, will have some or all of these habitat features.

Wetlands provide habitat for a broad range of fauna including invertebrates, reptiles and amphibians, anadromous and resident fish, wetland-associated birds, and wetland-associated mammals. Aquatic invertebrates that depend on wetland ecosystems are important to aquatic trophic systems or food webs (Rosenberg and Danks 1987, Wissinger 1999, in Sheldon et al. 2005). Native frogs and salamanders require wetlands for breeding. Buffer condition, habitat interspersion, wetland hydro-period, and diameter of emerged plant stems are all important factors that impact amphibian richness and abundance (Sheldon et al. 2005). Wetlands with surface connections to salmon-bearing streams can provide backwater refuge for anadromous fish if they also have ponded water at least 18 inches deep, low flow conditions, and cover such as overhanging or submerged plants (Sheldon et al. 2005). Resident fish also inhabit wetlands. Waterfowl rely upon wetlands for all or part of their life cycle (Kauffman et al. 2001, in Sheldon 2005). Suitability of wetland habitat for birds is dependent on buffer condition and width, presence of snags or other perches, corridor

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connections, open water, and forest canopy cover (Sheldon et al. 2005). Wetland-associated mammals, such as beaver and muskrat, also seek out well buffered vegetated corridors, interspersed habitat with open water, and a seasonally stable water level (Sheldon et al. 2005). According to a Washington Department of Fish and Wildlife (WDFW) study conducted by Knutson and Naef (1997) a predominance of terrestrial vertebrate species in Washington are dependent on streams and riparian areas, including wetlands.

Wetlands also provide habitat for many native plants species. Wetland characteristics that are correlated with plant richness are the hydro-period, duration of flooding, and variety of water depths (Schueler 2000 and Sheldon et al. 2005). Vegetated areas surrounding wetlands perform several important functions that in turn protect wetland functions.

Habitat fragmentation is a consequence of urbanization. As land is developed, continuous tracts of native habitat are reduced to patches, which become progressively smaller and more isolated. Dale et al. (2000) found that ecologic impacts of development are often overlooked and landscape-scale changes, particularly habitat fragmentation, alter the structure and function of those ecosystems.

The performance of wetland habitat functions is affected to varying degrees by the width and/or character of the surrounding buffer. Urbanization reduces wetland buffering and increases human encroachment. Disturbance vectors include noise; nighttime light; physical intrusion by equipment, people, or pets; and garbage. Each of these vectors can result in one or more of the following: disruption of essential wildlife activities, damage to native vegetation and invasion of non-native species, erosion, or wetland fill, among others. Semlitsch and Bodie (2003) found that upland areas surrounding wetlands are core habitats for many semi-aquatic species, such as amphibians and reptiles. Additionally, Attum et al. (2007) concluded in their study of wetland-upland linkages that wetland surroundings and wetland areas are likely of equal importance to wildlife. Therefore, smaller habitat patches inevitably diminish habitat value.

Cumulative impacts of direct and indirect wetland alterations, including hydrologic changes, compromised water quality, and habitat fragmentation tend to reduce the habitat functions and values an urban wetland provides (Sheldon et al. 2005, Azous and Horner 2010).

5.1.4 Wetland Loss

Urbanization is known to have repercussions that impact both individual wetlands and broad-scale watershed processes. Land use changes typically

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involve wetland fill, loss of forest, modified drainage systems, increased pollutants, and more impervious surface (Sheldon et al. 2005).

Due to the planned density that defines urban areas, impacts to natural areas including wetlands, are common. Nationally it is estimated that 85 percent of urban wetlands have been filled (Kusler and Niering 1998, in Sheldon et al. 2005). For example, linear improvement projects, public facility improvements, and legal lot requirements can each cause unavoidable wetland impacts, particularly in an urban core. To protect wetland resources under these conditions regulation of direct and indirect wetland impacts is necessary. Direct wetland impacts are activities that drain, fill or clear a wetland. Indirect impacts stem from changes in the surrounding landscape that degrade a wetland by altering the wetland hydroperiod, microclimate or habitat connectivity, for example (McMillan 2000).

5.2 Potential Protection Measures

As the City grows, BAS-based protection measures may be employed to maintain wetlands and the functions they provide. The primary tools regulators rely on to retaining wetland functions and values are: accurate wetland identification and classification, buffer width requirements, and compensatory mitigation.

5.2.1 Wetland Identification and Classification

In accord with Washington State Legislature Senate Bill 5776, wetland determinations are made using methodology from the *Washington State Wetlands Identification and Delineation Manual* (State Manual) (Washington Department of Ecology [WDOE] 1997; Ecology Publication # 96-94). To address regional wetland characteristics and improve wetland delineation accuracy, the US Army Corps of Engineers (Corps) issued regional supplements to their Wetland Delineation Manual (1987) on which the State Manual is based. Therefore, current wetland methodology is based on the Manual and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (Regional Supplement) (Corps May 2010). Both the State and Corps Manuals provide parameters and methods for determining presence or absence of jurisdictional wetlands within the landscape. Following this methodology, wetland determinations are based on an examination of vegetation, soils, and hydrology.

While some wetlands are inundated and obvious, many wetlands have little, no or only seasonal surface water. A scientifically sound wetland determination is one made by a qualified professional who can evaluate and document present or absence of the three wetland parameters, vegetation, soils and hydrology in a manner consist with current regulations and accepted BAS practices. Currently, there is no state licensing or certification requirement for soil and wetland

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science professions. However, bills HB 1313 and SB 5225, which would require professional licensing, have been introduced to the Washington State Legislature and may be adopted; the bills have been reintroduced by resolution, but no action has been taken to date.

Once a wetland is identified, classification allows regulators to determine the relative rarity and functional value of an individual wetland feature. A wide range of tools and techniques have been used to categorize or manage wetland resources starting with gross scale National Wetland Inventory (NWI) mapping by the U.S. Fish and Wildlife Service using the Cowardin classification system (Cowardin et al. 1979). The Cowardin system is still widely used and has been incorporated into more recent tools, such as the Washington State Department of Ecology *Washington State Wetland Rating System for Western Washington* (WDOE Rating System) (Hruby 2004; Ecology Publication # 04-06-025).

The WDOE Rating System is the most commonly used and regionally-accepted wetland classification system. It is a four-tier wetland rating system, which grades wetlands on a points-based system in terms of functions and values. WDOE specifically developed this tool to allow for relatively rapid wetland assessment while still providing some scientific rigor (Hruby 1999). This rating system incorporates other classification elements, such as Cowardin (Cowardin et al. 1979), hydrogeomorphic) classifications (Brinson 1993), and special characteristics such as bogs and mature forests. As described in the WDOE Rating System guidance: "This rating system was designed to differentiate between wetlands based on their sensitivity to disturbance, their significance, their rarity, our ability to replace them, and the functions they provide" (Hruby 2004). The rationale for each wetland categories under the WDOE Rating System is described below.

- Category I: These are the most unique or rare high-functioning wetland types that are highly sensitive to disturbance and/or relatively undisturbed wetlands with functions that are impossible to replace in a human lifetime.

- Category II: These wetlands are high functioning and difficult, though not impossible, to replace.

- Category III: These wetlands provide a moderate level of functions. They have generally been disturbed in some way and are characterized by landscape fragmentation and less diversity.

- Category IV: These wetlands are low functioning and can be replaced or improved. They are characterized by a high level of disturbance and are often dominated by invasive weedy plants.

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5.2.2 Wetland Buffers

Protection of wetland functions from effects of surrounding land uses is most commonly achieved through fixed buffers. Widely recognized buffer functions include limited moderation of precipitation and stormwater inputs (hydrology maintenance), removal ofof sediment, excess nutrients,and toxic substances(water quality improvement), influencing microclimate, maintaining adjacent habitat critical for wetland-dependent species, and maintaining habitat connectivity (wildlife habitat), and screening adjacent disturbances (disturbance barrier)()Sheldon et al. 2005). The factors that influence the performance of a buffer include vegetative structure, percent slope, soils, and buffer width and length. The scientific literature identifies four primary factors important in determining buffer width to adequately protect wetlands. These are 1) the functions and values of the subject wetland, 2) the characteristics of the buffer itself, 3) the intensity of surrounding land uses and their expected impacts and 4) the specific functions the buffer is intended to provide (Sheldon et al. 2005).

A synthesis of scientific studies summarizing, among other wetland topics, effectiveness of various buffer widths relevant to Western Washington was published by the Washington State Department of Ecology (Sheldon et al. 2005). Water quality is the wetland function that has been studied most comprehensively in the context of adequate buffer width. Water movement and quantity, habitat, and disturbance protection functions have been addressed to a lesser extent. General studies on stream buffer widths were also deemed relevant to discussions of wetland buffer widths because a vegetated buffer often operates independently of the sensitive area it is intended to protect, particularly for "sink" functions such as sediment and pollutant removal. The effective buffer width ranges given below (Table 5.1) are broad and variations are largely dependent on buffer condition, landscape setting, and specific metrics. For example, buffer widths that can effectively maintain water quality functions differ for sediment removal, nutrient removal, and pathogen removal. Even for sediment removal, effective buffer widths vary by particle size (Sheldon et al. 2005). Generally the minimum buffer deemed necessary to protect a wetland under most conditions is between (15-30 meters) 50-100 feet wide. To maintain conditions suitable for most wildlife, a minimum buffer of (60 meters) 197 feet is recommended (Granger et al. 2005). Table 5-1 summarizes general recommended buffer width ranges for protecting specified wetland buffer functions.

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Table 5-1. Range of Effective Wetland Buffer Widths in Existing Literature for Applicable Functions

Function	Range (ft) of Effective Buffer Widths	Sources Consulted
Stormwater control (hydrology maintenance)	50-300 (generally); vegetative structure and impervious surface in basin are more important factors	Wong and McCuen 1982; McMillan 2000; Azous and Horner 2001
Erosion control	Unknown: wetland size and buffer type are more important factors	Cooke Scientific Services 2000; Kleinfelter et al. 1992, in McMillan 2000
Water quality	15-325	Horner and Mar 1982; Lynch et al. 1985; Lee et al. 1999; Shisler et al. 1987, in McMillan 2000; Dillaha and Inamdar 1997; Daniels and Gilliam 1996; Magette et al. 1989; Sheldon et al. 2005
Wildlife habitat	45-300	Castelle et al. 1992b; Desbonnet et al. 1994; Semlitsch 1998; Richter 1997, in McMillan 2000; Cooke 1992
Disturbance barrier	45-200	Cooke 1992; Shisler et al. 1987, in McMillan 2000; Desbonnet et al. 1994

Table 5-2 below categorizes buffer width ranges according to two primary functions, habitat and water quality. Water quality stressors are commonly inferred by categorizing the intensity of adjacent land use. In this model, land uses are deemed high, moderate or low intensity. Dense residential development (>1 unit/acre), institutional, commercial, and high use recreation (e.g. ball fields) are considered high-intensity impacts. Moderate-density residential developments (1 unit/acre or less) and moderate-intensity open space (parks with paved trails) are examples of moderate-intensity land uses. Low-intensity land use would be open spaces or natural areas with unpaved trails for low impact activities like hiking (Granger et al. 2005).

Table 5-2. Range of Effective Wetland Buffer Widths based on Habitat Functions and Land-Use (Sheldon et al. 2005)

Habitat functions	Adjacent Land Use	Range of Effective Buffer Widths (ft)
minimal	low-intensity	25 to 75
moderate	moderate- or high- intensity	75 to 150
high	low-, moderate- or high-intensity	150 to 300+

Determining set buffer widths for wildlife in general is difficult, due to variability among species (Sheldon et al. 2005). As habitat functions increase, effective buffer widths are increasingly contingent on life-history needs of

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wetland dependent species. Protecting wildlife habitat generally requires larger buffers than protecting water quality.

Table 5-3. Example Wetland Buffer Recommendations for Western Washington (WDOE 2010a)*

Wetland Category	Standard buffer width (ft)	Additional buffer width (ft) if wetland scores 21-25 habitat points	Additional buffer width (ft) if wetland scores 26-29 habitat points	Additional buffer width (ft) if wetland scores 30-36 habitat points
Category I: Based on total score	75	105	165	225
Category I: Bogs	190	190	190	225
Category I: Forested	75	105	165	225
Category II (all)	75	105	165	225
Category III (all)	60	105	165	NA
Category IV (all)	40	NA	NA	NA

* Special wetland characteristics not present in the Woodinville Comprehensive Plan Update Study Area were omitted. This WDOE reference, *Wetlands & CAO Updates: Guidance for Small Cities Western Washington Version*, is provided in Appendix B of this report.

As Tables 5-1, 5-2 and 5-3 above show, recommended buffer widths vary widely depending on individual characteristics such as adjacent stressors, targeted functions, buffer condition, and species-specific habitat niche requirements.

Hydrology Maintenance

Similar to stream systems, vegetated wetland buffers can affect water quantity and hydrology in the wetland by moderating the input of precipitation in a number of ways. Vegetation slows the movement of water from above and outside of the buffer, allowing the water to infiltrate into the soil and/or groundwater. Over time, this stored water will slowly be released into the wetland. Leaf and other vegetative litter on and in the soil also capture water and improve the soil's infiltration capacity (Castelle et al. 1992b). Depending on the size of the basin, the type of wetland, and the degree to which stormwater falling on impervious surfaces is routed away from the buffer (either directly to the sensitive area protected by the buffer, to a detention or infiltration pond, or to some other facility), the contribution of a specific buffer to water quantity maintenance in a wetland may be high or low (McMillan 2000). In either case, water quantity maintenance as related to buffer width has not been sufficiently studied. However, buffer characteristics that influence performance of this function are: "vegetation cover, soil infiltration capacity, rainfall intensity and antecedent soil moisture conditions" (Wong and McCuen 1982).

Upland buffers also function to control erosion by slowing water flow and allowing greater time for infiltration. Buffer vegetation can reduce sediment

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input to the wetland through soil stabilization by roots, and reduction in rain energy by the vegetation canopy and organic material on the soil (Castelle et al. 1992b). The plant species growing in buffers are an important factor in the buffers' ability to perform this function. Plants with fine roots are most effective at preventing erosion by binding the soil (Kleinfelter et al. 1992, in McMillan 2000).

The literature does not recommend a specific buffer size or range of buffer sizes for hydrology maintenance.

Water Quality Improvement

Buffers protect water quality in wetlands through removal of sediment and suspended solids, nutrients, and pathogens and toxic substances (Desbonnet et al. 1994; McMillan 2000; Castelle et al. 1992b). Performance of the water quality improvement function depends on a number of variables, including slope, vegetation composition, leaf and wood litter, soil type, and the type of pollutant (Desbonnet et al. 1994). In general, optimum performance could be achieved with a diverse mix of trees, shrubs and groundcovers; poorly drained clay-loam soils with organic content; abundant downed wood and leaf litter; and no slope. Sediment and pollutants can either be prevented from reaching the wetland through physical mechanisms, such as wood or leaf litter holding or binding these materials, or through chemical/biological means, such as breakdown or uptake of certain pollutants by root systems or microorganisms in the soil (Desbonnet et al. 1994; McMillan 2000; Castelle et al. 1992b). Buffer vegetation can reduce sediment input to the wetland through stabilization of soils by roots, and reduction in rain energy by the vegetation canopy and organic material on the soil (Castelle et al. 1992b). Shading and wind reduction by buffer vegetation also influences water quality by maintaining cooler temperatures. Water temperature in wetlands can be critical to survival of aquatic wildlife species, but more importantly from a water quality perspective, it helps maintain sediment-pollutant bonds, increases the water's dissolved oxygen capacity (McMillan 2000), and limits excessive algal growth (Castelle et al. 1992b).

Desbonnet et al.'s (1994) literature summary concluded that approximately 70 percent or greater sediment and pollutant removal was obtained at buffer widths between approximately 65 and 100 feet. Between 60 and 70 percent of sediment and pollutant removal, except for phosphorus, occurs in buffers between 25 and 50 feet (Desbonnet et al. 1994). Phosphorus removal efficiencies of 60 percent or more are found in buffers greater than 40 feet wide (Desbonnet et al. 1994). McMillan's (2000) summary analyzed a range of buffer widths by specific water quality function and identified the following effective buffers: 5 to 100 meters (16 to 330 feet) for sediment removal; 10 to 100 meters (33 to 330 feet) for nitrogen removal; 10 to 200 meters (33 to 656 feet) for phosphorus removal; and 5 to 35 meters (16 to 100 feet) for bacteria and pesticide removal.

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Wildlife Habitat

Vegetated wetland buffers provide essential habitat for a wide variety of wildlife species, particularly those that are wetland-dependent, but require adjacent upland habitat for some part of their life cycle (e.g., some amphibians, waterfowl, some mammals). They also provide habitat for non-wetland-dependent species that prefer habitat edges, use the wetland as a source of drinking water, or use the protected buffer corridors to travel between different habitats. Studies have been done to determine necessary wetland buffer widths for wildlife in general, for particular species, and for particular life stages of particular species.

The recommended buffer widths range widely in the literature and are clearly species dependent. For example, a study conducted in urban King County (Milligan 1985) found that bird diversity was positively correlated with vegetated buffers of 50 feet or greater. One literature summary reports an effective buffer range of 50 feet (15 m) for many bird species up to 3,280 feet (1,000 m) for native amphibians (Milligan 1985 and Richter 2001, in Sheldon et al. 2005). A large number of studies recommend buffers between 150 and 300 feet (WDW 1992, in Castelle et al. 1992b). Triquet et al. (1990, in Desbonnet et al. 1994) recommend minimum buffer widths of 50 to 75 feet to provide general avian habitat. A minimum recommended wildlife corridor is 98 feet (Shisler et al. 1987, in McMillan 2000), although 490 feet was also recommended as a minimum travel corridor by Richter (1997). The generally recommended buffer widths for habitat protection range between 50 and 300 feet depending on factors including wetland habitat conditions, target species, buffer condition, and surrounding land uses (Sheldon et al. 2005).

Disturbance Barrier

Dense, vegetated buffers also provide a barrier between a wetland and the various vectors for human encroachment, including noise, light, trampling of vegetation, and the introduction of garbage and other pollutants. Buffer widths necessary to effectively reduce impacts vary by intensity of the adjacent land use. Buffer widths of 49 to 98 feet can effectively screen low-intensity land uses, such as agriculture and low-density residential. High-intensity land use, such as high-density residential, commercial and industrial, require buffer widths of 98 to 164 feet (Shisler et al. 1987 in Sheldon et al. 2005). The buffer itself, and the functions that it provides, is subject to human-related disturbance. Cooke (1992, in Castelle et al. 1992a) found that buffers less than 50 feet wide experienced the most loss of buffer function related to human disturbance, and this loss is related to gradual reduction in buffer width as adjacent land uses encroach.

5.2.3 Wetland Mitigation

Mitigation is a sequence of steps taken "to reduce the severity of an action or situation" (WDOE et al. 2006a). To bolster protection of our national wetland

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resources, a no net loss policy was adopted in 1988 by then president George H.W. Bush and has been upheld by all following presidents up through the present Obama administration.

On March 31, 2008, the U.S. Environmental Protection Agency (EPA) issued the Wetlands Compensatory Mitigation Rule. This rule emphasizes best available science to promote innovation and focus on results. *"Specifically, the rule:*

- *Emphasizes that the process of selection a location for compensation sites should be driven by assessments of watershed needs and how specific wetland restoration and protection projects can best address those needs;*
- *Requires measurable and enforceable ecological performance stands for all types of compensation so that project success can be evaluated;*
- *Requires regular monitoring to document that compensation sites achieve ecological performance standards;*
- *Clearly specifies the components of a complete compensation plan based on the principles of aquatic ecosystem science; and*
- *Emphasizes the use of science-based assessment procedures to evaluate the extent of potential water resource impacts and the success of compensation measures."*

Mitigation Sequencing

Wetland mitigation is typically achieved through a series of steps known as mitigation sequencing. WDOE recommends that the CAO contain clear language regarding mitigation sequencing. The mitigation sequence according to the implementing rules of SEPA (Chapter 197-11-768 WAC) follows:

> *(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.*

The ABCs of mitigation sequencing are to Avoid, Buffer, and Compensate for impacts. The WDOE publication, *Wetland Guidance for Small Cities* (see Appendix B), provides sample code language for this approach.

Mitigation ratios are intended to replace lost functions and values stemming from a proposed land use while also accounting for temporal losses. Mitigation ratios recommended by WDOE can be found in Table 3 below. As noted above, the U.S. Army Corps of Engineers and WDOE have a mandate to maintain "no

net loss" of wetlands. To that end, wetland creation and restoration are preferable to enhancement alone. WDOE guidance does allow for enhancement as sole compensation for wetland impacts at quadruple the standard ratio (Granger et al. 2005).

Per WDOE, compensatory mitigation should replace lost or impacted functions, unless out-of-kind mitigation can meet formally identified goals for the watershed. WDOE recommends prioritizing mitigation actions, location(s) and timing.

Mitigation Ratios

A relatively low success rate of wetland mitigation through both creation of new wetlands and restoration of historic wetlands (Castelle et al. 1992a; Johnson et al. 2002; NRC 2001) is generally acknowledged in the literature. Although more recent evaluations of wetland mitigation found that most wetland creation is at least moderately successful (WDOE 2008), the goal of no net loss is not being achieved (Johnson et al. 2002). The goal of no net loss of wetland function cannot be achieved through mitigation alone, but may be met through a number of factors, including adequate monitoring and maintenance and appropriate performance standards. NRC (2001) identifies factors that reduce the risk of mitigation failure, such as detailed functional assessment, high success standards, detailed mitigation plans, larger bonds, high replacement ratios, and greater expertise.

Mitigation estimates in the literature are most often based on temporal losses and known failure rates. Because compensatory mitigation implemented in the past has not fully replaced lost wetland area and functions, and because an immediate loss of habitat occurs when mitigation installation is delayed, compensation should never be made in less than a 1:1 ratio (Josselyn et al. 1990). Other research suggests that compensation should be made in substantially larger ratios to account for both the possibility of failure and the lapse of time between mitigation implementation and functionality; those mitigation ratios range from 1:1 (mitigation to impact) up to 10:1 (Josselyn et al. 1990; Willard and Hiller 1990). (Table 5-4).

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Table 5-4. Suggested Wetland Mitigation Ratios and Sources

Recommended Ratio	Wetland and/or Mitigation Type	Source
1.5:1	Restoration (1:1 for completion prior to impact)	Kruczynski 1990
2:1	Creation (1:1 for completion prior to impact)	Kruczynski 1990
3:1	Enhancement (1:1 for completion prior to impact)	Kruczynski 1990
2:1	Creation	Kantor and Charette 1986
10:1	Low quality replacement wetlands	Zedler 1991
5:1	Moderate quality replacement wetlands	Zedler 1991
2:1	Compensation for projects needing a Hydraulic Approval Permit	WDW Wetlands Policy (POL-3025)
various	Creation	WDOE 2006

WDOE provides a range of mitigation ratio recommendations as listed in Table 5-5 below, which vary by impact wetland classification and type of mitigation (e.g. wetland creation, wetland enhancement, etc.). WDOE recommends the following wetland replacement ratios for local governments within Washington State: 6:1 for forested Category I wetlands, 4:1 for most other Category I wetlands, 3:1 for Category II wetlands, 2:1 for Category III wetlands, and 1.5:1 for Category IV wetlands. WDOE's *Guidance on Wetland Mitigation in Washington State* (WDOE et al. 2006a) also suggests criteria to be met in consideration of lowering or raising ratios on a project-specific basis.

Table 5-5. WDOE Recommended Mitigation Ratios (Granger et al. 2005)*

Category of Wetland Impact	Creation	Rehabilitation Only	Creation and Rehabilitation	Creation and Enhancement	Enhancement Only
Category IV	1.5:1	3:1	1:1 C and 1:1 RH	1:1 C and 2:1 E	6:1
Category III	2:1	4:1	1:1 C and 2:1 RH	1:1 C and 4:1 E	8:1
Category II	3:1	6:1	1:1 C and 4:1 RH	1:1 C and 8:1 E	12:1
Category I: Forested	6:1	12:1	1:1 C and 10:1 RH	1:1 C and 20:1 E	24:1
Category I: Bog	Not possible	6:1 RH of a bog	Not possible	Not possible	Case-by-case
Category I: based on total score	4:1	8:1	1:1 C and 6:1 RH	1:1 C and 12:1 E	16:1 E

*This document, Appendix 8-C of *Wetlands in Washington State, Volume 2 – Protecting and Managing Wetlands* (Granger et al. 2005).
Legend: C = Creation, RH = Rehabilitation, E = Enhancement

Mitigation ratios are based primarily on area and do not account for specific functional losses. For example temporal functional loss is higher for slow

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growing coniferous forests than for more rapid growing deciduous forests and higher for forests than for shrub or emergent plant communities (Hruby 2011).

To give regulators and applicants a functions-based alternative to set mitigation ratios, the Washington State Department of Ecology recently developed a tool called the credit-debit method. This method, like the WDOE wetland rating form, is a peer reviewed rapid assessment tool. The credit-debit approach may be used to calculate functional gain of the proposed mitigation and functional loss due to proposed wetland impacts. This generates acre-points that can be compared in a balance sheet. Depending on specific site conditions, this may result in less or more mitigation than would be required under a set the standard mitigation ratio guidance (Hruby 2011).

Types of Compensatory Mitigation

Following mitigation sequencing, after demonstrating that a proposed wetland impact is unavoidable and has been minimized to the extent practical, compensatory mitigation is required by local, state and federal agencies. In general order of preference the agencies recommend wetland compensation in the form of: 1) restoration (re-establishment or rehabilitation), 2) creation (establishment), 3) enhancement, and 4) preservation (WDOE et al. 2006a).

Wetland restoration occurs when a historic or degraded wetland is returned to a naturally higher functioning system through the alteration of physical or biologic site characteristics. Restoration may involve re-establishment or rehabilitation. Re-establishment is typically achieved by modifying or restoring a hydrologic regime; this may include removing fill or plugging ditches. Rehabilitation is achieved by repairing or restoring historic functions. Restoring a floodplain connection by breaching a dike is an example of rehabilitation. Rehabilitation does not result in new wetland area.

Wetland creation or establishment is the development of a wetland at a site where a wetland did not naturally exist.

> "*Landscape position and proximity to a reliable water source are critical for the successful creation of wetlands. This cannot be over emphasized*" (WDOE et al. 2006a).

Both wetland enhancement and preservation result in a net loss of wetland acreage and are therefore, less preferable. Wetland enhancement typically increases structural diversity within a wetland, thus improving functions. Preservation of high functioning wetland systems in danger of decline may also be proposed as mitigation. While preservation does not increase wetland acreage, it may result in long-term functional gains (WDOE et al. 2006a).

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There are several approaches that can fulfill the compensatory mitigation requirement, including advance mitigation, programmatic mitigation, or consolidated mitigation (WDOE et al. 2006a). Examples of a consolidated mitigation approach would be an in-lieu fee program or mitigation bank. Individual applicants may also partner on a mitigation project.

Mitigation Site Selection

The Agencies (WDOE, Seattle District U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency Region 10) recommend selecting mitigation sites based on proximity to the impact and potential ability to replace impacted functions. In order of preference, a mitigation site should be:

> *"in the immediate drainage basin as the impact, then the next higher level basin, then the other sub-basins in the watershed with similar geology, and finally, the river basin"* (WDOE et al. 2006a).

In the past decade, national and state policies have shifted toward using a broader scale approach for mitigation site selection. A recent forum convened by WDOE and comprised of regulators, businesses, and environmental/land use professionals recommend that local jurisdictions "establish an ecosystem- or watershed-based approach to mitigation" (WDOE 2008). Due to the limited success of on-site mitigation, particularly in highly developed areas, a broader watershed scale approach is increasingly desirable and is viewed by the regulatory agencies as more sustainable (WDOE 2008). To guide practical applications of BAS-based compensatory mitigation, the Agencies issued an Ecology publication, *Selecting Wetland Mitigation Sites Using a Watershed Approach* (Hruby et al. 2009). As noted by Azous and Horner 2001 (in Hruby et al. 2009), recreating or maintaining wetland functions in a highly developed landscape may not be sustainable. To account for this, the watershed approach may require a combination of on- and off-site mitigation to achieve functional gains equivalent to the proposed losses.

As summarized in the Woodinville Shoreline Master Program, restoration opportunities have been identified in several regional plans. Specific restoration projects are recommended for the Sammamish River, Little Bear Creek, and associated wetlands. Identified restoration opportunities generally include replacing stream bank armoring with soft armoring and riparian vegetation, reconnecting floodplains and associated wetlands, enhancing and restoring riparian zones including wetlands, and creating or enhancing cool water refuges for migrating salmon (Woodinville 2009).

5.3 Summary

Wetlands are unique and potentially high functioning ecosystems. Many wetland functions such as water quality, flood control, and wildlife habitat, are

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valued in urban areas. As the literature documents, urbanization stresses and degrades wetland ecosystems. Through local planning and oversight, direct and cumulative impacts to wetlands can be reduced.

The primary wetland protection measure is buffering. The degree to which wetland functions are performed partially depends on the type and quality of buffer immediately surrounding the wetland. Preservation of fixed buffers is the most commonly used method of protecting wetland functional values. Existing science recommends buffer widths that vary widely depending on the specific wetland and functions to be protected, the characteristics of the buffer itself, and the proposed adjacent land use. Buffers perform four major functions in the protection of wetland functions: maintaining hydrology, preserving and improving water quality, providing fish and wildlife habitat, and protecting species from disturbance.

Water quality protection has been studied the most extensively in the context of protecting wetland function and buffer width, and recommended buffers in the literature vary generally from 10 to 200 feet for this function. The specific width at which a buffer is effective in protecting water quality function of wetlands depends on a number of factors, including the type of pollutant or sediment in question and the structure and composition of buffer vegetation.

Hydrologic maintenance, including stormwater and erosion control, is influenced by buffer and wetland vegetation and soil characteristics, rainfall, and soil moisture conditions. However, the literature does not provide a range of effective buffer widths. Of greater importance to a wetland's hydrologic regime is the percentage of development present in the wetland's drainage basin.

Similarly, effective buffer widths for protecting habitat depends upon which species are likely to be present and the life stages in which they use the buffer. Existing literature recommends a range of buffer widths from 50 to 300 feet for protecting most habitat functions.

Protection from disturbances such as noise, light, and physical intrusion may be achieved in a wetland by preserving buffers of 45 to 200 feet in width.

Stormwater management and watershed protection are large-scale, effective means of protecting wetlands.

Mitigation for wetland impacts can be achieved through wetland creation, restoration, and enhancement, and best available science recommends that it be implemented at greater than 1:1 ratios to compensate for the possibility of failure and any time lapse between wetland loss and equivalent functionality of the mitigation site.

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A watershed and functions-based approach to mitigation that is based on BAS is recommended by the Agencies. Long-term sustainability of mitigation sites should be a consideration when designing, reviewing or approving compensatory mitigation.

Wetland Classification

Protection of wetland functions, values, and uniqueness, as recommended by Washington Department of Commerce (WDC, formerly the Washington Department of Community, Trade and Economic Development) for compliance with the GMA, are to a large extent addressed under the WDOE system. Explicitly, WDC recommends use of the WDOE Rating System and urges the consideration of the following:

- Wetland functions and values;
- Wetland sensitivity to disturbance;
- Rarity of a wetland type; and
- The degree to which degradation or destruction of a wetland can be compensated.

An Ecology publication issued in 2010, which provides wetland guidance for CAO updates in small cities (Ecology Publication # 10-06-002, see Appendix B), also recommends the WDOE wetland rating system.

Wetland Buffers

WDOE and WDC suggest requiring wetland buffers based on either habitat scores (Table 5-3 above) and/or the intensity of proposed land use actions (Table 5-2 above). The WDOE-recommended standard buffer widths have been developed based on WDOE's review of the BAS for wetlands throughout the state. It is important to note that WDOE buffer recommendations assume the buffer is densely vegetated with native plants. Buffers not meeting these criteria should be enhanced with native plants or require a buffer width increase.

WDC acknowledges that the WDOE-recommended standard buffer widths may not be appropriate in non-rural and non-forested settings, and thus advised that local governments tailor them to meet specific needs in their jurisdictions. Some cities and counties throughout Western Washington have utilized a variable buffer width approach by assessing buffers based on habitat scores or combination of habitat score and land-use intensity.

Buffer averaging and buffer reduction with enhancement can be applied to the revised wetland buffer widths as incentive for landowners to improve buffer conditions. Both are standard practices in many jurisdictions.

WDOE and WDC guidelines allow for buffer width averaging, but recommend maintaining 75 percent of the standard buffer width at any given point. WDC

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also allows for buffer reduction with enhancement; again recommend requiring the buffer to be no less than 75 percent of the standard with or 35 feet, whichever is greater. To demonstrate how functions and values will be preserved, the Agencies recommend requiring all buffer averaging and reduction proposals to be submitted with a critical areas study that uses best available science. This WDOE guidance also recommended varying buffer widths based on the habitat score and water quality functions.

Wetland Mitigation

WDOE has identified key elements of successful wetland mitigation projects, resulting in the following five recommendations (WDOE 2008):

1) Reinforce importance of wetland impact avoidance and minimization to resources that are highly valuable or difficult to replace;
2) Establish an ecosystem or watershed-based approach to mitigation;
3) Develop and implement a wide variety of compensatory mitigation tools, including wetland banking, advance mitigation, and support development of a regional Puget Sound in-lieu fee program;
4) Develop coordinated, consistent review protocols for development projects and associated mitigation plans;
5) Support making mitigation work through standardized compliance monitoring and sufficient resourcing, adaptive management, and staff training or technical assistance.

Including options that may not be currently available to your citizens, such as in-lieu fee and mitigation banking, will enable the City to regulate use of those tools as needed in the future (WDOE 2010a).

Watershed-based planning is a way for local jurisdictions to manage ecologic resources sustainably. Currently, the Washington State Department of Ecology is working on a Puget Sound Watershed Characterization project. This project seeks to provide a landscape-scale perspective to help planners in our region manage their wetland and wildlife resources in a targeted and effective manner (WDOE 2010b).

Another planning strategy would be to conduct a comprehensive wetland inventory within City limits. Using publically available mapping resources, several significant wetland areas are already included on the City's current critical area map (see Appendix A). However, many wetlands, particularly small wetlands, are on private property and therefore difficult to inventory. Wetlands that are not included in inventory mapping may be inadvertently overlooked. A tool that could be used to improve the City's current map of hydrologic features, including wetlands, is LiDAR (Snohomish County 2008, Maxa and Bolstad 2009).

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6 Fish and Wildlife Habitat Conservation Areas

6.1 Identification and Classification

Per WMC 21.24.410, Fish and Wildlife Habitat Conservation Areas (FWHCAs) are *"…habitat areas that meet any of the following criteria:*

(a) Documented presence of species listed by the Federal Government or the State of Washington as endangered or threatened; or

(b) Heron rookeries or active nesting trees; or

(c) Class 1 wetlands and buffers as defined in WMC 21.24.310; or

(d) Type 1 streams and buffers as defined in WMC 21.24.350; or*

(e) Native growth protection easements/ native growth protection areas (NGPE/NGPA) and other areas designated by the City; or

(f) Sites containing a bald eagle territory as mapped by WDFW. Bald eagle habitat shall be protected pursuant to the Washington State Bald Eagle Protection Rules (Chapter 232-12-292 WAC)."

*Note: Type 1 streams under the current WMC 21.24.370 are equivalent to Type S streams under the Water Typing System (WAC 222-16-030).

Following the WAC 365-190-130, the definition of FWHCAs includes habitats and species of local importance, as determined locally, and naturally occurring ponds under twenty acres and their submerged aquatic beds that provide fish habitat.

The City of Woodinville, the Woodinville-proposed UGA in Snohomish County, and the City-King County Joint Study Area all contain FWHCAs. Known FWHCAs in the City of Woodinville include, the Sammamish River, Little Bear Creek, Lake Leota, and various native growth protection areas / native growth protection easements (NGPA/NGPE). Little Bear Creek in the UGA and the Sammamish River in the City-King County Joint Study Area meet the current definition of an FWHCA. A discussion of existing conditions in each of the above-listed streams, rivers, and lakes, as well as terrestrial habitats and corridors, and the condition of threatened, endangered, and sensitive species within the City, its UGA, and the Joint Study Area is provided in the *Woodinville Comprehensive Plan Update – Existing Conditions Report, Section 1.3* (Appendix A).

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Stream Classification / Water Typing System

Streams are commonly classified based on flow conditions and fish use. Under the current code, streams in Woodinville are classified as Type, 1, 2, 3 or 4 (WMC 21.24.370). The Department of Natural Resources (DNR) is encouraging all jurisdictions within the State to adopt the permanent water typing system upon completion of fish habitat water type mapping. The permanent system provides for four stream classes as listed in Table 1 below.

Table 6-1. Permanent Water Typing System (WAC 222-16-030)

Permanent Water Typing	Description
Type S	All waters, within their bank-full 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.
• Type F	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 four categories: (a) 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; (b) Waters, which are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type F Water upstream from the point of diversion for 1,500 feet, including tributaries if highly significant for protection of downstream water quality. The department may allow additional harvest beyond the requirements of Type F Water designation provided the department determines after a landowner-requested on-site assessment by the department of fish and wildlife, department of ecology, the affected tribes and interested parties that: (i) The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and (ii) Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery; (c) 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

Permanent Water Typing	Description
	camping unit, trail or other park improvement; (d) 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 the following criteria: (i) The site must be connected to a fish habitat stream and accessible during some period of the year; and (ii) The off-channel water must be accessible to fish.
• Type Np	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	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.

6.2 Functions and Potential Effects of Development

6.2.1 Streams & Riparian Areas

Riparian areas interact with fluvial and landscape processes, which act in concert to support a wide diversity of aquatic and terrestrial plant and wildlife species. Under natural conditions, a dynamic equilibrium within riparian areas provides for continual environmental change, such as channel migration, but supports the stability of species which rely on those changes for survival. The various components and interactions that support fish and wildlife are described below.

Natural Processes and Disturbance Events

Natural disturbances (e.g. floods, fire, landslides, channel migration) lead to spatial heterogeneity and temporal variability, which lead to numerous habitat niches and ecological diversity (Naiman et al. 1993; Gregory et al. 1991). Unmodified riparian corridors are characterized by high dynamism and disturbance events, which, in low-order[1] streams, consist primarily of landslides

[1]Stream order refers to a classification system that groups streams based upon their relative size. By convention, first-order streams have no tributaries, as viewed on a map, typically a USGS 7 ½-minute topographic map; second-order streams result from the confluence of two first-order streams; third-order streams are produced when two second-order streams meet; and so on. Recognition that many intermittent and small perennial streams are not represented on USGS 7 ½-minute topographic maps has led some to

and debris flows. Higher-order streams are typically characterized by floods and channel migration (Naiman et al. 1993). The survival of many plant and animal species is dependent upon such dramatic changes to the environmental landscape.

Stream channel migration is a key environmental disturbance necessary for the sustainability and richness of species along the riparian corridors. Erosion processes that occur during flood events and subsequent changes in channel direction lead to improvements in large woody debris (LWD) recruitment, gravel and sediment transport, and nutrient supply. These processes can also form off-channel habitat such as oxbows and side channels or even smaller incremental changes such as lateral bank scour and pool/riffle formations (King County 2005). Off-channel and floodplain habitats are particularly significant for salmonid over-winter survival and growth (e.g., Solazzi *et al.* 2000; Sommer *et al.* 2005; Tschapalinski and Hartman 1983). Together, these structural changes can result in increased habitat quality and complexity for salmon spawning and rearing, as well as for other aquatic species.

Within the City of Woodinville, substantial ecosystem alterations have resulted from the lowering of Lake Washington through the construction of the Hiram-Chittenden Locks in 1916, the dredging and channelization of the Sammamish River in the early 1960's, and the construction of drainage ditches in the river valley (Woodinville 2009). The Sammamish River is now confined in an entrenched channel, and many of the mouths of the small tributaries have become inaccessible to fish (Kerwin 2001). Woody debris was also removed from the channel along with essentially all of the natural vegetation from the riverbanks.

Land use can also have a significant affect the frequency and intensity of disturbance events (Nakamura et al. 2000), either by making such events more common (e.g., by increasing the frequency and intensity of high flow events) or less common (e.g., limiting channel changes by stabilizing streambanks). Urban land cover is correlated with increased high flows, increased variability in daily streamflow, reduced groundwater recharge, and reduced summer low flow conditions (Burges et al. 1998, Jones 2000, Konrad and Booth 2005, Cuo et al. 2009). Changes in hydrology related to development are generally associated with soil compaction, draining, and ditching across the landscape, increased impervious surface cover, and decreased forest cover (Booth and Jackson 1997,

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use the term "zero-order" for such streams. Reliable classification of stream order requires field verification.

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Moore and Wondzell 2005). Together, these changes reduce infiltration, evapotranspiration, and groundwater storage, and they increase surface flows.

The altered hydrology that is associated with development alters the geomorphic condition of streams, as well as sediment and pollutant transport (Arnold and Gibbons 1996, Booth and Jackson 1997, Booth and Henshaw 2001). Konrad et al. (2005) suggest that streams in urbanized watersheds may lack the longer duration high flows necessary to maintain stable channel conditions because development tends to result in shorter duration and more frequent high flow conditions. Changes in a stream's hydrograph associated with increased impervious surface coverage and decreased forest cover have been linked to decreased bank stability and increased erosion (May et al. 1997, Booth et al. 2002). In King County, Washington, stream instability was noted in watersheds with both rural (approximately 4 percent impervious surface coverage) and urban (over 10 percent impervious surface coverage) development densities, and the extent of instability was dependent on the percentage of forest cover retained (Booth et al. 2002). Based on the findings of Booth et al. (2002), in rural areas where less than 60 percent of forest cover is retained, unstable channels may occur, and if forest retention is less than 40 percent, unstable channels are expected to occur (Booth et al., Figure 6.1). While Woodinville is not rural, it does contain agricultural areas which retain a rural character. In the 15-year period between 1991 and 2006, forest cover within Urban Growth Areas (UGAs) in the little Bear Creek watershed —including the City of Woodinville – decreased by 350 acres, or 40 percent of the total forest cover (Vanderhoof 2011). Furthermore, Booth and Henshaw (2001) found that under highly susceptible conditions, post-development channel changes occur so rapidly that remediation efforts could only be successful if implemented prior to development. In urban environments, successful stream rehabilitation requires a clear understanding of the causes of degradation, integrative management to address those causes, and remedies at both the local (backyards) and regional (stormwater system) levels (Booth et al. 2004).

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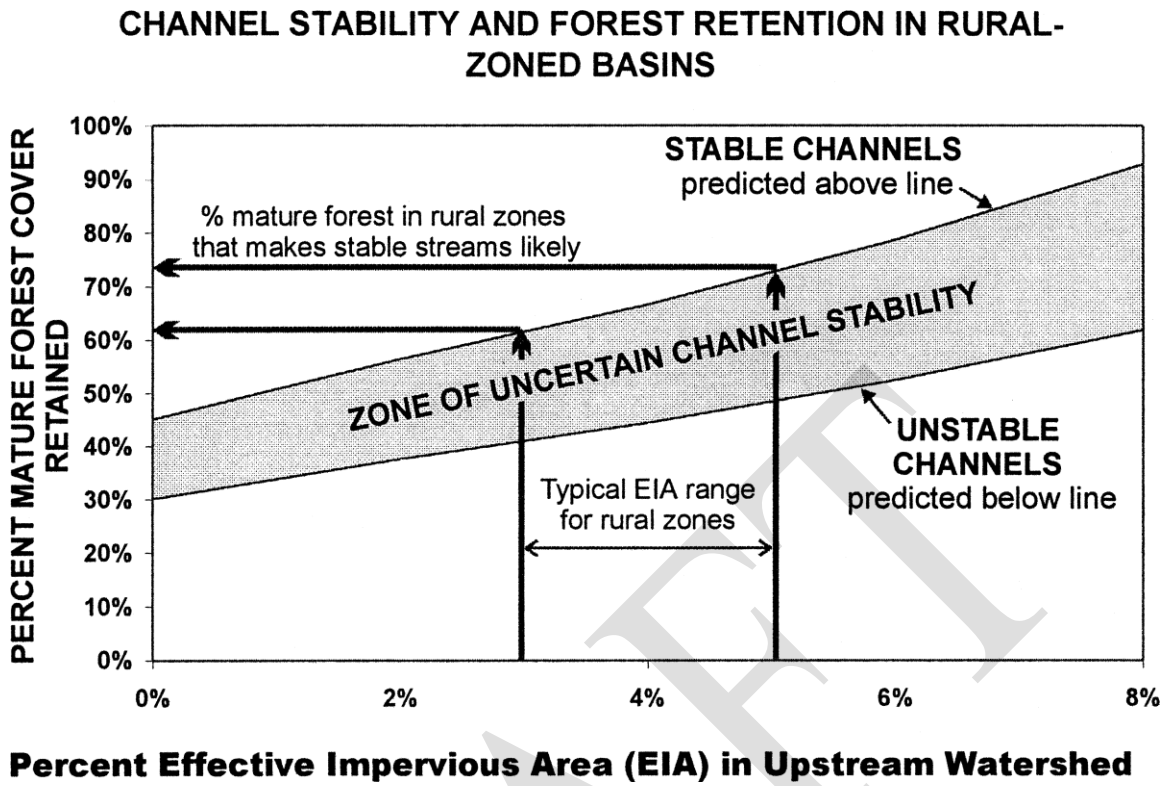

Figure 6-1. Generalized diagram showing the relationship between impervious surface area, forest cover, and channel stability in rural basins (from Booth et al. 2002).

Increased erosion and bank instability associated with development and reduction of forest cover often simplifies stream morphology, leading to incised, wider, straighter stream channels (Arnold and Gibbons 1996, Booth and Jackson 1997, Booth 1998, Konrad et al 2005). In turn, simplified stream channels accelerate water transport and reduce temporary instream flood storage capacity (Kaufmann and Faustini 2012), thereby exacerbating flooding downstream and reducing infiltration potential.

Changes in fish assemblages have been correlated with changes in stream temperature and base flow as a result of increased impervious surface coverage (Wang et al. 2003). Increases in flood frequency and volume have been correlated to declining salmon populations in some Puget Sound lowland streams (Moscrip and Montgomery 1997). While, impervious surface area alone is not the only component to predicting stream biological conditions (Booth et al. 2004), riparian quality has been shown to be inversely proportional to the level of urbanization (May et al. 1997b).

In general, development is known to have detrimental effects on salmonids, particularly with spawning abundance and success. Pess et al. (2002) found that wetland occurrence, local geology, stream gradient, and land use were significantly correlated with adult coho salmon abundance. While positive

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correlations were found between spawner abundance and forested areas, negative correlations were found between spawner abundance and areas converted to agriculture or urban development. Fish species diversity has been found to decline with increasing levels of urban development, while cutthroat trout (*O. clarki*) tend to become the dominant salmonid species (Lucchetti and Fuerstenberg 1993; Ludwa et al. 1997).

Water Quality

Water quality is characterized by several physical and biological factors, including suspended sediment, nutrients, metals, pathogens, and other pollutants. Water quality characteristics are controlled by upslope, as well as riparian conditions. This section discusses how water quality is maintained under natural conditions. Water temperature is also a component of water quality, which will be addressed separately.

When development results in reduced infiltration and increased surface flows, sediment and contaminants are transported more directly to receiving bodies without interfacing with natural soil filtration processes. Because of this, urban areas tend to contribute a disproportionate amount of sediment and contaminants to receiving waters relative to the percentage of urbanized area within the watershed (Sorrano et al. 1996). Heavy metals, bacterial pathogens, as well as PCBs, hydrocarbons and endocrine-disrupting chemicals are aquatic contaminants that are commonly associated with urban and agricultural land uses.

The full suite of sublethal and indirect effects of these contaminants and combinations of contaminants on aquatic organisms is not fully understood (Fleeger et al. 2003). Some contaminants with potentially severe repercussions for fish and wildlife have yet to be identified. For example, recent research in the Puget Sound region has identified mature coho salmon that return to creeks and die prior to spawning, a condition called pre-spawn mortality (Feist et al. 2011, Sholz et al. 2011). The specific cause of the condition has not yet been identified; however, the condition is linked to urbanized watersheds and is positively correlated with the relative proportion of roads, impervious surfaces, and commercial land cover within a basin (Feist et al. 2011). A model of the effects of pre-spawn mortality on coho salmon populations indicates that, depending on future rates of urbanization, localized extinction of coho salmon populations could occur within a matter of years to decades (Spromberg and Scholz 2001). This finding emphasizes the significance of efforts to address both point-source and non-point-sources of contaminants in the landscape.

Sediment

Sediment input to streams is supplied by bank erosion, landslides, and upland erosion processes. Other contaminants, including heavy metals and phosphorus,

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readily bind to suspended clay particles, and these contaminants are often transported with fine sediment in stormwater. Excess inputs of fine sediments into a stream channel reduce habitat quality for fish, amphibians, and macroinvertebrates. Fine sediment adversely affects stream habitat by filling pools, embedding gravels, reducing gravel permeability and increasing turbidity. In salmon-bearing streams, fine sediment fills interstitial spaces in redds, reducing the flow of oxygenated water to developing embryos and reducing egg-to-fry survival (Jensen et al. 2009). Higher levels of fine sediment are also correlated with lower salmonid growth rates (Suttle et al. 2004). Highly turbid water can impair fertilization success in spawning salmonids (Galbraith et al. 2006) and interfere with the respiration and reproduction amphibians (Knutson et al. 2004).

Vegetated riparian zones help stabilize stream banks and slow and filter overland flow, and temporarily store sediment that is gradually released to a stream. Sediment filtration is also high within intermittent and ephemeral streams, presumably because of the high interface with vegetative structures and the flux in water surface elevation, which allows for sediment storage along the streambanks (Dietrich and Anderson 1998).

Upland clearing and grading can result in long-term increases in fine sediment inputs to streams (Gomi et al. 2005, Jackson et al. 2007). Numerous studies have investigated the effectiveness of varying widths of buffers at filtering sediment. These studies have typically found high sediment filtration rates in relatively narrow buffer areas (Sheridan et al. 1999, reviewed in Wenger 1999, reviewed in Parkyn 2004, reviewed in Yuan et al. 2009). For example, a field plot experimental study of vegetated filter strip effectiveness found sediment retention of 68 percent in a 2-meter-wide filter strip, and 98 percent in a 15-meter-wide filter strip (Abu-Zreigh et al. 2004). The same study did not find a significant improvement in sediment retention beyond 15 meters.

It is significant to note, however, that field plot experiments tend to have much shorter field lengths (hillslope length contributing to drainage) than would be encountered in real-world scenarios (*i.e.*, ~5:1 ratio of field length to riparian width for a field plot compared to 70:1 ratio in NRCS guidelines). Since water velocities tend to increase with field length, field plot experiments may suggest better filtration than would be encountered under real-world conditions. Additionally, field-scale experiments generally do not account for flow convergence, which reduces sediment retention (Helmers et al. 2005) or for stormwater components that bypass filter strips through ditches, stormwater infrastructure, and roads (Verstraeten et al. 2006). Therefore, the effectiveness of filter strips at filtering sediment under real-world conditions and at the catchment scale is likely to be lower than what is reported in field plot experiments.

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Additionally, many studies on sediment retention in riparian zones consider sediment retention from one storm event, rather than accounting for sediment accumulation over time. Two studies used Cesium-137 to track the location of sediment deposition over many years. One of these studies considered the distance that sediment traveled across a riparian forest adjacent to cropland with sandy loam soils and a mean hillslope of 2-5% (Lowrance et al. 1988 in Wenger 1999). The greatest amount of sediment was deposited 30 m (98 ft) into the forest and the strongest signal of Cs-137, which has a high affinity for fine clay particles, was found 80 m (262 ft) into the forest). Therefore, fine sediments can become transported through riparian areas for long distances. The other study found that over 50% of sediment was transported over 100 m (328 ft) into the riparian zone, over hillslopes ranging from 0 % to 20% (Cooper et al. 1988 in Wenger 1999). Together these studies suggest that riparian zones from 30-100 m (98-328 ft) or more may be necessary to provide long-term sediment retention, and that studies of short-term sediment retention underestimate the riparian zone width needed for ongoing sediment filtration.

In addition to width, the slope, vegetation density, and sediment composition of a riparian area have significant bearing on sediment filtration potential (Jin and Romkens 2001). A recent model of sediment retention in riparian zones found that a grass riparian zone as small as 4 m (13 ft) could trap up to 100% of sediment under specific conditions (2% hillslope over fine sandy loam soil), whereas a 30 m (98 ft) grass riparian zone would retain less than 30% of sediment over silty clay loam soil on a 10% hillslope (Dosskey et al. 2008) (Figure 6-2). This study exemplifies the effects that soil type and hillslope have on sediment retention.

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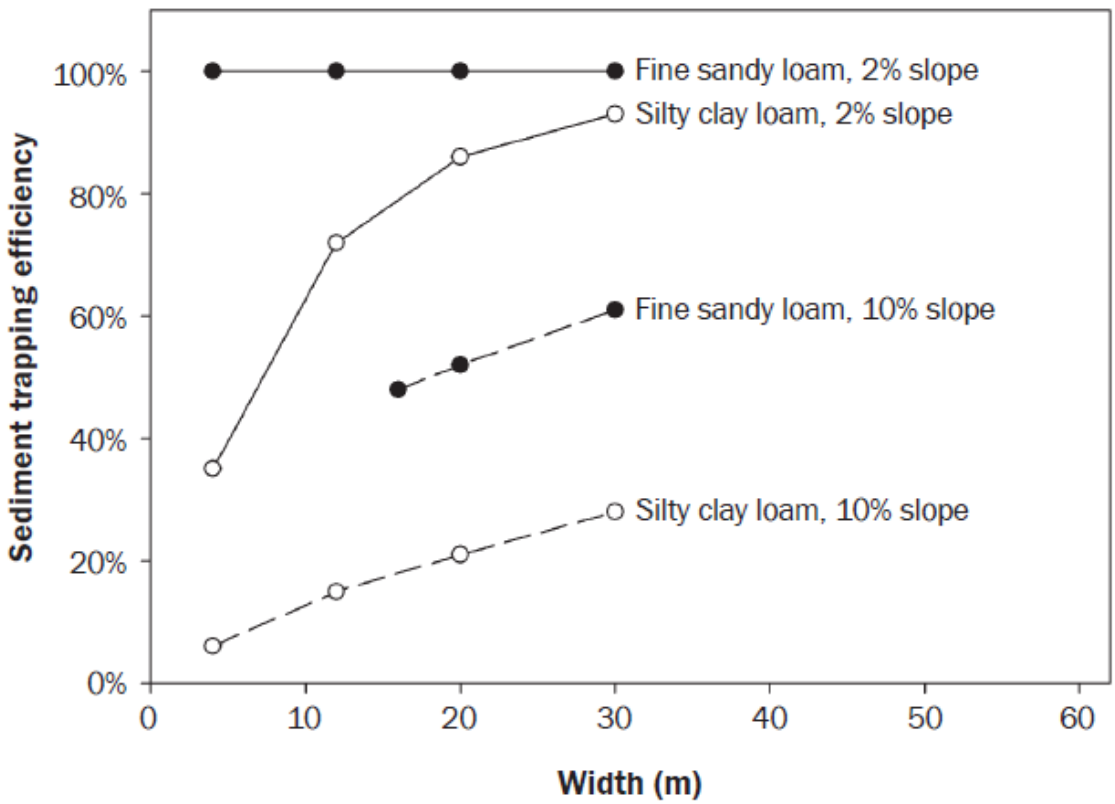

Figure 6-2. Sediment trapping efficiency related to soil type, slope, and buffer width. (Figure from Dosskey et al. 2008).

Multiple studies have found that larger particles tend to settle out within the first 3-6 m (10-20 ft) of the riparian zone, but finer particles that tend to degrade instream habitat, such as silt and clay, need a larger riparian zone, ranging from 15-120 m (49-394 ft), for significant retention (reviewed in Parkyn 2004). Lee et al. (2003) found higher sediment retention rates (92% and 97% respectively) in a 7 m (23 ft) grass riparian zone and a 16 m (52 ft) grass/forested riparian zone (5% slope, fine clay loam soil) than would be predicted by the Dosskey et al. study. However, the concentration of fine particles was greater leaving the riparian zone than entering it, indicating that larger particles settled out, while fine particles passed through the riparian zone (Lee et al. 2003).

Vegetative composition within the buffer also affects sediment retention. Vegetation tends to become more effective at sediment and nutrient filtration several years after establishment (Dosskey et al. 2007). Dosskey et al. (2007) did not find a significant difference between the filtration effectiveness of established grass and forested buffers. However, a meta-analysis of 81 buffer studies indicated that all-grass and all-forest buffers tend to more effectively filter sediment compared to buffers with a mix of grass and forested vegetation (Zhang et al. 2010). Additionally, whereas thin-stemmed grasses may become overwhelmed by overland flow, dense, rigid-stemmed vegetation provides

improved sediment filtration that is expected to continue to function better over successive storm events (Blanco-Canqui et al. 2004, Yuan et al. 2009).

Nutrients

In excess concentrations, nitrogen and phosphorus can lead to poor water quality conditions, including reduced dissolved oxygen rates, increased pH, and eutrophication (Mayer et al. 2005, Mayer et al. 2007)). Excessive amounts of nitrogen and phosphorus speed up eutrophication and algal blooms in receiving waters, which can deplete the dissolved oxygen in the water and result in poor water quality and fish kills (Mayer et al. 2005, Dethier 2006, Heisler et al. 2008).

Riparian zones can reduce nitrogen pollution through nutrient uptake, assimilation by vegetation, and through denitrification (Sobota et al. 2012). The rate of nitrogen removal from runoff varies considerably depending on local conditions, including soil composition, surface versus subsurface flow, riparian zone width, riparian composition, and climate factors (Mayer et al. 2005, Bernal et al. 2007, Mayer et al. 2007). Nutrient assimilation is also dependent on the location of vegetation relative to the nitrogen source, the flowpath of surface runoff, and position in the landscape (Baker et al. 2006).

Nutrients enter waterways through channelized runoff, groundwater flow, and overland flow. Nitrogen loading is often associated with agricultural activities, whereas low density residential development has been found to result in nitrate levels comparable to a forested basin (Poor and McDonnell 2007). Water quality monitoring indicates that the lowest reach of Woodin Creek does not regularly meet state surface water quality standards for nitrates (Adolfson and Associates 2004); however, neither the Sammamish River nor Little Bear Creek are identified as impaired based on nutrient loads by the State's Water Quality Assessment (WDOE, electronic reference).

As a result of this variability, a meta-analysis of studies of nutrient removal in riparian buffers ranging from 1-200 m (3-656 ft) concluded that buffers wider than 50 m (164 ft) remove nitrogen more effectively than buffers less than 25 m (82 ft) wide; however, within the categories of 0-25 m (0-82 ft), 25-50 m (82-164 ft), and >50 m (164 ft), factors other than buffer width determine nitrogen removal effectiveness (Mayer et al. 2007). Riparian zones less than 15 m (49 ft) actually contributed to nitrogen loading in some cases (Mayer et al. 2007). Another meta-analysis of nutrient removal studied buffers up to 22 m (72 ft) wide, and found that these buffers effectively removed 92 and 89.5 percent of nitrogen and phosphorus, respectively (Zhang et al. 2010).

Mayer et al. (2005, 2007) found that riparian zones ranging from 1-200 m (3-656 ft) generally removed 89% of *subsurface* nitrates regardless of riparian zone width. On the other hand, nitrate retention from *surface* runoff was related to

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riparian zone width, where 50%, 75%, and 90% surface nitrate retention was achieved at widths of 27 m (88 ft), 81 m (266 ft), and 131 m (430 ft) respectively (Mayer et al. 2007). This suggests that surface water infiltration in the riparian zone should be a priority to promote effective nutrient filtration. Where soils are poorly drained and infiltration capacity is limited, the effectiveness of nutrient removal in riparian buffers may also be limited (Wigington et al 2003).

The composition of the riparian zone also affects the efficiency of nutrient removal. Reviews of buffer effectiveness have found that forested riparian zones remove nitrogen and phosphorus more efficiently than grass/forested riparian zones (Zhang et al. 2010). And Mayer et al. (2007) found that herbaceous buffers had the lowest effectiveness compared to forested wetland, forested, and forested/herbaceous buffers. Other studies have found conflicting results, indicating that grass buffers remove nitrogen and phosphorus as well or better than forested buffers (reviewed in Polykov 2005). Where nitrogen-fixing species predominate, such as red alder, these buffers tend to have higher soil nitrate concentrations (Monohan 2004). These findings indicate that the nitrogen removal efficiency of buffers can vary depending on the size and species composition of the buffer.

Removal of phosphorus by riparian buffers is dependent on the form of phosphorus entering the buffer. Whereas phosphorus that is adsorbed by soil particles is effectively removed through sediment retention within a buffer, the retention of soluble phosphorus relies on infiltration and uptake by plants (Polyakov et al. 2005). One long-term study found that phosphorus uptake was directly proportional to the plant biomass production and root area over the four-year study period (Kelly et al. 2007). If a riparian buffer becomes saturated with phosphorus, its capacity for soluble phosphorus removal will be more limited (Polyakov et al. 2005). Another long-term study found that following a 15-year establishment period, a 40-meter (131 ft) wide, three-zoned buffer reduced particulate phosphorus by 22 percent, but dissolved phosphorus exiting the buffer was 26 percent higher than the water entering the buffer, so the buffer resulted in no net effect on phosphorus (Newbold et al. 2010).

In summary, most riparian zones reduce subsurface nutrient loading, but extensive distances are needed to reduce nutrients in surface runoff. Filtration capacity decreases with increasing loads (Mayer et al. 2005), so best management practices across the landscape that reduce nutrient loading will improve riparian function.

Metals

Although all metals can be toxic at high concentrations, cadmium, mercury, copper, zinc, and lead are particularly toxic even at low concentrations. Chronic and acute exposure to heavy metals have been found to impair, injure, and kill to

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aquatic plants, invertebrates, fish, and particularly salmonids (Grant and Ross 2002, ESV Environment Consultants 2003, Dethier 2006, Hecht et al. 2007, McIntyre et al. 2008, McIntyre et al. 2012). A review of contaminant effects on aquatic organisms summarized the factors affecting the toxicity of metals as follows:

- Duration and concentration of exposure
- The form of the metal at the time of exposure
- Synergistic, additive or antagonistic interactions of co-occurring contaminants
- Species sensitivity
- Life stage
- Physiological ability to detoxify and/or excrete the metal and,
- The condition of the exposed organism (ESV Environment Consultants 2003).

Metals are typically transported to the aquatic environment through fossil fuel combustion, industrial emissions, municipal wastewater discharge, and surface runoff (ESV Environment Consultants 2003). In general, heavy metals and hydrocarbons are found in road runoff, and these contaminants can reach the City's streams directly through existing stormwater systems. Stormwater systems that circumvent buffers limit the opportunity to filter runoff through adjoining soils and vegetation. Accordingly, stream buffers are typically underutilized for treatment of hydrocarbons and other pollutants found in typical stormwater runoff.

Pathogens

Waterborne pathogens associated with human and animal wastes are a concern for direct and indirect human exposure. Although pathogens include a suite of bacteria and viruses, fecal coliform bacteria is typically used as an indicator of the presence of these pathogens. Fecal pollution tends to be positively correlated with human population densities and impervious surface coverage (Glasoe and Christy 2004). The main sources of fecal pollutants include municipal sewage systems, on-site sewage systems, stormwater runoff, marinas and boaters, farm animals, pets, and wildlife (Glasoe and Christy 2004). As municipal wastewater systems have improved treatment quality and capacity in recent years, increasingly, non-point source (septic systems, stormwater, and pets) pollution is responsible for fecal contaminants in surface water (Glasoe and Christy 2004). Within the City, the lower reaches of the Sammamish River are on the state's 303(d) list of impaired waters for fecal coliform (WDOE, electronic source), and a Total Maximum Daily Load (TMDL) has been established to address elevated levels of fecal coliform bacteria in Little Bear Creek (Dettelbach and Garland 2005). Ongoing monitoring is required as part of the TMDL. Additionally, water

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quality monitoring indicates that the lowest reach of Woodin Creek does not regularly meet state surface water quality standards for fecal coliform standards (Adolfson and Associates 2004).

Herbicides and Pesticides

Commonly used herbicides and pesticides may also affect aquatic communities, and the acute and chronic effects of these chemicals or combinations of chemicals are not always well understood. Additionally, effects documented in the laboratory may differ significantly from effects identified in a field setting (Relyea 2005, Thompson et al. 2004). Despite our limited understanding, the effects of these chemicals may be long-lasting, as has been observed for legacy pesticides such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) in salmon, seabirds, and marine mammals in the Puget Sound (Calambokidis et al. 1984, O'Neill et al. 1998, Ross et al. 2000, Wahl and Tweit 2000, Grant and Ross 2002, West et al. 2008).

Herbicides and pesticides may reach aquatic systems through a number of pathways, including surface runoff, erosion, subsurface drains, groundwater leaching, and spray drift. Narrow hedgerows have been found to limit 82-97 percent of the aerial drift of pesticides adjacent to a stream (Lazzaro et al. 2008). In runoff, herbicide retention in a buffer is dependent on the percentage of runoff that infiltrates the soil (Misra et al. 1996). A study of herbicides in simulated runoff found that 6-meter-wide vegetated buffers were sufficient to reduce herbicide concentration exiting the buffer to zero (Otto et al. 2008). A meta-analysis found that filtration effectiveness increased logarithmically from 0.5 m to an asymptote at approximately 18 m (Zhang et al. 2010). In summary, relatively narrow vegetated buffers may be effective in limiting herbicides and pesticides from reaching aquatic habitats in surface runoff, erosion, and spray drift; however, transport via subsurface drainage and leaching are not affected by riparian buffers, and these processes are best managed through the use of best management practices in herbicide and pesticide applications to avoid contaminating groundwater (Reichenberger et al. 2007).

Pharmaceuticals

Pharmaceuticals are another class of contaminants, the effects of which remain poorly understood. Many commonly used pharmaceuticals are found in wastewater, particularly around more urban areas (Long et al. 2013). Many common pharmaceuticals have endocrine-disrupting properties, which can affect fertility and development in non-target aquatic species (Caliman and Gavrilescu 2009). The existing and potential population-scale effects of these chemicals in the environment are not yet well-understood (Mills and Chichester 2005, Caliman and Gavrilescu 2009).

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Water Temperature and Microclimate

Stream temperatures and riparian microclimate conditions are closely tied to each other. Factors influencing water temperature and microclimate include shade, orientation, relative humidity, ambient air temperature, wind, channel dimensions, groundwater, and overhead cover.

Salmon and native freshwater fish require cool waters (55-68°F) for migrating, rearing, spawning, incubation, and emergence (USEPA 2003). Thermal tolerances differ by species; coho salmon prefer the coolest temperatures, whereas steelhead can tolerate higher temperatures. A literature review of temperature effects on juvenile salmonid growth found that optimal growth occurred in field studies when daily maximum temperatures were 61-73°F for steelhead, 61°F for Chinook salmon, and 59°F for coho salmon (WDOE 2002). Riparian microclimate affects many ecological processes and functions, including plant growth, decomposition, nutrient cycling, succession, productivity, migration and dispersal of flying insects, soil microbe activity, and fish and amphibian habitat (Brosofske et al. 1997). Amphibians have narrow thermal tolerances, and they are particularly influenced by changes in microclimate conditions (Bury 2008).

Several studies have documented significant increases in maximum stream temperatures associated with the removal of riparian vegetation (Beschta et al. 1987; Murray et al. 2000, Moore et al. 2005, Gomi et al. 2006). Within the City of Woodinville, the Sammamish River exceeds salmonid temperature thresholds (King County 2005).

A number of studies have considered the extent to which different riparian zone widths modulate stream temperature. In headwater streams in British Columbia, 10 m (33 ft) riparian zones generally minimized effects to stream temperature from timber harvest, although maximum daily temperatures reached 3.6°F higher than control streams (Gomi et al. 2006). A comparative study of 40 small streams in the Olympic Peninsula found that mean daily maximum temperatures were 2.4°C higher in logged compared to unlogged watersheds, and that logged watersheds had greater diurnal fluctuations in water temperatures (Pollock et al. 2009). Another study of streams in Washington found that stream temperatures were most closely correlated with vegetation parameters associated with the riparian area, such as total leaf area and tree height, and that the effect of buffer width was less significant, particularly for buffers larger than 30 m (98 ft) (Sridhar et al. 2004). These findings are consistent with an earlier study relating angular canopy density, a proxy for shading, to riparian buffer width; which found that the correlation between shade and riparian buffer width increases approximately logarithmically, reaching an asymptote around 30 m (98 ft) (Bestcha et al. 1987). Therefore, for buffers less than 30 m (98 ft), buffer width is expected to be more

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closely related to shading and stream temperatures than buffers over 30 m (98 ft). A study in British Columbia found significant cooling of up to of 4°C in reaches downstream from logged areas even in relatively short lengths of shaded stream channel (200 m of 656 ft long); however, significant cooling was largely attributed to the cooling effect of groundwater in the shaded reaches (Story et al. 2003).

In addition to the effect of riparian areas, watershed-scale land uses can affect stream temperatures. For example, a study in British Columbia found that, after accounting for the effects of watershed size, air temperature, and elevation, the density of roads in a watershed was positively correlated with the summer maximum weekly average water temperature (Nelitz et al. 2007). In areas where headwater wetlands naturally moderate stream temperatures, these wetlands also tend to mitigate the effect of forest clearing on downstream temperatures (Rayne et al. 2008).

Riparian buffers necessary to maintain microclimate are controlled by edge effects, which tend to extend well within a forested area. One study in western Washington detected microclimate edge effects along the entire length of a 240 m (787 ft) buffer (Chen et al. 1995). Heithecker and Halperin (2007) found that most changes in light occurred within 20 m (66 ft) of the forest edge, and that air and soil temperatures stabilized within a range from 10-30 m (33-66 ft); but that throughout 1-hectare forested plots, air temperatures remained elevated compared to larger control plots. Another study in Western Washington found that buffers ranging from 16-72 m (52-236 ft) did little to limit elevated air temperatures associated with an adjacent clearcut in mid-summer (Dong et al. 1998). In contrast to these studies, a study of small streams in Western Washington indicated that buffers greater than 45 m (147 ft) wide are generally sufficient to protect riparian microclimate at streams (Brosofske et al. 1997). In summary, edge effects on forest microclimate extend well into forested areas adjacent to clearings and traditional riparian buffers are not expected to attain pre-disturbance microclimate conditions unless they are several hundred meters wide, but buffers ranging from 10-45 meters in width may minimize microclimate effects related to light, soil, and air temperatures.

Two studies in the Pacific Northwest considering the effects of partial forest retention on microclimate found that retention of 15 percent of a forest basal area was not sufficient to maintain microclimate conditions (Heithecker and Halperin 2006, Aubry et al. 2009); however, 40 percent basal area retention resulted in cooler mean air temperatures than clearcut conditions and light conditions similar to an undisturbed forest (Heithecker and Halperin 2006).

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Bank Stabilization

Riparian vegetation helps provide bank stabilization through a complex of tree roots, brush, and soil/rock. A study in British Columbia concluded that major bank erosion is 30 times more likely on stream bends with bare banks compared to vegetated banks, and that densely vegetated banks are the most effective at resisting erosion (Beeson and Doyle 1995). Woody vegetation tends to provide greater bank stability than herbaceous vegetation because woody vegetation has larger roots that extend deeper into the streambank (Wynn and Mostaghimi 2006).

Bank stabilization functions are potentially subject to degradation in an urbanized watershed. Culp and Davies (1983) observed that a 10 m (33 ft) riparian zone maintained bank stability in a 3rd order stream in British Columbia one year after logging. Another study suggested that larger riparian zones (>15 m or 49 ft) were needed to adequately limit stream bank erosion (Whipple *et al*. 1981). In a study in northern California, Erman *et al.* (1977) found that stream channel stability (based on both bank and instream metrics), was reduced in clear-cut streams and streams with riparian zones less than 30 m (98 ft), whereas riparian zones over 30 m (98 ft) maintained stream channel stability similar to unlogged streams. As with sediment reduction, the streambank stabilization functions of vegetation increase with buffer width out to approximately 80 to 100 feet; after this point, disproportionately large increases are needed to improve riparian function (Castelle and Johnson 1998).

Headwater Systems

Headwater streams and wetlands may be considered as hydrologic source areas, where runoff converges and groundwater rises to form surface water drainageways (Qiu 2003, 2009). These source areas are particularly significant in controlling downstream hydrology, sediment transport, and ecological functions. Headwater streams typically represent the most stream miles in the watershed and they have more channel edge compared to larger streams (FEMAT 1993, Knutson and Naef 1997).

Because of the smaller size of the stream channel, riparian buffers may exert a greater influence on small, low order streams compared to higher order streams. Riparian zones along small, low order streams have also been found to be more effective at reducing downstream temperatures compared to riparian buffers along larger channels (Elliot 2003, Cristea and Janisch 2007). Riparian areas associated with headwater streams produce significant quantities of litterfall (Gomi et al. 2002) and invertebrates (Wipfli 2005; Wipfli and Gregovich 2002, Wipfli et al. 2007) that are transported downstream to fish-bearing waters. In many cases, small, intermittently flowing channels are productive rearing areas for juvenile salmonids (e.g., Wigington et al. 2006, Colvin et al. 2009). Riparian areas associated with intermittent and headwater streams also provide sheltered

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humid environments for amphibian dispersal (Sheridan and Olson 2003, Olson et al. 2007, Welsch & Hodgson 2008), and amphibian densities are higher in those headwater streams with riparian buffers (Stoddard and Hayes 2005).

Headwater streams play an important role in denitrification as a result of the high surface area to volume ratio of sediment and biofilms to streamflow (Peterson et al. 2001). In fact, headwaters are responsible for over 40 percent of the nitrogen flux in fourth order and larger streams (Alexander et al. 2007).

Disturbance of headwater source areas may have disproportionate effects on water flow processes throughout a watershed. Hydrologic changes from development are expected to be most significant in small- to intermediate-sized streams with naturally low seasonal and storm flow variability (Konrad and Booth 2005).

Protection of headwater streams and wetlands may be one of the most effective means of protecting hydrologic processes, as well as water quality conditions. Because of the smaller size of the stream channel, riparian buffers may exert a greater influence on small, low-order streams compared to higher order streams (Vannote et al. 1980, Gregory et al. 1991, Bilby and Bisson 1998). Riparian zones along small, low order streams have also been found to be more effective at reducing downstream temperatures compared to riparian buffers along larger channels (Brazier and Brown 1973, Cristea and Janisch 2007). Riparian areas associated with low-order streams produce significant quantities of litterfall (Gomi et al. 2002) and invertebrates (Wipfli and Gregovich 2002, Wipfli 2005, Wipfli et al. 2007) that are transported downstream to fish-bearing waters. Forested riparian areas associated with intermittent and headwater streams also provide sheltered humid environments for amphibian dispersal (Sheridan and Olson 2003, Olson et al. 2007, Welsch & Hodgson 2008), and amphibian densities are higher in those headwater streams with riparian buffers (Stoddard and Hayes 2005).

Qiu et al. (2003, 2009) and Tomer et al. (2009) modeled the effects of protecting these hydrologic source areas related to water quality. Because increased surface water flows are responsible for the increased transport of pollutants, they found that buffers were most effective in maintaining water quality conditions in watersheds where these hydrologic source areas were protected in riparian buffers. The significance of headwater systems is evidenced by the importance of hyporheic flows out of Lake Leota, which provide a source for the cool groundwater that feeds Cold Creek, maintaining summer water temperatures 5-7 degrees Celsius colder than Cottage and Bear Creeks (Kerwin 2001).

Longitudinal continuity of buffers along streams is also an important factor determining the effectiveness of buffers at improving channel conditions.

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Riparian continuity is correlated with abundance and diversity of sensitive invertebrates (Wooster and DeBano 2006) and metrics of physical stream conditions (McBride and Booth 2005). On the other hand, fragmented riparian zones may not be sufficient to improve degraded instream habitat conditions. A study of fragmented riparian zones in New Zealand found that 12- and 17- acre forested plots that stretched 250-350 m along the downstream ends of 3rd order streams did not improve riffle depth, substrate size, stream temperatures, or sensitive invertebrate communities degraded by upstream agriculture lacking riparian zones (Harding et al. 2006). Harding et al. (2006) suggested that greater riparian continuity was needed to see notable improvement in instream conditions. Similarly, a watershed-scale study in Southwest Washington found that stream conditions were best maintained with continuous buffers, compared to patch buffers or no buffers (Bisson et al. 2013)

Invertebrates and Detritus

Terrestrial and aquatic invertebrates serve an important role at the base of aquatic food webs. In streams in Southeast Alaska, aquatic and terrestrial invertebrates are consumed by coho salmon in approximately equal proportions (Allan et al. 2003).

Aquatic invertebrates are sensitive to water quality, flows, and habitat structure, and they are often considered as indicators of stream habitat conditions (Karr 1998, Utz et al. 2009). Hydrologic changes associated with basin and subbasin development have been correlated to degraded indices of invertebrate community integrity (Booth et al. 2004, Alberti et al. 2007, DeGasperi et al. 2009). DeGasperi et al. (2009) proposed that the frequency and range of flood pulses may best explain the correlation between the hydrologic effects of urbanization and the observed degradation of invertebrate communities. Utz et al. (2009) reported that sensitive aquatic invertebrates were not present when impervious cover was in the range of 3 to 23 percent, and the sensitivity of invertebrates to impervious surface cover varied with hydrogeomorphic factors.

Although urbanization at a catchment scale is correlated with a reduction in sensitive invertebrate species, those urbanized catchments with intact riparian buffers along the longitudinal stream gradient maintain a higher proportion of sensitive species compared to those without vegetated riparian corridors (Miltner et al. 2004, Moore and Palmer 2005, Walsh et al. 2007, Shandas and Alberti 2009).

In some cases, the immediate effects of forest clearing have produced unexpected results relating to invertebrate composition. For example, where clearcuts leave significant quantities of woody slash in the stream, an associated increase in collector and shredder invertebrates occurs for years following harvest (Jackson et al. 2007). On the other hand, Kiffney et al. (2003) observed an increase in

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tolerant Chironomid invertebrates following logging with 0, 10 m (33 ft), and 30 m (98 ft) buffers. Kiffney et al. (2003) and Hoover et al. (2007) concluded that 10-meter-wide buffers were not sufficient to protect stream invertebrate communities from the effects of logging. Kiffney et al. (2003, 2004) concluded that buffers over 30 m (98 ft) in width are necessary to avoid disturbing invertebrate communities.

In-Stream Habitat (Large Woody Debris)

Large woody debris (LWD) plays a significant role in geomorphic functions such as directing stream flows to shape the channel form and influencing sediment storage, transport, and deposition rates. The collection of woody debris and the subsequent entrapment of smaller branches, limbs, leaves and other material reduce flow conveyance in small streams and increase temporary flood storage (Dudley et al. 1998). By retaining smaller organic debris, LWD provides substrate for microbes and algae, and prey resources for macroinvertebrates (Bolton and Shellberg 2001). Just as riparian areas have a more significant effect on smaller channels compared to larger channels (Vannote et al. 1980), the effects of LWD in small channels are particularly significant (Harmon et al. 1986). In small channels, LWD provides important structures in the stream, controlling rather than responding to hydrologic and sediment transport processes (Gurnell et al. 2002). For this reason, large wood is responsible for significant sediment storage in small channels (Nakamura and Swanson 1993, May and Gresswell 2003). Large wood that partially blocks flow can also help to encourage hyporheic flow (Poole and Berman 2001, Wondzell et al. 2009).

Large woody debris also plays an important role in forming complex in-water habitat structures that provide flow refugia and essential cover and improved foraging conditions for fish. Fausch and Northcote (1992) found that streams containing large amounts of LWD supported populations of juvenile cutthroat and coho salmon five times greater than streams within the same river system that had been cleared of LWD. Roni and Quinn (2001) found that winter densities of coho salmon, steelhead, and cutthroat trout were higher in streams where LWD had been added.

Large woody debris can enter channels through individual trees falling into the stream, as well as through larger disturbances, such as landslides and fire (Bragg 2000). A comparison of 51 streams with varying channel form in mature forests of British Columbia found that of the approximately one-third of LWD pieces for which the source could be identified, tree mortality was the most common (65 percent) entry mechanism (Johnston 2011). Streambank erosion is a common method of wood recruitment in large alluvial channels (Murphy and Koski 1989), whereas in smaller, steeper channels, wood recruitment predominantly occurs through slope instability and windthrow (May and Gresswell 2003).

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The probability of a tree entering the channel decreases as you move away from the stream (McDade et al. 1990, Grizzel et al. 2000). Past research has found that most LWD originates within approximately 30 m (98 ft) of a watercourse (Murphy and Koski 1989, McDade et al. 1990, Van Sickle and Gregory 1990, Robison and Beschta 1990). In 90 percent of the 51 streams surveyed in British Columbia, 90 percent of the LWD at a site originated within 18 m (59 ft) of the channel (Johnston 2011). May and Gresswell (2003) found that wood was recruited from distances further from the stream channel in small, steep channels (80 percent from 50 m (164 ft) from the channel), compared to broad alluvial channels (80 percent from 30 m (98 ft) from the channel) because of the significance of hillslope recruitment in narrow valleys. Trees beyond one site-potential-tree-height (SPTH) from a creek also influence LWD recruitment indirectly by knocking down other trees closer to the stream when they fall (Reid and Hilton 1998).

The likelihood of downstream transport of LWD is dependent on the length of wood relative to bankful width of the stream (Lienkaemper and Swanson 1987). Wood that is shorter than the average bankful width is transported more readily downstream compared to wood that is longer than the bankful width (Lienkaemper and Swanson 1987). Therefore, large wood is rarely transported downstream from small channels less than 5 m (16 ft) in width (May and Gresswell).

Similar to large wood, beaver dams slow water, retain sediment, and create pools and off channel ponds used by rearing coho salmon (Naiman et al. 1988, Pollock et al. 2004). The removal of these structures throughout history has been linked to a significant reduction in coho salmon summer and winter rearing habitat in the nearby Stillaguamish River (Pollock et al. 2004).

6.2.2 Ponds and Lakes

Lake Leota is presently the only open-water lake within the City of Woodinville and it meets the WAC definition of a FWHCA. The Lake is approximately 10 acres and shallow (up to 23 feet deep); it is part of the headwaters of Cold Creek; and Cold Creek is an important tributary to Bear Creek (Falter 2007). Lake Leota is also fringed by Class 2 and Class 3 wetlands (Steward & Associates and Jones & Stokes 2007).

The lake's functions are described in the *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A), and key ecological conditions are summarized here. Lake Leota is a perched lake, meaning that the great majority of its surface water is lost through groundwater seepage (Falter 2007). This seepage provides a source for the cool groundwater that feeds Cold Creek, maintaining summer water temperatures 5-7 degrees Celsius colder than Cottage and Bear Creeks (Kerwin 2001). The cool, groundwater-fed waters from

Cold Creek cool downstream salmon-bearing waters, including Cottage Lake Creek, Bear Creek, and the Sammamish River, helping to maintain habitat conditions suitable for spawning salmonids. The Lake's surface outlet to the Cold Creek intermittently flows only during periods of high water. Because the Lake has limited surface water drainage and as a result of the sediment loads associated with stormwater contributions from development in the basin, the already shallow lake is becoming more shallow and eutrophic. Over time, the Lake is expected to evolve into an emergent wetland, and eventually a wet meadow (Falter 2007). To the extent that sediment runoff to Lake Leota from new and existing development can be limited, the lake will retain its existing functions and values for a longer period of time.

Much of the Lake Leota shoreline is armored, and most residences around the Lake also have docks. Although Lake Leota does not directly support salmonid species, to the extent that shoreline armoring and docks preclude natural wetland vegetation, they also limit available wetland habitat. Use of the lakeshore by herons and other birds is likely concentrated where vegetative cover exists and the shoreline is unarmored.

6.2.3 Upland Habitat

As developing areas in western Washington grow in population and cities, suburbs, and rural areas support greater densities, natural wild areas become fewer and urban natural areas become increasingly valuable to both wildlife and humans. Recent scientific research has responded in kind, and a growing knowledge base confirms what is best captured in the summary: "All urban areas have the potential to contribute to conservation of wildlife diversity" (Marzluff and Rodewald 2008).

Human-caused development that influences wildlife and wildlife habitat in urban, suburban, and rural Washington include urbanization, agriculture, recreation, and infrastructure. The amount and quality of upland native habitat is influenced by the expected and regular actions of that occur as part of development, land use, and land management. As structures, roads, yards, and other man-made features perforate the landscape, suitable habitat becomes less available in absolute area and remaining habitat becomes isolated in patches or fragmented, often to the detriment of wildlife (Marzluff and Ewing 2001).

Proximity of development, in addition to habitat loss, has been demonstrated to impact some taxa, such as native grassland rodents, when it disrupts habitat (Bock et al. 2002). Impacts of such development in and near native habitat are presented in the following sections.

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Habitat Loss

Development in vegetated areas has the immediate impact of removing habitat for individuals, and in some cases populations, of species present in the area. Extirpation of animals dependent on large forested tracts, for example, occurs when a habitat patch is reduced below the needed area; further, the reduced population will at some point be unable to support a viable population of area-sensitive species and may become a "sink."

Birds are probably the most-studied taxon in urbanizing areas. Although they are more mobile than most other terrestrial wildlife, they often exhibit population responses to the habitat changes associated with development. Long-term viability of avian populations appears to be lowered by reduced quality, abundance, and connectivity (see Section 7.2.2) of native forest in urbanizing areas (Belisle et al. 2001, Donnelly and Marzluff 2004). In the Vancouver, British Columbia area, Melles et al. (2003) showed an inverse relationship between species richness and level of urbanization, with local- and landscape-scale attributes exerting an effect. In this study, the presence of large conifers, berry-producing vegetation, and streams increased the likelihood of recording birds on the local level, and forest cover improved the chances of observation. In many cases, relationships are non-linear, with density and richness peaking at intermediate levels of disturbance. This phenomenon often was the result of varying levels of adaptability of species to disturbance.

Habitat loss and fragmentation are leading causes in the global decline of amphibians (Becker et al. 2007). The level of urbanization also impacts some amphibian species, reducing abundance and species richness (Rubbo and Kiesecker 2005). Forest removal impacts migration and dispersal from wetlands, and effects may occur regardless of efforts to reduce to impact of specific silvicultural practices (Todd et al. 2009).

In a summary of the existing literature, Marzluff (2001) reported that human-driven land use cover changes that occur with development have generally resulted in increases in non-native bird species, increases in species that nest in human structures, increased nest predation, and decreases in forest-interior and ground-nesting species. Factors favoring increases in non-native species and those nesting regularly in human structures were primarily increased food, and less importantly, fewer predators, less persecution by humans, and habitat enhancement. Factors driving declines in forest-interior and ground-nesting species were decreased available habitat, reduced habitat patch size, increased edge habitat (the interface between different vegetative communities or habitat types), increased non-native vegetation, decreased vegetative complexity, and increased nest predation. Loss of important habitat features such as snags has also reduced density of birds (cavity-nesters) in urbanizing areas (Blewett and Marzluff 2005).

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Agricultural development has been responsible for the loss of entire habitats in the United States, and secondarily leads to increases in edge, fragmentation, structural and compositional simplification, and establishment and proliferation of non-native and invasive vegetation (Southerland 1993). As with other habitat types, loss of area of prairie habitat can result in direct loss of wildlife species (Herkert 1994), and impacts due to the secondary effects listed above can result in higher predation rates on waterfowls and other reproduction impacts (Pasitschniak-Arts and Messier 1995, Herkert et al. 2003). On the other hand, with the loss of wetland and estuarine habitats, fallow fields and flooded pastures can help provide foraging habitat for wintering migratory waterfowl, (Ball et al. 1989).

Replacement of native vegetation with maintained lawns negatively affects bird and butterfly abundance and species richness (Nelson and Nelson 2001). Increased non-native vegetative cover, which can include ornamental species used in landscaping, was one of several factors that simultaneously led to reductions in the number and quality of urban songbird nest sites in several studies, and exotic shrub cover was correlated with an increased risk of nest predation (Marzluff 2001). Exotic ground and shrub cover was locally associated with a decrease in forest bird species and an increase in synanthropic species, or those that adapted readily to human presence, in the Seattle area, although whether these changes were also the result of other concurrent effects of urbanization was unclear (Donnelly and Marzluff 2004). Ironically, dispersal of non-native plant species may be facilitated by birds in the urban landscape, leading to the propagation of discrete infestations (Reichard et al. 2001).

Habitat Fragmentation and Connectivity

A strong example of the influence human impacts on wildlife and habitat, including FWHCAs, can be seen in connectivity effects on local habitat. The pattern of habitat loss and unavoidable consequent fragmentation may exert a greater influence on wildlife, including birds, mammals, and insects, than habitat loss alone, with declines in populations a primary impact (Bender et al. 1998).

Urban development generally causes more persistent and drastic fragmentation than other anthropogenic land uses, such as forestry and agriculture, as fragments are commonly separated by impervious surface, structures, impassable barriers, and infrastructure used by vehicles and people. Water flow is obstructed or redirected, nutrient cycling is disrupted, and ecological function may be interrupted or altered. Total habitat area is reduced; dispersal and travel by many wildlife species is altered or obstructed; and the processes of predation, parasitism and interspecies competition are affected (Marzluff and Ewing 2001). Isolated habitat fragments tend towards degradation and the establishment of non-native habitat (Marzluff 2001).

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Fragmentation has been shown to be detrimental to migratory bird species in many studies, although it should be noted that increased edge is an inevitable consequence of fragmentation and often confounds results (Parker et al. 2005) and may skew results. Less mobile species, such as invertebrates and small mammals, often exhibit a more profound response to development than more mobile species (Hansen et al. 2005), and they might be expected to be more greatly impacted by fragmentation. On the other hand, bird population dynamics may be related to amount of vegetated area available rather than configuration because birds are highly mobile and able to travel between disjunct patches (Marzluff 2005).

The benefit to wildlife of connected habitat areas is evident, as habitat corridors facilitate the movement of individual animals and connect even distant "source" areas to local habitat patches. An understanding of the existing landscape and evident wildlife responses to landscape condition and use can inform local management decisions, as it both provides an opportunity to understand current local habitat use and to aid in determining the potential for meeting management goals. The *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A) describes riparian zones and other remaining vegetated corridors in the City.

Biodiversity as a whole may be impacted less by fragmentation than habitat loss (Fahrig 2003), and evidence of richness peaks in some taxa is presented in the *Habitat Loss* section, above.

Patch Size and Isolation Effects

Isolated terrestrial habitat patches resulting from fragmentation were predicted from earlier collected literature to support more species as the size of the patch increases (Adams 1994). This model held true for woodland birds, chaparral birds, land vertebrates, flies, and beetles The influence of patch size has been further investigated in more recent literature, as presented in this section, with greater consideration of landscape parameters, scale, and other potentially confounding factors.

More recently, Donnelly and Marzluff's (2004) work in the Seattle metropolitan area shows evidence that species richness increases with habitat patch size, as reported elsewhere in the literature, in all landscapes (urban, suburban, and exurban) because large reserves are able to support more species drawn from the regional pool. Large reserves in more developed areas supported greater species richness than large exurban reserves because of their ability to recruit and support synanthropic species that were generally not present in exurban areas. As well, larger reserves can be expected to contain greater habitat diversity and subsequently more niches for species to utilize. Donnelly and Marzluff (2004) attributed the differences in species richness between large and small reserves to

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local extinctions. As reserve size decreased, those species depending on intact or expansive forest were the first to disappear. A tendency for some neotropical migrant bird species to decline in smaller forested areas was observed as well. Small mammals have also showed a higher likelihood to immigrate to larger fragments when faced with smaller alternatives (Diffendorfer et al. 1995).

A similar effect was demonstrated in forest-interior birds in southeast Alaska (Kissling and Garton 2008). Very large reserves supported most native forest bird species found in the area, while reserves within landscapes of high (>40%) urban cover supported most of the synanthropic species found here. In summary, forest species occurrence decreased with decreasing habitat patch size, and synanthropic species occurrence increased with the amount of urbanization in the surrounding landscape. Non-native groundcover explained much of this variation: native forest species decreased and synanthropic species increased with the amount of exotic ground vegetation. The complex juxtaposition of habitats in more urban landscapes seems to allow for the occurrence of synanthropic species in urban reserves.

Patch size has the potential to impact species with small home ranges to a greater extent than relatively mobile avian species. Higher small mammals abundance and/or richness has been demonstrated in larger patches (Pardini et al. 2005) and in patch interiors (Orrock and Danielson 2005), and amphibians may show a positive response to buffers that increase over habitat patch size (see *Corridors and Buffers* section). While species requiring smaller home ranges throughout their lifecycle may initially respond less negatively to habitat loss than species that generally need larger areas, this seeming resilience may be short-lived. While a lesser impact has been demonstrated in amphibians with lower dispersal abilities than those with greater abilities, the more tolerant species are likely to face equally negative consequences with time (Cushman 2006). Mammals and insects exhibit a similar varied response to patch size depending on life history strategies. Edge and interior species exhibit positive and negative responses, respectively, to decreasing patch size (Bender et al. 1998).

Large forest patches in the greater landscape may be important to adjacent developed areas in that they act as "sources," protecting the long-term survival of species that may use urban areas but cannot exist without larger habitat patches in the greater vicinity. Similarly, in North Carolina development-sensitive bird species richness and abundance decreased with increasing percent cover of managed (mowed or cleared) area within and adjacent to forested greenways, with most sensitive species persisting only in the widest remaining forested tracts (Mason et al. 2007). In contrast, fragmented habitat matrices are a major influence on urban habitat patches as a source of invasive plants and predators (McKinney 2002). They may eventually become "sinks," or areas unable to support viable populations of particular species or other taxa.

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Despite higher species richness in the large reserves, the relative abundance of birds was greater in habitat patches in urban and suburban landscapes than in more rural landscapes (Kissling and Garton 2008). The authors suggest that density increased because individual forest birds pack into reserves when forest habitat is scarce, increasing densities. Individuals are more able to disperse when reserves are bigger, evidenced by the tendency of lower densities in larger reserves. Increased densities could result in density-dependent interactions, such as greater competition for resources, in smaller habitat patches.

Small reserves may support one or more life history phases (e.g., foraging or rearing), but they may not be sufficient for species to complete their life cycles. For example, Kissling and Garton (2008) found that small forest patches in urban landscapes had no value as breeding areas for at least some forest bird species. The highest shrub nest densities, apart from those in large, exurban reserves, were observed in medium-sized (mean of 34.7 ha) suburban reserves. These considerable habitat patches potentially act as a means of retaining forest species in developing landscapes. In some cases, corridors may facilitate wildlife travel between small forest patches, but vegetated corridors are not always effective, particularly for migratory birds (Hannon and Schmiegelow 2002) (See *Corridors and Buffers* section).

Gaps, Edge, Roads, and Disturbance

In addition to patch size and isolation effects, particular species and guilds may show varying sensitivity to patch isolation, habitat within the patch, landscape characteristics surrounding patches, and species interactions with other wildlife using the landscape. Even small breaks between habitat patches can deter wildlife travel and, in some cases, directly impact wildlife abundance. For example, the relatively small gaps from bridges, perhaps coupled with the disturbance of vehicles and noise, were associated with decreases in riparian bird species richness and density (Lens and Dhondt 1994, Machtans et al. 1996).

For highly mobile species, the size of gaps between forest patches determines the effects on the species. More mobile taxa may be less deterred from travel between habitat patches over unvegetated gaps. However, even some mobile species (*e.g.*, songbirds) exhibit a preference for traveling between habitat patches through wooded areas compared to open gaps, even when the wooded route was up to three times longer than the gap (Desrochers and Hannon 1997).

Forest songbirds in an urban landscape in Alberta were significantly more likely to move between vegetation patches when gaps were <30 meters, and the difference was more dramatic when gaps reaches 45 m (Tremblay and St. Clair 2009). Traffic also reduced movement. Railroads had a lesser effect, probably due to narrow width, and rivers had a higher impact than anthropogenic linear features. Small mammals, on the other hand, moved between fragments in lower

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numbers as fragmentation increased, and tended to move greater distances (Diffendorfer et al. 1995).

The location of roads among habitat patches can impact wildlife using the patches. Fahrig et al. (1995) documented a proportional increase in frog and toad mortality with traffic intensity on roads, and suggested that mortality contributed to decreased abundance in areas of high-intensity road use. Lehtinen et al. (1999) also found that road density in particular was associated with a decline in amphibian species richness. While terrestrial habitat exerted the greatest influence on the occurrence of amphibian species and community richness on a local scale (50-400 m) in northern Italy, the presence of roads had a significant effect on a larger spatial scale (300-1500 m) (Ficetola et al. 2008), demonstrating that buffer regulatory decisions should take into consideration the amount and type of development and land uses across the landscape. Neotropical migrant bird abundance, richness, and diversity have been associated with areas containing the fewest roads in Portland, Oregon (Hennings and Edge 2003). Recommendations based on review of literature up to 1997 include retaining forest with few roads adjacent to wetlands to minimize disturbances to birds that result from access (Azous and Horner 1997).

Wildlife Guilds and Adaptation

Bird and mammal studies show that species have different ways of adapting to drastic changes with urbanization. Urban avoiders, in roughly decreasing order of sensitivity, are rare species with low reproductive rates, large mammals, old-growth and mature forest species, insectivorous tree foragers, neotropical migrant birds, and ground-nesting birds (McKinney 2002). These species and guilds are generally the first to be excluded from urbanizing areas, although sensitivity to urbanization is not always apparent (Oneal and Rotenberry 2009). As a developing area that generally comprises urban and mixed environs, westside lowland conifer-hardwood forest, and agriculture/pasture/mixed environs habitat types, with numerous wetlands and streams (Johnson and O'Neil 2001), Woodinville presently supports a wide range of wildlife species and taxa. The potential for land use actions to enhance or diminish suitability for sensitive species, synanthropic species, species of local interest, and pest species can be addressed through an understanding of how various guides adapt and respond to changes. This will aid in efforts to protect species during the planning process.

Species and guilds that are able to adapt to human-induced changes include edge species, omnivores, ground-foragers, seed-eaters, aerial sweepers, tree/shrub/cavity nesters, burrowing mammals, and human food eaters. These "urban adapters" benefit from the interspersion of habitats that residential development often results in, including edges created where open areas or maintained properties meet native forest (Adams 1994). They are able to utilize

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native resources, as well as foods that are available as a result of human presence. These include intentionally provided bird foods, seed- and fruit-producing landscape plants, and garbage. Aerial insectivores probably take advantage of open areas and artificial lights that attract insects (although Blair (1996) noted the loss of native insectivorous birds from built areas in California); seed-eaters benefit from both landscape plants and birdfeeders; and omnivores, corvids in particular, seem able to exploit garbage sources (McKinney 2002). Species, including some swallows and wrens, that are able to nest in man-made structures find an abundance of nest sites in urban habitat, and these species increase with some types of fragmentation and disturbance (Rottenborn 1999). The availability of human-introduced resources is one of the reasons that abundances of urban-adapters tend to be higher than found in natural situations (Adams 1994, Marzluff 2001). The tendency of more highly tolerant species to displace or out-compete native species is of concern when management goals include preserving biodiversity in developing areas.

Finally, the proliferation of synanthropic species occurs as development infringes on the landscape, leading toward a more homogeneous fauna. Although during intermediate stages of development, when cleared areas intersperse with forest patches to produce edge, species richness peaks for some groups, including songbirds (Blair 1999, Marzluff 2005), the effect disappears as development becomes denser.

Corridors and Buffers

One solution to the negative impacts of fragmentation is to manage connectivity (Schaefer 2003). Connectivity refers more to the ability of a species to traverse or reproduce across an area than any innate condition of the habitat itself. It can refer to the intactness of a patch or expanse of habitat (in contrast to fragmented habitat) or to a travel corridor between larger habitat patches.

The existing Woodinville Municipal Code incorporates some protection of habitat connectivity of natural and vegetated areas. The City's critical areas mitigation standards require the retention of contiguous wildlife habitat corridors and reduction of fragmentation potential. Critical areas regulations call for the use of wildlife-friendly fencing and signage to promote protection of wildlife corridors associated with other critical areas. The city's Sustainable Development Project maps depict a network of corridors, or "wildlife habitat connectivity emphasis areas," for consideration in planning (Steward & Associates and Jones & Stokes 2007).

Vegetated corridors tend to be correlated with watercourses in urbanizing settings because of regulatory protections on streams and rivers. The associated riparian systems make up a relatively small percentage of land cover in the western United States, yet they provide habitat for rich wildlife communities

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(Knopf et al. 1988, Johnson and O'Neil 2001, which in turn provide a source for habitat patches or reserves. Consequently, streams in urban areas can support rich wildlife communities (Johnson and O'Neil 2001), with implications for the use of buffers to preserve biodiversity.

Many studies address the importance of vegetated corridors to wildlife, particularly in developed areas (Knopf et al. 1988, Gillies and St. Clair 2008, Gilbert-Norton et al. 2010)). They are particularly valuable in fragmented habitats because they can facilitate travel among habitat patches for wildlife. Riparian corridors may also play a role in maintaining microhabitat and suitable microclimates for species associated with streams (Klubar et al. 2008). A 1998 synthesis (Beier and Noss 1998) concluded that while the results of previous empirical studies have been affected by confounding factors, results of the best-designed studies suggest that corridors contribute to wildlife conservation. Subsequent studies demonstrate the value of habitat corridors, as well as the potential risks of creating habitat sinks (Hilty et al. 2006). The number of wildlife species present has been demonstrated to be directly proportional to corridor width (Dickson 1989, as cited in Keller et al. 1993), although other studies show conflicting results (Pearson and Manuwal 2001) and species-specific variation (Ficetola et al. 2008). Published results pertain to a wide range of taxa, including birds, small and large mammals, herptiles, and insects, in environments similar to those in Woodinville. The widespread occurrence of streams and other features that may contribute to habitat corridors in the City create the opportunity to apply corridor study results to management strategies and decisions.

It is becoming increasingly apparent that landscape configurations are an important factor in species occurrence and distribution (Rodewald 2003), but it follows that different wildlife species perceive and use connectivity differently. Small, terrestrial organisms require separate consideration from more mobile large mammals and birds when planning width and composition of corridors. For example, breeding bird species richness was greater in wider forested riparian areas in than narrower strips in northeastern Missouri, and richness was greater in narrow riparian strips with grassland-shrub buffers than in narrow strips without vegetated buffers (Peak and Thompson 2006). Conversely, synanthropic bird species richness and abundance have been correlated with the narrowest of preserved forest corridors studied (Hennings and Edge 2003, Mason et al. 2007).

Recent synthesis papers have summarized the results of primary studies on corridor and buffer width needs for wildlife in urban and urbanizing areas. Terrestrial buffers on streams and wetlands are particularly important for reptiles and amphibians, as they depend on these areas for certain lifecycle stages. A 2003 synthesis found that terrestrial core habitat (buffers associated

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with wetlands) of 159-290 m and 127-289 m in width were required by amphibians and reptiles, respectively (Semlitsch and Bodie 2003) while a primary study that four species of stream breeding salamander in Appalachia required buffer widths of 77 m to provide habitat and buffer edge effects (Crawford and Semlitsch 2007). Buffers of 92.6 m were recommended to accommodate the farther-ranging individuals.

Most studies report a range of 125 to 400-meter-wide corridors necessary to provide essential habitat for avian species (Shirley and Smith 2005, Peak and Thompson 2006, Kissling and Garton 2008). Other work suggests that vegetative structure in corridors (sometimes in conjunction with buffer width) explains use by birds (Pearon and Manuwal 2001, Shirley 2006). Based on songbird studies, while wide corridors are optimal, management efforts should focus on restoring or creating vegetated riparian areas along streams that currently lack vegetation, as even narrow buffers have been shown to provide habitat for many species (Pearson and Manual 2001, Keller et al. 1993).

The likelihood of small mammals to respond to the presence of vegetated corridors varies among species. A preference for connected habitat patches implies a use of corridors in some species (Pardini et al. 2005), and some species respond in a strong positive way to corridors (Lanoue 1988 *in* Gilbert-Norton 2010), while others exhibit avoidance (Orrock and Danielson 2005). In a fragmented landscape, corridors did not influence home range size in some small mammals, whereas the species' habitat needs and sex influenced its likelihood to move among patches (Mabry and Barrett 2002). As well, the position of corridors relative to patches and the overall increase in habitat area that they create may result in a positive response in captures of some small mammal species (Orrock and Danielson 2005).

A 2010 review of the literature found that corridors most effectively facilitated movement or dispersal through fragmented landscapes by invertebrates, plants, and non-avian wildlife (Gilbert-Norton et al. 2010). This work showed that use of corridors was not influenced by independent variables such as total vegetated area. Most research indicates that landscape- and watershed-scale elements, including patch size and landscape positioning, should be considered in determining effective buffer widths, as parameters measured at these greater spatial scales can impact wildlife occurrence and population dynamics (Ficetola et al. 2008, Rubbo and Kiesecker 2005, Willson and Dorcas 2003).

Finally, despite the potential benefits of habitat corridors, it should be noted that as a result of their high edge-to-area ratio, corridors may facilitate the establishment of invasive species and access by predators, and they generally provide smaller buffers from disturbance than non-linear habitat patches.

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Invasive and Non-native Species

As notes above, infestation by invasive and non-native species can be a consequence of urbanization and other development (McKinney 2002, Southerland 1993, Zedler and Kercher 2004). Consequences of infestations can be to the detriment of native species and habitats and may include extirpation of native species (Ricciardi et al. 1998), impacts to wildlife species and communities (Olden et al. 2004, Pimentel et al. 2005), and food-web simplification (Olden et al. 2004). These effects can take place at levels ranging from populations to ecosystems.

Under growing conditions present in altered disturbance regimes of anthropogenic origin, invasive plants are able to increase their performance over native plant species (Daehler 2003). Noxious plant species in particular can compete successfully for natives for pollinators (Brown and Mitchell 2001, Brown et al. 2002) and cause changes in fire regime (Brooks et al. 2004). In prairie ecosystems, invasive plants can modify soils to facilitate conditions favorable to themselves and other invasives (Jordan and Larsen 2008). As well, wetlands appear to be particularly vulnerable to infestation by invasive species, possibly to due factors that include inflows of plant material in surface flows from urban and agricultural areas, dispersal along rivers, and hydrological disturbance that affect nutrient availability (Zedler and Kercher 2004).

6.2.4 Endangered, Threatened, or Sensitive Species and Species of Local Importance

The City of Woodinville includes habitat types that are known to be used or could potentially be used by species of interest (excluding fish), including those species with State or federal status and WDFW priority species. These habitats include forested upland, wetlands, riparian areas, scrub-shrub, and open habitat such as ROW. Functions of and potential impacts to these habitats are addressed in the preceding sections. The *Woodinville Comprehensive Plan Update - Existing Conditions Report, Section 1.3* (Appendix A) addresses species of interest that are known to or may potentially occur in the City of Woodinville.

Species of local interest with the potential to use habitat within the City are listed in Table 6.1. Suitability and availability of habitat in the City of Woodinville for species of interest known or likely to occur in the City are addressed in the following sections.

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Table 6-2. Birds and Mammal Species of Local Importance potentially occurring in the City of Woodinville.

Common Name	Scientific Name	State Status	Federal Status	PHS?
Birds				
Great blue heron	*Ardea herodias*	M		Y
Green heron	*Butorides virescens*	M		Y
Band-tailed pigeon	*Patagioenas fasciata*			Y
Pileated woodpecker	*Dryocopus pileatus*	S	Co	Y
Peregrine falcon	*Falco peregrinus*	S	Co	Y
Osprey	*Pandion haliaetus*	M		Y
Bald eagle	*Haliaeetus leucocephalus*	S	Co	Y
Purple martin	*Progne subis*	C		Y
Vaux's swift	*Chaetura vauxi*			Y
Mammals				
Townsend's big-eared bat	*Corynorhinus townsendii*	C	Co	Y
Columbian black-tailed deer	*Odocoileus hemionus columbianus*			Y

M=Monitor species
S=Sensitive species
C=Candidate species
Co=Species of Concern

6.3 Protection Measures

6.3.1 Streams and Riparian Areas

The literature points to a range of recommended management measures and buffer considerations to help maintain stream functions for fish and wildlife. Effective methods to reduce impacts from urbanization and associated runoff can include the following:

- Limiting development densities and impervious surface coverage;
- Limiting vegetation clearing and retaining forest cover;
- Concentrating impact activities, particularly roads and pollutant sources, away from watercourses;
- Limiting the total area of roads and requiring joint use of new access roads;
- Protecting vegetation and limiting development on or near hydrologic source areas;

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- Maintaining densely vegetated riparian buffers with native trees, shrubs, and groundcover species;
- Low impact development (LID);
- Municipal stormwater treatment;
- Public education.

In establishing the appropriate level of protection for different stream classes throughout the City, various inferences must be drawn. Many of the scientific studies that critically examine the functions and values associated with riparian areas have been conducted in forested environments. As such, fundamental differences between forested, agricultural, and urban areas, including land use and hydrology, are frequently overlooked. Moreover, there is a limited body of literature on the effects of incremental changes in riparian buffer widths. Lastly, riparian studies often fail to account for the contribution of engineering and public works projects, such as surface-water detention facilities, that can supplement natural riparian function in more urban settings. Thus, although stream and riparian conservation measures should be based in Best Available Science, some level of policy interpretation must be made by a local jurisdiction.

In an analysis of riparian zone ordinances, Wenger and Fowler (2000) support using approaches that allow some flexibility in how policies are implemented on a parcel scale. Whereas variable-width policies provide greater flexibility and adaptability to address site-specific conditions, it is noted that fixed buffer widths are more easily established, require a lesser degree of scientific knowledge to implement, and generally require less time and money to administer (Castelle and Johnson 1998).

Recent updates to critical area regulations within some other jurisdictions (e.g. King County, Thurston County, City of Redmond) have utilized a variable width approach based on best available science in which stream buffers may be larger/smaller depending upon connectivity to special aquatic areas such as Puget Sound or other Shorelines of the State. Buffer averaging provides an another example of flexibility, where limited reductions in riparian zone width are allowed so long as they are offset by wider riparian zones in adjacent areas. This type of approach could be particularly effective if implemented such that the wider buffer areas are located in existing depressions or swales where surface runoff is likely to become channelized. Other approaches that have been used in riparian zone policies to balance land use and environmental concerns include: conservation overlays, riparian habitat criteria (*e.g.*, density or size of trees, shade, LWD recruitment, etc.), and mitigation fees. These approaches to balance land use and ecological needs present potential benefits, but ecosystem tradeoffs

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and cumulative effects should be carefully weighed if these alternative approaches are considered.

If fixed-width buffers are implemented, conservative (larger) buffer widths are recommended in order to ensure that riparian buffers are effective under a range of variable conditions (Haberstock et al. 2000). Table 6.2 notes the ranges of effective buffer widths (as outlined in each subsection) based on each function and some notes on the functions that were studied.

Table 6-3. Range of Effective Buffer Widths for Each Applicable Riparian Function

Function	Range of Effective Buffer Widths	Notes on Function
Water Quality		
Sediment	4-30 m (13-98 feet), up to 120 m (394 feet) for fine sediment	Filtration is widely variable depending on slope and soils.
Nutrients	Subsurface flow: not dependent on buffer width Surface flow: 15-131 m (49-430 feet)	In addition to buffer width, the rate of nutrient removal is dependent on infiltration, soil composition, and climate. Filtration capacity decreases with increasing loads, so best management practices that reduce nutrient loading will improve riparian function.
Metals	NA- Appropriate buffer width not established	Stormwater system improvements to slow and infiltrate runoff could help reduce metals entering aquatic systems.
Pathogens	NA- Appropriate buffer width not established	Minimizing the density of septic systems, maximizing the distance of septic systems from aquatic resource areas, and promoting pet waste management will help limit the transport of pathogens to aquatic systems.
Herbicides	6-18 m (20-59 feet)	Best management practices during application of herbicides and pesticides can help limit leeching to groundwater.
Pharmaceuticals	NA- Appropriate buffer width not established	Best management practices for disposal of pharmaceuticals may limit potential impacts.
Bank Stabilization	10-30 m (33-98 feet)	Beyond 98 feet from the stream, buffers have little effect on bank

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Function	Range of Effective Buffer Widths	Notes on Function
		stability.
Stream Temperature	10-30 m (33-98 feet)	Leaf cover is more closely related to stream temperature than buffer width.
Microclimate	(10-45 m) 33-150 feet	Most microclimate changes occur within 10-45 m (33 to 150 feet) from the edge, but microclimate effects extend over 240 m (790 feet) from the forest edge.
Invertebrates and Detritus	30 m (98 feet)	Areas with 10 m (33 ft) buffers exhibit changes in invertebrate community composition.
Wildlife Habitat	100 to 600 feet	Minimum width for supporting habitat varies among taxa, guides, and species. Functions include both corridor (travel and migration) and support of lifecycle stages, including breeding.
In-stream Habitat (large woody debris – LWD)	18-50 m (59 to 164 feet)	Although most LWD is recruited from the area adjacent to the stream, tree-fall from beyond 1 SPTH may affect LWD loading.

To achieve improved water quality in the City's streams, riparian buffer areas should be utilized effectively to provide both biofiltration of stormwater runoff and protection from adjacent land uses. Both of these goals can be achieved by providing dense, well-rooted vegetated buffer areas, and by ensuring that buffers apply to hydrologic source areas.

Biofiltration swales, created wetlands, and infiltration opportunities for specific stormwater runoff discharges can be utilized to intercept runoff before it reaches stream channels. Stormwater runoff that is conveyed through stream buffers in pipes or ditch-like channels and discharged directly to stream channels "short circuits" or bypasses buffer areas and receives little water quality treatment via biofiltration. In areas where stormwater flows untreated through riparian buffer areas, the buffer is underutilized and is prevented from providing the intended or potential biofiltration function.

6.3.2 Endangered, Threatened, or Sensitive Species and Species of Local Importance

General recommendations for terrestrial habitat are listed in the following section. Where species-specific recommendations are available for Washington State from WDFW guidance documents, these are summarized separately below.

General Terrestrial Habitat Management Recommendations

- Generally, plan development to minimize fragmentation of native habitat, particularly large, intact habitat areas. Where large forest stands exist, manage for forest-interior species and avoid fragmentation (Donnelly and Marzluff 2004, Diffendorfer et al. 1995, Mason et al. 2007, Orrock and Danielson 2005, Pardini et al. 2005 and others).

- Manage agricultural development to limit fragmentation and edge; preserve vegetative structural diversity whenever possible in agricultural areas by retaining hedge rows and areas of native vegetation (Southerland 1993).

- Control invasive species where needed on a site- and species-specific basis. Address invasive species specifically addressed in areas where environmental conditions tend to promote infestation, including created edges, roadways, and riparian zones where they are contiguous with developed areas that may act as a seed source (Olden et al. 2004, Pimentel et al. 2005, McKinney 2002 and others).

- Maintain or provide habitat connectivity with vegetated corridors between habitat patches (Schaefer 2003, Clair 2008, Gilbert-Norton et al. 2010 and others).

- Protect, maintain, and promote habitat features such as snags and downed wood (Blewett and Marzluff 2005).

- Manage for increase native vegetative cover in landscaping and discourage lawns (Nelson and Nelson 2001).

- Plan habitat areas away from roads (Fahrig et al. 1995, Lehtinen et al. 1999).

- Promote buffers of adequate width to support wildlife guilds in adjacent habitat (Ficetola et al. 2008, Semlitsch and Bodie 2003, Crawford and Semlitsch 2007).

- Preserve habitat patches of at least moderate size 35 ha (86 ac) within developed areas (Kissling and Garton 2008).

6.3.3 WDFW Species-specific Management Recommendations

Bald Eagle

Bald eagles are likely to be detrimentally impacted by activities that later nest, roost, or perch trees; removal of adequate buffers; noise and other human disturbance; and potentially decreasing salmon runs (Watson and Rodrick 2000).

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WDFW recommendations focus on retaining buffers, from different activities, as shown in Table 6-3. Nest protections need to be in place year-round, as bald eagles typically reuse nests from year to year, skipping years or moving to alternate nests on occasion. Exact activities and protections within each zone may vary by site, but generally should include retention of large trees and restriction of most construction (Protected Zone), and protection of alternate nest locations, perch trees, and foraging sites and avoidance of construction use activities that are not low-impact (Conditioned Zone). Non-nesting protections include retaining and protecting perch trees and buffering foraging sites from disturbance.

Table 6-4. Bald eagle recommended buffers from Watson and Rodrick 2000.

	Protected Zone	**120 m (400 ft)**
Nesting	Conditioned Zone	100-240 m (330-800 ft) beyond Protection Zone
Roosting	Timber Harvest Zone	100 m (400 ft)
	Human Disturbance Zone	100 m (400 ft)
Perching and Foraging	Perch Protection	Protect perches within 75 m (246 ft) of top-of-bank or shoreline
	Human Disturbance and Structures	450 m (1,500 ft)

Great Blue Heron

WDFW recommends protection mechanisms for Heron Management Areas, which consist of the nesting colony, year-round and seasonal buffers, foraging habitat, and congregation areas where they exist (Azerrad 2012). Specifically, clearing vegetation, grading, and construction should never occur in the core zone, and other potential disturbances, including recreation and vegetation management, should be minimized or restricted to the period outside of the breeding season. Foraging habitat should be protected with riparian buffers, and activities such as vegetation removal, logging, perch tree disturbance, wetland filling, and construction should be minimized. A specific watercraft use buffer of 180 m (590 feet) from shallow foraging waters is recommended. Heron colonies closer to human activity may tolerate more disturbance than colonies in more undisturbed areas; therefore, appropriate buffers may be smaller in more developed areas. Year-round and seasonal buffer recommendations are provided in Table 6-4.

Table 6-5. Great blue heron recommended buffers from Azerrad 2012.

Year-round Buffers	
Undeveloped	300 m(984 ft)
Suburban/rural	200 m (656 ft)
Urban	60 m (196 ft)
Seasonal Buffers (February-September)	
Loud noises	200 m (656 ft)
Extreme loud noises like blasting	400 m (1320 ft)

Peregrine Falcon

General WDFW management recommendations for the species include routing powerlines away from nests, protecting wetlands used by peregrine falcons, restricting pesticide use in winter foraging areas and near nests during the breeding season, maintaining large trees and snags in winter feeding areas, and retaining snags and debris on mud flats (Hays and Milner 1999). Buffer recommended for specific activities are shown in Table 6-5.

Table 6-6. Peregrine falcon recommended buffers from Hays and Milner 1999.

Activity	**Buffer width**	**Buffer from**	**Timing**
Human access to cliffs	800 m (2620 ft)	Cliff nest	March-late June
Human activities on or below cliffs	400-800 m (1310-2620 ft)	Cliff nest	March-late June
Recreation (trails/picnic area) development	400-800 m (1310-2620 ft)	Cliff nest	Year-round
All development	NA	Cliff nest	Year-round
Forest practices (review rules)	400 m (1310 feet)	Any nest	Year-round
	800 m (2620 ft)		March 1-June 30
Aircraft approaches	500 m (1640 ft)	Any nest	March 1-June 30

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Pileated Woodpecker

WDFW management recommendations for pileated woodpecker specific to western Washington are aimed at forest stand features and protection strategies within home ranges rather than creation of buffers for individual nest sites. Maintaining snags and decaying live trees within home ranges for nesting and roosting, retaining snags and downed wood for foraging, using average snag-retention recommendations (rather than minimums), and creating snags in older secondary forest are general strategies (Lewis and Azerrad 2003 with January 2005 updates). In western Washington, home range size is on average 600 ha (1480 ac), west of the Cascades and about 850 ha (2100 ac) on the Olympic peninsula. Maintenance of coniferous forest of about 60 years or more in age at 70% canopy cover is recommended overall. Snag retention recommendations are given in Table 6-6.

Table 6-7. Snag retention recommendations for pileated woodpecker (from Lewis and Azerrad 2003 with January 2005 updates).

Habitat component focus	Size class (dbh)	Snags to retain (per ac)
Nesting and roosting	≥76 cm (≥30 in)	≥0.2
	155-310 cm (61-122 in)	≥7
Foraging	25-50 cm (10-20 in)	≥12
	50-76 cm (20-30 in)	≥12
	≥76 cm (≥30 in)	≥12

6.4 FWHCA Summary

Known FWHCAs in the City of Woodinville, the Woodinville-proposed Urban Growth Area (UGA) in Snohomish County, and the City-King County Joint Study Area per the City's current Critical Areas Ordinance includes, the Type 1 streams, Class 1 wetlands, and native growth protection areas / native growth protection easements (NGPA/NGPE). However, in accord with the WAC 365-190-130, FWHCAs also include ponds and lakes under 20 acres and habitats of local importance. Upland development has the potential to affect FWHCAs through impacts to water flow, water quality, and direct and indirect alterations to habitat conditions. Methods to effectively protecting FWHCAs include limiting development densities, controlling stormwater, and protecting vegetation (both upland and riparian corridors).

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7 REFERENCES

7.1 Section 1 Introduction

RCW (Revised Code of Washington). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/rcw/

WAC (Washington Administrative Code). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/WAC/default.aspx

WDOE (Washington State Department of Ecology). 2010. Wetlands & CAO Updates: Guidance for Small Cities. Ecology Publication No. 10-06-002.

Woodinville. 2004. City of Woodinville Municipal Code—Chapter 21.24 Critical Areas. Obtained from City website: http://www.codepublishing.com/wa/woodinville/http://www.codepublishing.com/wa/woodinville/

7.2 Section 2 Critical Aquifer Recharge Areas

Alley, W.M., T.E. Reilly, and O.L. Franke, 1999. Sustainability of Ground Water Resources, U.S. Geological Survey Circular 1186, 86 pp. http://water.usgs.gov/pubs/circ/circ1186/pdf/circ1186.pdf

Binder, L.C. Whitely, et al. 2010. Preparing for climate change in Washington State. Climatic Change 102.1-2: 351-376.

Driscoll, Fletcher G. Groundwater and Wells. Second edition. Johnson Division. St. Paul, MN. 1986

Dunne, Thomas and Leopold, Luna B. Water in Environmental Planning. W.H.Freeman and Co. San Francisco, CA. 1978

EPA (U.S. Environmental Protection Agency). 1989. Wellhead Protection Programs: Tools for Local Governments. EPA 440/6-89-002. Washington D.C.: Office of Groundwater Protection, U.S. Environmental Protection Agency.

EPA (U.S. Environmental Protection Agency). 1995. Benefits and Costs of Prevention: Case Studies of Community Wellhead Protection, EPA 813-B-95-005, 74 pp.

DRAFT

EPA (U.S. Environmental Protection Agency). 2008. Environmental Protection Agency (EPA), Region 10. Cross Valley Sole Source Aquifer. Map created 12/04/2008. http://www.epa.gov/region10/pdf/water/ssa/maps/ssa_cross_valley_2008.pdf

Fetter, C.W., 1980. Applied Hydrogeology, Charles E. Merril Publishing Company, 488pp.

Godfrey, E., Woessner, W.W., Benotti, M.J. 2007. Pharmaceuticals in on-site sewage effluent and ground water, western Montana. Ground Water 45(3): 263-271.

Golder Associates. 2007. Apprendix A-1: Hydrogeologic Analysis for City of Woodinville Sustainable Development Program. (Excerpt from Draft Sustainable Development Study - R-1 Zone: Environmental Report.)

Granger, T., Hruby, T., McMillan, A., Peters, D., Rubey J., Sheldon, D., Stanley, S., Stockdale, E. 2005. Wetlands in Washington State, Volume 2 – Guidance for Protecting and Managing Wetlands. Washington State Department of Ecology Publication No. 05-06-008.

King County. *No date*. iMAP: Interactive Mapping Tool. Available online: http://www.kingcounty.gov/operations/gis/Maps/iMAP.aspx.

King County, 2004. Executive Report – Best Available Science, Volume 1, Chapter 6 Critical Aquifer Recharge Areas, – February 2004, http://www.metrokc.gov/ddes/cao/PDFs04ExecProp/BAS-Chap6-04.pdf

Morgan, L. 2005. Critical Aquifer Recharge Areas Guidance Document. Washington State Department of Ecology Publication 05-10-028.

RCW (Revised Code of Washington). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/rcw/

San Juan County (SJC) 2004. San Juan County Water Resource Management Plan; WRIA 2. San Juan County Board of County Commissioners.

San Juan County, 2008. San Juan County Summary of Best Available Science for Critical Areas. July, 2008.

WAC (Washington Administrative Code). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/WAC/default.aspx

WDOE (Washington State Department of Ecology). 2005. Stormwater Management Manual for Western Washington. Ecology Publication No. 05-10-029 to-033.

WDOE (Washington State Department of Ecology)Facility Site Atlas, *No date*. http://apps.ecy.wa.gov/website/facsite/viewer.htm)

DRAFT

WDOE (Washington State Department of Ecology) Well Logs, *No date*. https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/default.aspx

Washington State Department of Health Well Source Water Assessment Program Maps, *No date*. (https://fortress.wa.gov/doh/eh/dw/swap/maps/. (https://fortress.wa.gov/doh/eh/dw/swap/maps/

Washington State Department of Natural Resources, Geology. https://fortress.wa.gov/dnr/geology/?Site=wigm

Winter, T.C., Harvey, J.W., Franke, O.L., and Alley, W.M. Ground Water and Surface Water a Single Resource. U.S. Geological Survey Circular 1139. Denver, CO. 1998

Woodinville. 2004. City of Woodinville Municipal Code (WMC)—Chapter 21.24 Critical Areas. Obtained from City website: http://www.codepublishing.com/wa/woodinville/http://www.codepublishing.com/wa/woodinville/

7.3 Section 3 Flood Hazard Areas

Alberti, M., Booth, D., Hill, K., Coburn, B., Avolio, C., Coe, S., Spirandelli, D. 2006. The impact of urban patterns on aquatic ecosystems: An empirical analysis in Puget lowland su-basins. Landscape and Urban Planning 80: 345-361.

ASFPM (Association of State Floodplain Managers). 2003. No Adverse Impact: A toolkit for common sense floodplain management. Association of State Floodplain Managers, Madison, Wisconsin.

Bolton, S. and J. Shellberg. 2001. White Paper: Ecological Issues in Floodplains and Riparian Corridors. Washington Department of Fish and Wildlife. 88 pp.

Booth D.B. 1990. Stream-Channel Incision Following Drainge-Basin Urbanization. Water Resources Bulletin, American Water Resources Association. 26(3): 407-417.

Booth, D.B. and P. Henshaw. 2001. Rates of Channel Erosion in Small Urban Streams. Land Use and Watersheds: Human Influence on Hydrology and Geomorphology in Urban and Forest Areas. Mark Wigmosta and Stephen Burges, (eds.). American Geophysical Union, Washington, D.C. pp. 17-38.

DRAFT

Booth, D.B., D. Hartley, and R. Jackson, 2002. Forest cover, impervious surface area, and the mitigation of stormwater impacts. J. Amer. Water Res. Assoc. 38(3): 835-845.

Booth, D.B., Karr, J.R., Schauman, S/. Konrad, C.P., Morley, S.A., Larson, M.G., Burges, S.J. 2004. Reviving urban streams: Land use, hydrology, biology, and human behavior. Journal of the American Water Resources Association 40(5): 1351-1364.

Dunne, T., and L.B. Leopold. 1978. Water in environmental planning. San Francisco, CA. W.H. Freeman.

FEMA (Federal Emergency Management Agency). 2013. Federal Interagency Floodplain Management Task Force Work Plan. 21 pgs.

Gurnell, A., Klement, T., Edwards, P., Petts, G. 2005. Effects of deposited wood on biocomplexity of river corridors. Front. Ecol Environ 3(7):377-382.

WDOE (Washington State Department of Ecology). 1991. Comprehensive Planning for Flood Hazard Management. Ecology Publication No. 91-44.

WDOE (Washington State Department of Ecology). 2005. Stormwater Management Manual for Western Washington. Ecology Publication No. 05-10-029 to-033.

King County. 2004. Best Available Science, Volume I: A review of science literature. King County Department of Natural Resources and Parks, Seattle, WA.

Knighton, D. (1998). Fluvial Forms and Processes: A New Perspective. Oxford University Press. New York. 383

Leopold, L.B. 1994. A View of the River. Harvard University Press, Cambridge, MA. 281 pgs.

Mote, P. et al. 2003. Preparing for Climatic Change: The Water, Salmon, and Forests of the Pacific Northwest. Climatic Change, 61:45-88.

Mote, P. and Salathe, E. 2010. Future climate in the Pacific Northwest. Climatic Change, 102:29-50.

Naiman, R.J. and H. Decamps. 1997. The ecology of interfaces: riparian zones. Annu. Rev. Ecol. Syst. 28: 621-58.

WAC (Washington Administrative Code). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/WAC/default.aspx

DRAFT

7.4 Section 4 Geologically Hazardous Areas

Atwater, B. F., M. Satoko, S. Kenji, T. Yoshinobu, U. Kazue and D. K. Yamaguchi, 2005. The Orphan Tsunami of 1700; Japanese Clues to a Parent Earthquake in North America. US Geological Survey, Reston, VA.

Blakely, R. J., R. E. Wells, C. S. Weaver, and S. Y. Johnson. 2002. Location, structure, and seismicity of the Seattle fault zone, Washington: Evidence from aeromagnetic anomalies, geologic mapping, and seismic-reflection data. Geological Society of America Bulletin 114 (2): 169–177, doi:10.1130/0016-7606(2002)114<0169:LSASOT>2.0.CO;2.

Blakely, R. J., B. L. Sherrod, J. F. Hughes, M. L. Anderson, R. E. Wells, and C. S. Weaver. 2009. The Saddle Mountain Fault Deformation Zone, Olympic Peninsula, Washington: Western Boundary of the Seattle Uplift. Geosphere 5 (2): 105–125, doi:10.1130/GES00196.1.

Booth, D.B. 1990. Stream-channel incision following drainage-basin urbanization. JAWRA (Journal of American Water Resources Association) 26(3):407-417.

Booth, D. B. 1991. Urbanization and the natural drainage system impacts, solutions, and prognoses. The Northwest Environmental Journal 7(1):93-118.

Booth, D.B., D. Hartley, and R. Jackson, 2002. Forest cover, impervious surface area, and the mitigation of stormwater impacts. J. Amer. Water Res. Assoc. 38(3): 835-845.

Fredricksen, R. L., and R. D. Harr. 1981. Soil, vegetation and watershed management. In *Forest Soils of the Douglas Fir Region*. P. E. Heilman, H. W. Anderson, D. M. Baumgartner (editors) Washington State University Co-op Extension Service.

Gerstel, W. J., M. J. Brunengo, W. S. Lingley Jr., R. Logan, H. Shipman, and T. Walsh, 1997. Puget Sound Bluffs: The Where, Why, and When of Landslided following the Holiday 1996/97 Storms. Washington Geology, vol. 25, no. 1, March 1997.

Golder Associates. 2007. Appendix A-1: Hydrogeologic Analysis for City of Woodinville Sustainable Development Program. (Excerpt for Draft Sustainable Development Study R-1 Zone: Environmental Report).

Gray, D. and Sotir, R.B. Sotir. 1996. Biotechnical and Soil Bioengineering Slope Stabilization: a Practical Guide for Erosion Control. John Wiley and Sons.

Houghton, P. D. and Charman, P.E.V. 1986. Glossary of Terms Used in Soil Conservation, Soil Conservation Service of NSW, Sydney.

Keefer, D. K., 1983, Landslides, soil liquefaction, and related ground failures in Puget Sound earthquakes. In Yount J. C.; Crosson, R. S., editors, 1983, *Proceedings of*

DRAFT

Conference XIV, Earthquake hazards of the Puget Sound region, Washington: U.S. Geological Survey Open-File Report 83-19, p. 280-299.

King County. 2004. Best Available Science, Volume I: A review of science literature. King County Department of Natural Resources and Parks, Seattle, WA.

Langston, C. A. and J. J. Lee. 1983. Effect of structure geometry on strong ground motions-The Duwamish River Valley, Seattle, Washington. Seismological Society of America Bulletin, v. 73, no. 6.

Menashe, E. 1993. Vegetative management: A guide for Puget Sound bluff property owners. Washington State Department of Ecology, Ecology Publication No. 93-31, 46 p.

McCarty, L., 1993. Coal in the Puget Sound Region. HistoryLink.Org, Essay 5158. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=5158

Nelson, E., Booth D.B. 2002. Sediment budget of a mixed-use, urbanizing watershed. Journal of Hydrology. 264(1): 51-68.

RCW (Revised Code of Washington). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/rcw/

Schmidt, K.M., J.J. Roering, J. D. Stock, W.E. Dietrich, D. R. Montgomery, and T. Schaub, 2001. The variability of root coehesion as an influence on shallow landslide susceptibility in the Oregon Coast Range. Can. Geotech. J., Vol 38, pp995-1024.

Sherrod, B., Blakely, R., Weaver, C., Kelsey, H., Barnett, E., Wells, R. 2005. Holocene fault scarps and shallow magnetic anomalies along the southern Whidbey Island fault zone near Woodinville, WA. USGS Open File Report 2005-1136.

Shipman, H. 2004. Coastal bluffs and sea cliffs on Puget Sound, Washington. In: Formation, evolution, and stability of coastal cliffs – status and trends. Hampton M, Griggs G (eds) U.S. Geological Survey Professional Paper 1693, 81-94.

Stover, C. W. and Coffman, J. L. 1993. Seismicity of the United States, 1568-1989 (Revised), U.S. Geological Survey Professional Paper 1527, United States Government Printing Office, Washington.

USGS. 2004. Landslide Types and Processes. USGS Fact Sheet 2004-3072, http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf

Varnes D. J., 1978. Slope movement types and processes. In: Schuster R. L. & Krizek R. J. Ed., *Landslides, analysis and control*. Transportation Research Board Sp. Rep. No. 176, Nat. Acad. oi Sciences, pp. 11–33.

DRAFT

WAC (Washington Administrative Code). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/WAC/default.aspx

Washington Military Department (WMD), Emergency Management Division. 2012. Washington State Enhanced Hazard Mitigation Plan. http://www.emd.wa.gov/plans/washington_state_hazard_mitigation_plan.shtml

Watson, I., and A. D. Burnett, 1995. *Hydrology: An environmental approach*. CRC Press, Inc. Boca Raton, FL.

WDC (Washington Department of Commerce, formerly Washington Department of Community, Trade and Economic Development). 2003. Critical Areas Assistance Handbook; available along with additional state guidance at: http://www.commerce.wa.gov/_CTED/documents/ID_976_Publications.pdf.

WDOE (Washington State Department of Ecology). *No date*. Erosion and Sediment Control Plan webpage. http://www.ecy.wa.gov/programs/wq/sand/escp.html

Wolfe, E. W., and T. C. Pierson, 1995, Volcanic-Hazard Zonation for Mount St. Helens, Washington, 1995: USGS Open-File Report 95-497

Woodinville, City of. 2009. City of Woodinville Shoreline Master Program.

7.5 Section 5 Wetlands

Adamus, P. R., E. J. Clairain, D. R. Smith, and R. E. Young. 1991. Wetland Evaluation Technique (WET). Vol. I. Literature Review and Evaluation Rationale. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Azous, A. and Horner, R. 2010. Wetlands and urbanization: implications for the future. CRC Press.

Booth, D. B. 1991. Urbanization and the natural drainage system impacts, solutions, and prognoses. The Northwest Environmental Journal 7(1):93-118.

Brinson, M. M. 1993. A hydrogeomorphic classification for wetlands. Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A270 053.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, and M. Witter. 1992a. Wetland Buffers: An Annotated Bibliography. Publ. 92-11. Adolfson Assoc., for Shorelands and Coastal Zone Manage. Program, Washington Dept. of Ecology, Olympia, WA.

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Mauermann, T. Erickson, and S.S. Cooke. 1992b. Wetland Buffers: Use and Effectiveness. Publ.

DRAFT

92-10. Adolfson Assoc., for Shorelands and Coastal Zone Management Program. Washington Dept. of Ecology, Olympia, WA.

Castelle, A.J., A.W. Johnson, and C. Conolly. 1994. Wetland and Stream Buffer Size Requirements - A Review. J. Environ. Qual. 23:878-882.

Castelle, A.J. and A.W. Johnson. 1998. Riparian vegetation effectiveness. *In* Abstracts from the Salmon in the City conference. Center for Urban Water Resources Management, University of Washington, 65 pp.

Castelle, A.J., and A.W. Johnson. 2000. Riparian Vegetation Effectiveness. National Council for Air and Stream Improvement Tech. Bull. No. 799.

Cooke Scientific Services Inc. 2000. Wetland and buffer functions semi-quantitative assessment methodology (SAM). Final working draft, user's manual. Seattle, WA.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. Publ. # FWS/OBS-79/31. 131 p.

Desbonnet, A., P. Pogue, V. Lee, and N. Wolff. 1994. Vegetated buffers in the coastal zone - A summary review and bibliography. Coastal Resources Center Technical Report No. 2064. University of Rhode Island Graduate School of Oceanography. Narragansett, RI 02882. 72 p.

Falter, C. M. 2007. Lake Leota Analysis for City of Woodinville Sustainable Development Program. Prepared for Steward and Associates and the City of Woodinville.

Granger, T., Hruby, T., McMillan, A., Peters, D., Rubey J., Sheldon, D., Stanley, S., Stockdale, E. 2005. Wetlands in Washington State, Volume 2 – Guidance for Protecting and Managing Wetlands. Washington State Department of Ecology Publication No. 05-06-008.

Hattermann, F., Krysanova, V., Hesse, C. 2008. Modelling wetland processes in regional applications. Hydrological Sciences Journal, 53(5), pp. 1001-1012.

Hogan, D. M., and M. R. Walbridge. 2007. Urbanization and nutrient retention in freshwater riparian wetlands. Ecological Applications 17(4):1142–1155.

Hruby, T. 1999. Assessments of wetland functions: What they are and what they are not. Environmental Management 23:75-85.

DRAFT

Hruby, T. 2004, Rev. 2006 (Updated Oct. 2008). Washington State Wetland Rating System for Western Washington. Washington State Department of Ecology Publication No. 04-06-025. Olympia, Washington.

Hruby, T., K Harper, S. Stanley. 2009. Selecting Wetland Mitigation Sites Using a Watershed Approach. Washington State Department of Ecology Publication No. 09-06-032. Olympia, WA.

Hruby, T. 2011. Calculating Credit and Debits for Compensatory Mitigation in Wetlands of Western Washington. Operational Draft. Washington State Department of Ecology Publication No. 10-06-011. Olympia, WA.

Hunt, R., D. Krabbenhoft, and M. Anderson. 1996. Groundwater inflow measurements in wetland systems. Water Resour. Res., 32(3): 495-507.

ITRC (Interstate Technology & Regulatory Council). 2003. Technical and regulatory guidance documents for constructed treatment wetlands. Prepared by the ITRC Wetland Team. Available online: http://www.itrcweb.org/Documents/WTLND-1.pdf.

Josselyn, M., J. Zedler, and T. Griswold. 1990. Wetland mitigation along the Pacific coast of the United States. Pages 3-36 in J.A. Kusler and M.E. Kentula (eds.). Wetland Creation and Restoration: The Status of Science, Part 2: Perspectives. Island Press, Washington, D.C.

Maxa, M. and Bolstad P. 2009. Mapping Northern Wetlands with High Resolution Satellite Images and LiDAR. Wetlands 29(1): 248-260.

McMillan, A. 2000. The science of wetland buffers and its implications for the management of wetlands. M.S. Thesis, Evergreen State College. 102 p.

Mitsch, W.J. and J. G. Gosselink. 2000. Wetlands, Third Edition. John Wiley & Sons, Inc. New York, New York.

NRC (National Research Council). 2001. Compensating for wetland losses under the Clean Water Act. National Academy Press, Washington D.C.

Poiani, K. A., B. Bedford, and M. Merrill. 1996. A GIS-based index for relating landscape characteristics to potential nitrogen leaching to wetlands. Landscape Ecology 11(4): 237-255.

Reinelt, L. E. and R. R. Horner. 1995. Pollutant removal from stormwater runoff by palustrine wetlands based on comprehensive budgets. Ecological Engineering 4(2): 77-97.

DRAFT

Richter, K.O. 1997. Criteria for the restoration and creation of wetland habitats of lentic-breeding amphibians of the Pacific Northwest. In: Macdonald KB, Weinmann F, eds. Wetland and Riparian Restoration: Taking a Broader View. U.S. Environmental Protection Agency, Region 10, Seattle, WA. pp. 72-94. EPA 910-R-97-007.

Schueler, T.R. 2000. The Impact of Stormwater on Puget Sound Wetlands. Technical Note #109 from Watershed Protection Techniques 3(2), Article 33.

Sheldon, D., T. Hruby, P. Johnson, K. Harper, A. McMillan, T. Granger, S. Stanley, and E. Stockdale. 2005. Wetlands in Washington State, Vol. 1: A Synthesis of the Science. Washington State Department of Ecology Publication #05-06-006. Olympia, WA.

Snohomish County. 2008. Critical Area Monitoring and Adaptive Management Plan.

U.S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0). Environmental Laboratory ERDC/EL TR-08-13, Wetlands Regulatory Assistance Program, U.S. Army Corps of Engineers Engineer Research and Development Center, Vicksburg, Mississippi.

WAC (Washington Administrative Code). November 2013. Washington State Legislature. Viewed online: http://apps.leg.wa.gov/WAC/default.aspx

WDOE (Washington State Department of Ecology). 1997. Washington State Wetlands Identification and Delineation Manual. Ecology Publication No. 96-94.

WDOE (Washington State Department of Ecology), U.S. Army Corps of Engineers Seattle District, and Environmental Protection Agency Region 10. 2006a. Wetland Mitigation in Washington State Part 1 – Agency Policies and Guidance. Ecology Publication No. 06-06-011a.

WDOE (Washington State Department of Ecology), U.S. Army Corps of Engineers Seattle District, and Environmental Protection Agency Region 10. 2006b. Wetland Mitigation in Washington State Part 2 – Developing Mitigation Plans. Ecology Publication No. 06-06-011b.

WDOE (Washington State Department of Ecology). 2008. Making Mitigation Work. The Report of the Mitigation that Works Forum. Ecology Publication No. 08-06-018.

WDOE (Washington State Department of Ecology). 2010a. Wetlands & CAO Updates: Guidance for Small Cities. Ecology Publication No. 10-06-002.

DRAFT

WDOE (Washington State Department of Ecology). 2010b. Puget Sound Watershed Characterization: Introduction to the Water Flow Assessment for Puget Sound, A Guide for Local Planners. Ecology Publication No. 10-06-014.

Wigington, Jr., P.J., J.L. Ebersole, M.E. Colvin, et al. 2006. Coho salmon dependence on intermittent streams. Front. Ecol. Environ. 10:513–18.

Wigington, P.J. Jr, S.M. Griffith, J.A. Field, J.E. Baham, W.R. Horwath Owen, J.H. Davis, S.C. Rain and J.J. Steiner. 2003. Nitrate removal effectiveness of a riparian buffer along a small, agricultural stream in Western Oregon. Journal of Environmental Quality 32:162-170.

Willard, D.E. and A.K. Hiller. 1990. Wetland dynamics: considerations for restored and created wetlands. Pages 459-466 in J.A. Kusler and M.E. Kentula (eds.). Wetland Creation and Restoration: The Status of the Science, Part 2: Perspectives. Island Press, Washington, D.C.

Wong, S.L. and R.H. McCuen. 1982. Design of vegetative buffer strips for runoff and sediment control. Maryland Department of Natural Resources, Coastal Resources Division, Tidewater Administration, Annapolis, MD. 23 p.

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Abu-Zreig, M., R.P. Rudra, M.N. Lalonde, H.R. Whiteley, and N.K. Kaushik. 2004. Experimental Investigation of Runoff Reduction and Sediment Removal by Vegetated Filter Strips. Hydrological Processes. 18: 2029-2037. Published online 12 May 2004 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hyp.1400.

Adams, L.W. 1994. Urban Wildlife Habitats: A Landscape Perspective. Univ. of Minn. Press, Minneapolis, MN. 208pp.

Alexander R.B., E.W. Boyer, R.A. Smith, et al. 2007. The role of headwater streams in downstream water quality. J. Am. Water Resour. 43:41–59.

Allan, J.D., M.S. Wipfli, J.P. Caouette, A. Prussian, J. Rodgers. 2003. Influence of streamside vegetation on inputs of terrestrial invertebrates to salmonid food webs. Canadian Journal of Fisheries and Aquatic Sciences. 60(3): 309-320.

DRAFT

Arnold, Jr., C.L. and C.J. Gibbons. 1996. Impervious surface coverage: the emergence of a key environmental indicator. Journal of the American Planning Association 62(2): 243-258.

Adolfson Associates, Inc. 2004. Woodin Creek Basin Habitat Assessment: Final Report. Prepared for the City of Woodinville. 66pp + Appendices.

Aubry K., C. Halpern, and C.Peterson. 2009. Variable-retention harvests in the Pacific northwest: a review of short-term findings from the DEMO study. For Ecol Manage 258(4):398-408.

Azerrad, J.M. 2012. Management Recommendations for Washington's Priority Habitats and Species: Great Blue Heron (Ardea herodias). 3-1 to 3-18 in E. Larsen, J. M. Azerrad, N. Nordstrom, editors. Management Recommendations for Washington's Priority Species, Volume IV: Birds. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Azous, A. L. and R.R. Horner. 1997. Wetlands and urbanization: Implications for the Future. Final Report of the Puget Sound Wetlands and Stormwater Management Research Program. Washington State Department of Ecology; King County Water and Land Resources Division; and University of Washington.

Baker M.E., D.E. Weller, and T.E. Jordan. 2006. Improved methods for quantifying potential nutrient interception by riparian buffers. Landscape Ecol 21(8):1327-45.

Ball, J., Bauer, RD., Vermeer, K., & Rabenberg, M.J. 1989. Northwest riverine and Pacific coast. In: Smith, L.M., Pederson, R.L. & Kaminski, R.M.(Eds.). Habitat Management for Migrating and Wintering Waterfowl in North America. Texas Tech University Press, Lubbock, Texas. Pp. 429-44.

Becker, C.G., C.R. Fonseca, C.F.B. Haddad, R.F. Batista, and P.I. Prado. 2007. Habitat split and the global decline of amphibians. Science 318:1775-1777

Beeson, C. and P. Doyle. 1995. Comparison of Bank Erosion and Vegetated and Non-Vegetated Channel Bends. Journal of American Water Resources Association 31(6)983-990.

Beier, P. and R.F. Noss. 1998. Do habitat corridors provide connectivity? Conserv. Bio. 12:1241-1252

DRAFT

Belisle,M., A. Desrochers, and M.J. Fortin. 2001. Influence of forest cover on the movements of forest birds: a homing experiment. Ecology, 82(7):1893–1904.

Bender, D., T. Contheran, and L. Fahrig. 1998. Habitat loss and population decline: A meta-analysis of the patch size effect. Ecology, 79(2):517–533.

Bernal, S., F. Sabater, A. Butturini, E. Nin, and S. Sabater. 2007. Factors limiting denitrification in a Mediterranean riparian forest. Soil Biology & Biochemistry 39 (10): 2685-2688.

Beschta, R. L., Bilby, R. E., Brown, G. W., Holtby, L. B., and Hofstra, T. D. 1987. Stream temperature and aquatic habitat: Fisheries and forestry interactions. Pages 191-232 *in* E. O. Salo, and T. W. Cundy, editors. Streamside management: Forestry and Fishery Interactions. University of Washington, Seattle, WA.

Bilby, R.E., and P.A. Bisson. 1998. Function and distribution of large woody debris. In R.J. Naiman and R.E. Bilby [eds.], Ecology and Management of Rivers. Springer-Verlag, New York.

Bisson, P. A., S.M. Claeson, S.M. Wondzell, A.D. Foster, and A. Steel. 2013. Evaluating Headwater Stream Buffers: Lessons Learned from Watershed- scale Experiments in Southwest Washington. Pgs. 165-184 In: Anderson, P. D. and Ronnenberg, K. L. (eds.). Density Management in the 21st Century: West Side Story. General Technical Report, PNW-GTR-880. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Blair, R. 1996. Land use and avian species diversity along an urban gradient. Ecol. Appl. 6:506-519.

Blair, R. 1999. Birds and butterflies along an urban gradient: surrogate taxa for assessing biodiversity? Ecol. Appl. 9:164-170.

Blanco-Canqui, H., C.J. Gantzer, S.H. Anderson, and E.E. Alberts. 2004. Grass barriers for reduced concentrated flow induced soil and nutrient loss. Soil Science Society of America Journal 68:1963-1972.

Blewett, C.M. and J.M. Marzluff. 2005. Effects of urban sprawl on snags and the abundance and productivity of cavity-nesting birds. Condor 107:677-692.

DRAFT

Bock, C.E., K.T. Vierling, S.L. Haire, J.D. Boone, and W.W. William. 2002 Patterns of rodent abundance on open-space grasslands in relations to suburban edges. Conserv. Biol. 16:1653-1658.

Bolton, S. and J. Shellberg. 2001. Ecological Issues in Floodplains and Riparian Corridors. Report to Washington Dept. of Transportation, Olympia.

Booth, D.B., and P.C. Henshaw. 2001. Rates of channel erosion in small urban streams. Pages 17-38 in M.S. Wigmosta and S.J. Burges, editors. Land Use and Watersheds: human influences on hydrology and geomorphology in urban and forestry areas. Water and Science Application Volume 2. Amer. Geophysical Union, Washington, DC.

Booth, D.B. and C.R. Jackson. 1997. Urbanization of aquatic systems-- degradation thresholds, stormwater detention, and the limits of mitigation. Journal of American Water Resources Association 22:

Booth, D.B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious-surface area, and the mitigation of stormwater impacts. Journal of American Water Resources Association 38:835-845.

Booth, D. B., J. R. Karr, S. Schauman, C. P. Konrad, S. A. Morley, M. G. Larson, and S. J. Burges. 2004. Reviving urban streams: land use, hydrology, biology, and human behavior. Journal of the American Water Resources Association, 40:1351-1364.

Bragg, DC. 2000. Simulating Catastrophic and Individualistic Large Woody Debris Recruitment for a Small Riparian System. Ecology 81(5):1383-1394.

Brazier, J. R., and G.W. Brown, G. W. 1973. Buffer strips for stream temperature control. Forest Research Laboratory, School of Forestry, Oregon State University, Corvallis, OR.

Brooks, M. L.,C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, D. Pyke. 2004. Effects of Invasive Alien Plants on Fire Regimes. BioScience, 54(7), 677.

Brosofske, K.D., J.Q Chen, R.J. Naiman, and J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in Western Washington. Ecological Applications 7: 1188-1200.

DRAFT

Brown, B. and R. Mitchell. 2001. Competition for pollination: effects of pollen of an invasive plant on seed set of a native congener. Oecologia, 129(1), 43–49.

Brown, B. J., R.J. Mitchell, and S.A. Graham. 2002. Competition for pollination between an invasive species (Purple loosestrife) and a native congener. Ecology, 83(8), 2328–2336.

Burges, S. J., M. S. Wigmosta, and J.M. Meena. 1998. Hydrological effects of land-use change in a zero-order catchment. Journal of Hydrologic Engineering.

Calambokidis, J. et al. 1984. Chemical Contaminants in Marine Mammals from Washington State. NOAA Tech. Memo. NOS OMS 6.

Caliman, F.A. and M. Gavrilescu. 2009. Pharmaceuticals, personal care products and endocrine disrupting agents in the environment - a review. Clean Soil, Air, Water 37:4-5.

Colvin, R., G.R. Giannico, J. Li, K.L. Boyer, and W.J. Gerth. 2009. Fish use of intermittent watercourses draining agricultural lands in the upper Willamette River Valley, Oregon. Trans. Am. Fish. Soc. 138: 1303-1313.

Crawford, J.A. and R.D. Semlitsch. 2007. Estimation of Core Terrestrial Habitat for Stream-Breeding Salamanders and Delineation of Riparian Buffers for Protection of Biodiversity. Conserv. Biol. 21:152-158

Cristea, N. and J. Janisch. 2007. Modeling the effects of riparian buffer width on effective shade and stream temperature. Publication No. 07-03-028. Washington Department of Ecology.

Cuo, L., D.P. Lettenmaier, M. Alberti, and J.E. Richey. 2009. Effects of a century of land cover and climate change on the hydrology of the Puget sound basin. Hydrol Process 23(6):907-33.

Cushman, S. A. 2006. Effects of habitat loss and fragmentation on amphibians: A review and prospectus. Biological Conservation, 128(2), 231–240.

Daehler, C. C. 2003. Performance comparisons of co-occurring native and alien invasive plants: Implications for conservation and restoration. Annual Review of Ecology, Evolution, and Systematics, 34(1), 183–211.

DRAFT

DeGasperi C., H. Berge, K. Whiting, J. Burkey, J. Cassin, R. Fuerstenberg. 2009. Linking hydrologic alteration to biological impairment in urbanizing streams of the Puget lowland, Washington, usa. J Am Water Resour Assoc 45(2):512-33.

Desrochers, A. and S. J. Hannon. 1997. Gap crossing decisions by dispersing songbirds during the post-fledging period. Conserv. Biol. 11:1204-1210.

Dethier, M. 2006. Native Shellfish in Nearshore Ecosystems of Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-04. Seattle District, U.S. Army Corps of Engineers, Seattle, WA.

Dettelbach, A. and D. Garland. 2005. Little Bear Creek Fecal Coliform Bacteria Total Maximum Daily Load (Water Cleanup Plan) Submittal Report. Ecology Publication 05-10-034.

Diffendorfer, J. E., M.S. Gaines, and R.D. Holt. 1995. Habitat Fragmentation and Movements of Three Small Mammals (Sigmodon, Microtus, and Peromyscus). Ecology, 76(3), 827.

Dong, J., J. Chen, K.D. Brosofske, and R.J. Naiman. 1998. Modelling air temperature gradients across managed small streams in western Washington. Journal of Environmental Management 5:309-321.

Donnelly, R. and J.M. Marzluff. 2004. Importance of reserve size and landscape context to urban bird conservation. Conserv. Biol. 18:733-745.

Dosskey, M.G., K.D. Hoagland, and J.R. Brandle. 2007. Change in filter strip performance over ten years. J Soil Water Conserv 62(1):21-32.

Dosskey, M. G., M. J. Helmers, and D. E. Eisenhauer. 2008. A design aid for determining width of filter strips. Journal of Soil and Water Conservation 63(4):232-241.

Dudley, S., J. C. Fischenich, and S. R. Abt. 1998. Effect of woody debris entrapment on flow resistance. J. Amer. Water Res. Assoc. 34(5): 1189-1197.

Fahrig, L. 2003. Effects of habitat fragmentation on Biodiversity. Annu. Rev. Ecol. Evol. Syst. 2003. 34:487-515.

Fahrig, L., J.H. Pedlar, S.H. Hope, P.D. Taylor, and J.F. Wagner. 1995. Effects of road traffic on amphibian density. Biol. Conserv. 73:177-182.

DRAFT

Falter, C. M. 2007. Lake Leota Analysis for City of Woodinville Sustainable Development Program. Prepared for Steward and Associates and the City of Woodinville.

Fausch, K. D., and T.G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fisheries and Aquatic Sciences 49:682-693.

Feist, B. E., E.R. Buhle, P. Arnold, J.W. Davis and N.L. Scholz. 2011. Landscape Ecotoxicology of Coho Salmon Spawner Mortality in Urban Streams. PLoS ONE 6(8):e23424. doi:10.1371/journal.pone.0023424.

FEMAT (Forest Ecosystem Management Assessment Team). 1993. Forest ecosystem management: an ecological, economic, and social assessment. U.S. Departments of Agriculture, Commerce, and Interior. Portland Oregon.

Fleeger, J. W., K.R. Carman, and R.M. Nisbet. 2003. Indirect Effects of Contaminants in Aquatic Ecosystems. The Science of the Total Environment.

Galbraith, R.V., E.A. MacIsaac, J. Macdonald, J. Stevenson, A.P. Farrell. 2006. The effect of suspended sediment on fertilization success in sockeye (Oncorhynchus nerka) and coho (Oncorhynchus kisutch) salmon. Canadian Journal of Fisheries & Aquatic Sciences.

Gilbert-Norton, L, R Wilson, JR Stevens, and KH Beard. 2010. A meta-analytic view of corridor effectiveness. Conserv. Biol. 24:660-668.

Gillies, C.S. and C.C. St. Clair. 2008. Riparian corridors enhance movement of a forest specialist in a fragmented tropical forest

Glasoe, S. and A. Christy. 2004. Literature Review and Analysis: Coastal Urbanization and Microbial Contamination of Shellfish Growing Areas. Puget Sound Action Team. Publication #: PSAT04-09

Gomi, T., R. D. Moore, and A.S. Dhakal. 2006. Headwater Stream Temperature Response to Clear-cut Harvesting with Different Riparian Treatments, Coastal British Columbia, Canada. Water Resources Research. Vol. 42, W08437, doi:10.1029/2005WR004162.

Gomi, T., D. Moore, and M. Hassan. 2005. Suspended sediment dynamics in small forest streams of the pacific northwest. J Am Water Resour Assoc 41(4):877-98.

DRAFT

Gomi, T., R. Sidle, and J. Richardson. 2002. Understanding processes and downstream linkages of headwater systems. Bioscience 52(10):905-16.

Grant, S.C.H and P.S. Ross. 2002. Southern Resident Killer Whales at Risk: Toxic Chemicals in the British Columbia and Washington Environment. Canadian Technical Report of Fisheries and Aquatic Science 2412. Fisheries and Oceans Canada.

Gregory, S.V., F.J. Swanson, W. A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41: 540-551.

Grizzel, J., M. McGowan, D. Smith, and T. Beechie. 2000. Streamside buffers and large woody debris recruitment: evaluating the effectiveness of watershed analysis prescriptions in the North Cascades region. TFW-MAG1-00-003. Olympia, WA. Timber Fish and Wildlife 37p.

Gurnell, A.M., H. Piegay, F.J. Swanson, and S.V. Gregory. 2002. Large wood and fluvial processes. Freshwater Biology, 47(4), 601–619.

Hannon, S.J. and F.K.A. Schmiegelow. 2002. Corridors may not improve the conservation value of small reserves for most boreal birds. Ecological Applications 12:1457–1468.

Hansen, A. J., R. L. Knight, J. M. Marzluff, S. Powell, K. Brown, P. H. Gude, and K. Jones. 2005. Effects of exurban development on biodiversity: patterns, mechanisms, and research needs. Ecol. Applic. 15:1893-1905.

Harding, J. S., K. Claassen, and N. Evers. 2006. Can forest fragments reset physical and water quality conditions in agricultural catchments and act as refugia for forest stream invertebrates? Hydrobiologia 568:391-402.

Harmon, M.E., J.F. Franklin, F.J. Swanson, P. Sollins, S.V. Gregory, J.D. Lattin, N.H. Anderson, S.P. Cline, N.G. Aumen, J.R. Sedell, G.W. Lienkaemper, K. Cromack Jr., and K.W. Cummins. 1986. Ecology of Coarse Woody Debris in Temperate Ecosystems. Advances in Ecological Research 15:133-301.

Hays, D.W and R.L. Milner. 1999. Peregrine Falcon. Pages 11-1 to 11-4 in E. Larsen, J. M. Azerrad, N. Nordstrom, editors. Management Recommendations for Washington's Priority Species, Volume IV: Birds. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

DRAFT

Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross, and N.L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. NOAA Technical Memorandum NMFS-NWFSC-83.

Herkert, J. 1994. The Effects of Habitat Fragmentation on Midwestern Grassland Bird Communities. *Ecological Applications*, *4*(3), 461–471. Retrieved from http://www.jstor.org/stable/1941950.

Heisler, J., M. Glibertb, J.M. Burkholder, D.M. Anderson, W. Cochlane, W.C. Dennison, Q. Dortch, C.J. Gobler, C.A. Heil, E. Humphries, A. Lewitus, R. Magnien, H.G. Marshall, K. Sellner, D.A. Stockwell, D.K. Stoecker, M. Suddleson. 2008. Eutrophication and harmful algal blooms: A scientific consensus. Harmful Algae 8 (3-13)

Heithecker, T. and C. Halpern. 2006. Variation in microclimate associated with dispersed-retention harvests in coniferous forests of western Washington. Forest Ecology and Management 226(1-3): 60-71.

Heithecker, T. and C. Halpern. 2007. Edge-related gradients in microclimate in forest aggregates following structural retention harvests in western Washington. for Ecol Manage 248(3):163-73.

Helmers, M.J., D.E. Eisenhauer, M.G. Dosskey, T.G. Franti, J.M. Brothers, and M.C. McCullough. 2005. Flow pathways and sediment trapping in a field-scale vegetative filter. Transactions of the ASAE 48:955-968.

Hennings, L.A. and W.D. Edge. 2003. Riparian bird community structure in Portland, Oregon: Habitat, urbanization, and spatial scale patterns.Condor 105:288–302.

Herkert, J. R., D. L. Reinking, D. A. Wiedenfeld, M. Winter, J. L. Zimmerman, W. E. Jensen, E. J. Finck, R. R. Koford, D. H. Wolfe, S. K. Sherrod, M. A. Jenkins, J. Faaborg and S. K. Robinson. 2003. Effects of Prairie Fragmentation on the Nest Success of Breeding Birds in the Midcontinental United States. Conserv. Biol 17:587-594.

Hilty, J.A., W.Z. Lidicker Jr., and A.M. Merenlender. 2006. Corridor Ecology: The science and practice of linking landscapes for biodiversity conservation. Island Press, Washington, DC.

DRAFT

Hoover S., L. Shannon, J. Ackerman. 2007 . The effect of riparian condition on invertebrate drift in mountain streams. Aquat Sci 69(4):544-53.

Jackson, C. R., D.P. Batzer, S.S. Cross, S.M. Haggerty, C.A Sturm.. 2007. Headwater streams and timber harvest: Channel, macroinvertebrate, and amphibian response and recovery. Forest Science.

Jensen, D.W., E.A. Steel, A.H. Fullerton, G.R. Pess. 2009. Impact of Fine Sediment on Egg-To-Fry Survival of Pacific Salmon: A Meta-Analysis of Published Studies. Reviews in Fisheries Science.

Jin, C.X. and M.J.M. Romkens. 2001. Experimental studies of factors in determining sediment trapping in vegetative filter strips. Trans. ASAE 44:277-288.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press. Corvallis, Oregon. 736 pp.

Jones, J.A.. 2000. Hydrologic processes and peak discharge response to forest removal, regrowth, and roads in 10 small experimental basins, western Cascades, Oregon. Water Resources Research.

Jordan, N. R., D.L. Larson, and S.C. Huerd. 2008. Soil modification by invasive plants: effects on native and invasive species of mixed-grass prairies. Biological Invasions, 10(2), 177–190.

Karr, J.R. 1998. Rivers As Sentinels: Using the Biology of Rivers to Guide Landscape Management. In River Ecology and Management: Lessons from the Pacific Coastal Ecoregion, ed. R.J. Naiman and R.E. Bilby, 502-528. New York: Springer-Verlag.

Kaufmann, P.R and J.M. Faustini. 2012. Simple measures of channel habitat complexity predict transient hydraulic storage in streams. Hydrobiologia.

Keller, C.M.E., C.S. Robbins, and J.S. Hatfield. 1993. Avian communities in riparian forests of different widths in Maryland and Delaware. Wetlands 13:137-144.

Kelly J.M., J.L. Kovar, R. Sokolowsky, T.B. Moorman. 2007. Phosphorus uptake during four years by different vegetative cover types in a riparian buffer. Nutr Cycling Agroecosyst 78(3):239-51.

DRAFT

Kerwin, J., 2001. Salmon and Steelhead Habitat Limiting Factors Report for the Cedar - Sammamish Basin (Water Resource Inventory Area 8). Washington Conservation Commission. Olympia, WA.

Kiffney P., J. Richardson, and J. Bull. 2003. Responses of periphyton and insects to experimental manipulation of riparian buffer width along forest streams. J Appl Ecol 40(6):1060-76.

Kiffney, P M., J.S. Richardson, and J.P. Bull 2004. Establishing light as a causal mechanism structuring stream communities in response to experimental manipulation of riparian buffer width. Journal of the North American Benthological Society 23(3):542-555.

King County. 2005. Sammamish River Water and Sediment Quality Assessment Final Report. June 2005. Water and Land Resources Division, Seattle, WA.

Kissling, M.L and E.O. Garton. 2008. Forested buffer strips and breeding bird communities in Southeast Alaska. Journal of Wildlife Management 72(3):674-681.

Klubar, M.R., D.H. Olson, and K.J. Puettmann. 2008. Amphibian distributions in upslope areas and their habitat associations on managed forest landscapes in the Oregon coast range. For. Ecol. ad Manage. 256:529-535

Knopf, F.L., R.R. Johnson, T. Rich, F.B. Samson, and R.C. Szaro. 1988. Conservation of riparian ecosystems in the United States. Wilson Bull. 100:272-284.

Knutson, K.L. and V.L. Naef. 1997. Management Recommendations for Washington's Priority Habitats: Riparian. Washington Department of Fish and Wildlife, Olympia, Washington. 181pp.

Knutson, M.G., W.B. Richardson, D.M. Reineke, B.R Gray, J.R. Parmelee, and S.E. Weick. 2004. Agricultural ponds support amphibian populations. Ecological Applications 14:669-684.

Konrad, C.P., and D.B. Booth. 2005. Hydrologic changes in urban streams and their ecological significance. In L. R. Brown, R. H. Gray, R. M. Hughes, and M. R. Meador (editors). Effects of urbanization on stream ecosystems. Symposium 47. American Fisheries Society, Bethesda, Maryland (in press).

DRAFT

Konrad, C.P., D.B. Booth, and S.J. Burges. 2005. Effects of urban development in the Puget Lowland, Washington, on interannual streamflow patterns: Consequences for channel form and streambed disturbance. Water Resources Research 41(7): W0700.

Lazzaro, L., Otto, S., and G. Zanin. 2008. Role of hedgerows in intercepting spray drift: Evaluation and modelling of the effects. Agriculture, Ecosystems and Environment, 123(4):317-327; Feb 2008

Lee, K. H., T.M. Isenhart, and R.C. Schultz. 2003. Sediment and nutrient removal in an established multi-species riparian buffer. Journal of Soil and Water Conservation 58(1):1-10.

Lehtinen, R.M., S.M. Galatowitsch, and J.R. Tester. 1999. Consequences and habitat loss and fragmentation for wetlands amphibian assemblages. Wetlands 19:1-12.

Lens, L. and A.A. Dhondt. 1994. Effects of habitat fragmentation on the timing of Crested Tit Parus cristatus natal dispersal. Ibis 135:147-152.

Lewis, J.C. and J.M. Azerrad. 2003. Pileated Woodpecker. Pages 29-1 to 29-9 in E. Larsen, J. M. Azerrad, N. Nordstrom, editors. Management Recommendations for Washington's Priority Species, Volume IV: Birds. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Lienkaemper, G.W., and F.J. Swanson. 1987. Dynamics of large woody debris in streams in old-growth Douglas-fir forests. Canadian Journal of Forest Research 17:150-156.

Long, E. R., M. Dutch, S. Weakland, B. Chandramouli and J.P. Benskin. 2013. Quantification of pharmaceuticals, personal care products, and perfluoroalkyl substances in the marine sediments of Puget Sound, Washington, USA. Environmental Toxicology and Chemistry, 32: 1701–1710.

Mabry, K.E. and G.W. Barrett. 2002. Effectrs of corridors on home range sizes and interpatch movements of three small mammal species. Landscape Ecol. 17:629-636

Machtans, C.S., M.A. Villard, and S.J. Hannon. 1996. Use of riparian buffer strips as movement corridors by forest birds. Conserv. Biol. 10:1366-1379.

DRAFT

Marzluff, J.M. 2001. Worldwide urbanization and its effects on birds. Pages 19-48 in Marzluff, J.M., R. Bowman, and R. Donnelly, editors. Avian Conservation and Ecology in an Urbanizing World. Kluwar Academic Press, Norwell, MA. 585pp.

Marzluff, J.M and K. Ewing. 2001. Restoration of fragmented landscapes for the conservation of birds: a general framework and specific recommendations for urbanizing landscapes. Restor. Ecol. 9:280-292.

Marzluff, J.M. 2005. Island biogeography for an urbanizing world: how extinction and colonization may determine biological diversity in human-dominated landscapes. Urban Ecosyst. 8:157-177.

Marzluff, J.M. and A.D. Rodewald. 2008. Conserving biodiversity in urbanizing areas: nontraditional views from a bird's perspective. Cities and the Environ. 1:1-28.

Mason J., C. Moorman, G. Hess, and K. Sinclair. 2007. Designing suburban greenways to provide habitat for forest-breeding birds. Landscape Urban Plann 80(1-2):153-64.

May, C. L., and R.E. Gresswell. 2003. Large wood recruitment and redistribution in headwater streams in the southern Oregon Coast. Canadian Journal of Forest Research, 33, 1352–1362. doi:10.1139/X03-023.

May, C. W., R. R. Horner, J. R. Karr, B. W. Mar, and E. B. Welch. 1997. Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion. Watershed Protection Techniques Vol. 2, No. 4.

May, C.W., E.B. Welch, R.R. Horner, J.R. Karr, and B.W. Mar. 1997b. Quality Indices for Urbanization Effects in Puget Sound Lowland Streams. Final Report for Washington Department of Ecology, Centennial Clean Water Fund Grant No. G9400121. Department of Civil Engineering, University of Washington, Seattle, WA.

Mayer, P.M., S.K. Reynolds, J. Marshall, D. McCutchen, and T.J. Canfield. 2007. Meta-Analysis of Nitrogen Removal in Riparian Buffers. Journal of Environmental Quality. 36: 1172-1180.

Mayer, P.M., S.K. Reynolds, D. McCutchen, and T.J. Canfield. 2005. Riparian Buffer Width, Vegetative Cover, and Nitrogen Removal Effectiveness: A Review of Current Science and Regulations. EPA/600/R-05/118. Cincinnati, Ohio, U.S. Environmental Protection Agency.

DRAFT

McBride, M. and D.B. Booth. 2005. Urban impacts on physical stream condition: Effects of spatial scale, connectivity, and longitudinal trends. Journal of the American Water Resources Association 41:565-580.

McDade M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. Van Sickle . 1990. Source distances for coarse woody debris entering small streams in western Oregon and Washington. Can J Forest Res 20:326–330

McIntyre, J. K., D. H. Baldwin, J. P. Meador, and N. L. Scholz. 2008. Chemosensory deprivation in juvenile coho salmon exposed to dissolved copper under varying water chemistry conditions. Environmental Science & Technology 42:1352-1358.

McIntyre, J. K., D.H. Baldwin, D. Beauchamp, and N.L. Scholz. 2012. Low-level copper exposures increase visibility and vulnerability of juvenile coho salmon to cutthroat trout predators. Ecological applications : a publication of the Ecological Society of America, 22(5):1460–71.

McKinney, M. L. 2002. Urbanization, Biodiversity, and Conservation. BioScience, 52(10).

Melles, S., S. Glenn, and K. Martin. 2003. Urban bird diversity and landscape complexity: species-environment associations along a multiscale habitat gradient. Conserv. Ecol. 7 [online].

Mills, L.J. and C. Chichester 2005. Review of evidence: Are endocrine-disrupting chemicals in the aquatic environment impacting fish populations? Sci Total Environ 343(1-3):1-34.

Miltner, R., D. White, and C. Yoder. 2004. The biotic integrity of streams in urban and suburbanizing landscapes. Landscape Urban Plann 69(1):87-100.

Misra, A.K., J.L. Baker, S.K. Mickelson, and H. Shang. 1996. Contributing area and concentration effects on herbicide removal by vegetative buffer strips. Trans. ASAE 39:2105-2111.

Monohan, C.E. 2004. Riparian buffer function with respect to nitrogen transformation and temperature along lowland agricultural streams in Skagit County, Washington. Dissertation, Univ. Washington, Seattle.

Moore, A.A. and M.A. Palmer. 2005. Invertebrate biodiversity in agricultural and urban headwater streams: Implications for conservation and management. Ecological Applications 15:1169-1177.

DRAFT

Moore, R.D. and S.M. Wondzell. 2005. Physical hydrology and the effects of forest harvesting in the Pacific Northwest: a review. Journal of the American Water Resources Association 41:763-784.

Moore, R.D., D.L. Spittlehouse, and A. Story. 2005. Riparian microclimate and stream temperature response to forest harvesting: a review. Journal of the American Water Resources Association 41:813-834.

Moscrip, A.L., and D.R. Montgomery. 1997. Urbanization, flood frequency, and salmon abundance in Puget lowland streams. Journal American Water Resources Association 33(6): 1289-1297.

Murphy, M. L. and K. V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American Journal of Fisheries Management.9(4):427-436.

Naiman, R.J., T.J. Beechie, L.E. Benda, D.R. Berg, P.A. Bisson, L.H. MacDonald, M.D. O'Connor, P.L. Olson, and E.A. Steel. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion, p. 127-188. In: R.J. Naiman (ed.), Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag, New York.

Naiman, R.J., C.A.Johnson, and J.C. Kelley. 1988. Alteration of North American Streams by Beaver: structure and dynamics of streams are changing as beaver recolonize their historic habitat. Bioscience 38(11)753-762.

Naiman, R.J., H. Décamps, and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. Ecological Applications 3(2): 209-212

Nakamura, F. and F. Swanson. 1993. Effects of coarse woody debris on morphology and sediment storage of a mountain stream system in western Oregon. Earth Surface Processes and Landforms 18: 43-61.

Nakamura, F., F.J. Swanson, and S.M. Wondzell. 2000. Disturbance regimes of stream and riparian systems -- a disturbance-cascade perspective. Hydrological Processes 14:2849-2860.

Nelitz M.A., E.A. MacIsaac, and R.M. Peterman. 2007. A science-based approach for identifying temperature-sensitive streams for rainbow trout. N Am J Fish Manage 27(2):405-24.

DRAFT

Nelson, G.S. and S.M. Nelson. 2001. Bird and butterfly communities associated with two types of urban riparian areas. Urban Ecosyst. 5:95-108.

Newbold, J. D., S. Herbert, B.W. Sweeney, P. Kiry, and S.J. Alberts. 2010. Water Quality Functions of a 15-Year-Old Riparian Forest Buffer System. JAWRA Journal of the American Water Resources Association, 46: 299–310.

Olden, J. D., L. Poff, M.R. Douglas, M.E. Douglas and K.D. Fausch. 2004. Ecological and evolutionary consequences of biotic homogenization. Trends in ecology & evolution, 19(1), 18–24.

O'Neill, S.M., J.E. West, and J.C. Hoeman. 1998. Spatial Trends in the Concentration of Polychlorinated Biphenyls (PCBs) in Chinook (Oncorhynchus tshawytscha) and Coho Salmon (O. kisutch) in Puget Sound and Factors Affecting PCB Accumulation: Results from the Puget Sound Ambient Monitoring Program. Washington Department of Fish and Wildlife.

Olson D, P. Anderson, C. Frissell, H. Welsh, and D. Bradford. 2007. Biodiversity management approaches for stream-riparian areas: Perspectives for Pacific northwest headwater forests, microclimates, and amphibians. for Ecol Manage 246(1):81-107.

Oneal, A. and J. Rotenberry. 2009. Scale-dependent habitat relations of birds in riparian corridors in an urbanizing landscape. Landscape Urban Plann 92(3-4):264-75.

Orrock, J. L. and B. J. Danielson. 2005. Patch shape, connectivity, and foraging by the oldfield mouse, Peromyscus polionotus. Journal of Mammalogy 86: 569-575.

Osborne, L. L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. Freshwater biology 29:243-258.

Otto S., M. Vianello, A. Infantino, G. Zanin, and A. Di Guardo. 2008. Effect of a full-grown vegetative filter strip on herbicide runoff: Maintaining of filter capacity over time. Chemosphere 71(1):74-82.

Pardini, R, S. Marques de Souza, R. Braga-Neto, and JP Metzger. 2005. The role of forest structure, fragment size, and corridors in maintaining small mammal abundance and diversity in an Atlantic forest landscape. Biological Conserv. 124: 253-266.

DRAFT

Parker, T.H., B.M. Stansberry, C.D. Becker, and P.S. Gipson. 2005. Edge and area effects on the occurrence of migrant forest songbirds. Conservation Biology 19:1157-1167.

Parkyn, S. 2004. Review of Riparian Buffer Zone Effectiveness. Canada Ministry of Agriculture and Forestry (MAF). Technical Paper No: 2004/05.

Pasitschniak-Arts, M., and F. Messier. 1995. Risk of predation on waterfowl nests in the Canadian prairies: effects of habitat edges and agricultural practices. Oikos 73: 347- 355.

Peak, R.G. and F.R. Thompson. 2006. Factors affecting avian species richness and density in riparian areas. J. Wildlife Manage. 70(1):173–179.

Pearson, S.F. and D.A. Manuwal. 2001. Breeding bird response to riparian buffer width in managed Pacific Northwest Douglas fir forests. Ecological Applications 11: 840-853.

Pess, G.R., D.R. Montgomery, E.A. Steel, R.E. Bilby, B.E. Feist, H.M. Greenberg. 2002. Landscape characteristics, land use, and coho salmon (Oncorhynchus kisutch) abundance, Snohomish River, Wash., U.S.A. Canadian Journal of Fisheries & Aquatic Sciences.

Peterson, B.J., W.M. Wollheim, P.J. Mulholland, J.R. Webster, J.L. Meyer, J.L. Tank, E. Martí, W.B. Bowden, H.M. Valett, A.E. Hershey, W.H. McDowell, W.K. Dodds, S.K. Hamilton, S. Gregory, and D. Morrall. 2001. Control of nitrogen export from watersheds by headwater streams. Science. 292: 86-90.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics, 52(3), 273–288.

Pollock, M.M., T.J. Beechie, M. Liermann, and R.E. Bigley. 2009. Stream temperature relationships to forest harvest in western Washington. Journal of the American Water Resources Association 45(1):141–156.

Pollock, M., G. Pess, T. Beechie, D. Montgomery. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River basin, Washington, USA. American Journal of Fisheries Management 24: 749-760.

DRAFT

Polyakov, V. A. Fares, and M.H. Ryder. 2005. Precision Riparian Buffers for the Control of Nonpoint Source Pollutant Loading into Surface Water: A Review. Environmental Review. 13: 129-144. Published on the NRC Research Press Web site at http://er.nrc.ca/ on 16 August 2005.

Poole, G.C. and C.H. Berman. 2001. An ecological perspective on in-stream temperature: natural heat dynamics and mechanisms of human-caused thermal degradation. Environmental Management 27(6): 787-802.

Poor, C. and J. McDonnell. 2007 . The effects of land use on stream nitrate dynamics. J Hydrol (Amst) 332(1-2):54-68.

Qiu, Z. 2003. A VSA-based strategy for placing conservation buffers in agricultural watersheds. Environmental Management 32:299-311.

Qiu, Z. 2009. Assessing Critical Source Areas in Watersheds for Conservation Buffer Planning and Riparian Restoration. Environmental Management: 44:968-980.

Rayne, S., G. Henderson, P. Gill, and K. Forest. 2008. Riparian forest harvesting effects on maximum water temperatures in wetland-sourced headwater streams from the nicola river watershed, British Columbia, Canada. Water Resour Manage 22(5):565-78.

Reichard, S.H., L. Chlker-Scott, and S. Buchanan. 2001. Interactions among non-native plants and birds. Pages 179-223 in Marzluff, J.M., R. Bowman, and R. Donnelly, editors. Avian Conservation and Ecology in an Urbanizing World. Kluwar Academic Press, Norwell, MA. 585pp.

Reichenberger, S., M. Bach, A. Skitschak, and H.G. Frede. 2007. Mitigation strategies to reduce pesticide inputs into ground- and surface water and their effectiveness; a review. Sci Total Environ 384(1-3):1-35.

Reid, L. and S. Hilton. 1998. Buffering the Buffer. Proceedings of the conference on coastal watersheds: the Caspar Creek Story; 6 May 1998, Ukiah, CA, United States Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Relyea, R.A. 2005. The lethal impact of Roundup® on aquatic and terrestrial amphibians. Ecological Applications 15:1118-1124

DRAFT

Ricciardi, A., R.L. Neves, and J.B. Rasmussen. 1998. Impending extinctions of North American freshwater mussels (Unionoida) following the zebra mussel (Dreissena polymorpha) invasion. Journal of Animal Ecology, 67(4), 613–619.

Robison, E.G. and R.L. Beschta. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. Forest Science. 36(3):790-801

Rodewald, A.D. 2003. The importance of land uses within the landscape matrix. Wildl. Soc. Bull. 31:586-592.

Roni, P. and T.P. Quinn. 2001. Density and size of juvenile salmonids in response to placement of large woody debris in western Oregon and Washington streams. Canadian Journal of Fisheries & Aquatic Sciences.

Rottenborn, S.C. 1999. Predicting the impacts of urbanization on riparian bird communities. Biol. Conserv. 88:289-299.

Rubbo, M. J., and J.M. Kiesecker. 2005. Amphibian Breeding Distribution in an Urbanized Landscape. Conservation Biology, 19(2), 504–511.

Schaefer, V. 2003. Green links and urban biodiversity: an experiment in connectivity. 2003 Proceedings of the Georgia Basin/Puget Sound Research Conference. 9pp.

Scholz, N. L., M. S. Myers, S. G. McCarthy, J. S. Labenia, J. K. McIntyre, G. M. Ylitalo, L. D. Rhodes, C. A. Laetz, C. M. Stehr, B. L. French, B. McMillan, D. Wilson, L. Reed, K. D. Lynch, S. Damm, J. W. Davis, and T. K. Collier. 2011. Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. PloS one 6(12):e28013.

Semlitsch, R.D. and J.R. Bodie. 2003. Biological Criteria for buffer zones around wetland and riparian habitats for amphibians and reptiles. Conserv. Biol. 17:1219-1228.

Shandas, V. and M. Alberti. 2009. Exploring the role of vegetation fragmentation on aquatic conditions: Linking upland with riparian areas in Puget Sound lowland streams. Landscape Urban Plann 90(1-2):66-75.

Sheridan, C. and D. Olson. 2003. Amphibian assemblages in zero-order basins in the Oregon coast range. Can J for Res /Rev can Rech for 33(8):1452-77.

DRAFT

Sheridan, J.M., R. Lowrance, and D.D. Bosch. 1999. Management effects on runoff and sediment transport in riparian forest buffers. Transactions of the American Society of Agricultural Engineers 42(1): 55-64.

Shirley, S.M. 2006. Movement of forest birds across river and clearcut edges of varying riparian buffer strip widths. Forest Ecology and Management 223(1):190-199.

Shirley, S.M. and J.N.M. Smith. 2005. Bird community structure across riparian buffer strips of varying width in a coastal temperate forest. Biological Conservation 125:475-489.

Sobota, D. J., S.L., Johnson, S.V. Gregory, and L.R. Ashkenas. 2012. A Stable Isotope Tracer Study of the Influences of Adjacent Land Use and Riparian Condition on Fates of Nitrate in Streams. Ecosystems 15:1-17

Solazzi, M. F., Nickolson, T. E., Johnson, S. L., and Rogers, J. D. 2000. Effects of increasing winter rearing habitat on abundance of salmonids in two Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 57(5):906-914.

Sommer, T. R., Harrell, W. C., and Nobriga, M. L. 2005. Habitat use and stranding risk of juvenile Chinook salmon on a seasonal floodplain. North American Journal of Fisheries Management 25(4):1493-1504.

Southerland, M. 1993. Habitat Evaluation: Guidance for the review of environmental impact assessment documents. Prepared for the U.S. Environmental Protection Agency.

Spromberg, J.A. and N.L. Scholz. 2011. Estimating the Future Decline of Wild Coho Salmon Populations Resulting from Early Spawner Die-Offs in Urbanizing Watersheds of the Pacific Northwest, USA. Integrated Env. Assessment and Management. Vol 7. No 4: 648-656.

Sridhar, V., A.L. Sansone, J. LaMarche, T. Dubin, and D.P. Lettenmaier. 2004. Prediction of Stream Temperature in Forested Watersheds. Journal of the American Water Resources Association (JAWRA) 40(1): 197-213.

Steward & Associates and Jones and Stokes. 2007. Sustainable Development Study – R1 Zone: Environmental Report. Report to City of Woodinville Development Service Department.

DRAFT

Stoddard, M.A. and J.P. Hayes. 2005. The influence of forest management on headwater stream amphibians at multiple spatial scales. Ecological Applications 15(3): 811-823; June 2005.

Story, A., R. Moore, and J. Macdonald. 2003. Stream temperatures in two shaded reaches below cutblocks and logging roads: downstream cooling linked to subsurface hydrology. Canadian Journal of Forest Research 33(8): 1383-1396.R.

Suttle, K. B., M. Power, J. Levine, and C. McNeely. 2004. How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications 14(4):969-974.

Thompson, D.G., B.F. Wojtaszek, B. Staznik, D.T., and G.R. Stephenson. 2004. Chemical and biomonitoring to assess potential acute effects of Vision® herbicide on native amphibian larvae in forest wetlands. Environmental Toxicology and Chemistry 23: 843-849.

Todd, B.D., T. Luhring, B. Rothermel , J. Whitfield Gibbons. 2009. Effects of forest removal on amphibian migrations: implications for habitat and landscape connectivity. Journal of Applied Ecology 46:3, 554-561

Tomer, M., M. Dosskey, M. Burkart, D. James, M. Helmers, and D. Eisenhauer. 2009. Methods to Prioritize Placement of Riparian Buffers for Improved Water Quality. Agroforestry Systems 75:17-25.

Tremblay, MA and CC St Clair. 2009. Factors affecting the permeability of transportation and riparian corridors to the movements of songbirds in an urban landscape. J. Applied Ecol. 46:1314-1322.

Tschapalinski, P. J. and Hartman, G. F. 1983. Winter distribution of juvenile coho salmon (Oncorhynchus kisutch) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Canadian Journal of Fisheries and Aquatic Sciences 40(4):452-461.

United States Environmental Protection Agency (USEPA). 2003. EPA Region 10 guidance for Pacific Northwest state and tribal temperature water quality standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

DRAFT

Utz, R., R.H. Hilderbrand, and D.M. Boward. 2009. Identifying regional differences in threshold responses of aquatic invertebrates to land cover gradients. Ecological Indicators 9:556–567.

Van Sickle, J., and S. V. Gregory. 1990. Modeling inputs of large woody debris to streams from falling trees. Canadian Journal of Forest Research 20: 1593-1601.

Vanderhoof. J. 2011. Lake Washington/Cedar/Sammamish Watershed Land Cover Change Analysis. WRIA 8 Technical Memorandum 2011-01.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. 37: 130-137.

Verstraeten, G, J. Poesen, K. Gillijns, G. Govers. 2006. The use of riparian vegetated filter strips to reduce river sediment loads: an overestimated control measure? Hydrol Process 20(20):4259-67.

Walsh CJ, K. A. Waller, J. Gehling and R. MacNally. 2007. Riverine invertebrate assemblages are degraded more by catchment urbanisation than by riparian deforestation. Freshwater Biology 52: 574–587.

Wang, L., J. Lyons, and P. Kanehl. 2003. Impacts of urban land cover on trout streams in Wisconsin and Minnesota. Trans. Amer. Fish. Soc. 132: 825-839.

Washington State Department of Ecology (Ecology). 2002. Evaluating Standards for Protecting Aquatic Life in Washington's Surface Water Quality Standards Temperature Criteria: Draft discussion paper and literature review.

_____. Electronic Reference. Water Quality Assessment and 303(d) List. http://www.ecy.wa.gov/programs/Wq/303d/index.html [Accessed December 10, 2013]

Watson and Rodrick. 2000. Bald Eagle. 9-1 to 9-15 in E. Larsen, J. M. Azerrad, N. Nordstrom, editors. Management Recommendations for Washington's Priority Species, Volume IV: Birds. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent, and vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia. Internet: http://outreach.ecology.uga.edu/toos/buffers/lit_review.pdf

DRAFT

Wigington, Jr., P.J., J.L. Ebersole, M.E. Colvin, et al. 2006. Coho salmon dependence on intermittent streams. Front. Ecol. Environ. 10:513–18.

Wigington, P.J. Jr, S.M. Griffith, J.A. Field, J.E. Baham, W.R. Horwath Owen, J.H. Davis, S.C. Rain and J.J. Steiner. 2003. Nitrate removal effectiveness of a riparian buffer along a small, agricultural stream in Western Oregon. Journal of Environmental Quality 32:162-170.

Willson, J.D. and M.E. Dorcas. 2003. Effects of habitat disturbance on stream salamanders: implications for buffer zones and watershed management. Conservation Biology 17:763-771.

Wipfli M.S., J.S. Richardson, and R.J. Naiman. 2007. Ecological linkages between headwaters and downstream ecosystems: Transport of organic matter, invertebrates, and wood down headwater channels. J Am Water Resour Assoc 43(1):72-85.

Wipfli, M. S. 2005. Trophic linkages between headwater forests and downstream fish habitats: implications for forest and fish management. Landscape and Urban Planning 72:205-213.

Wipfli, M.S. and D.P. Gregovich. 2002. Export of invertebrates and detritus from fishless headwater streams in southeastern Alaska: implications for downstream salmonid production. Freshwater Biology 47: 957-969.

Wondzell, S. M., J. Lanier, et al. 2009. Changes in hyporheic exchange flow following experimental wood removal in a small, low-gradient stream. Water Resources Research 45(5).

Woodinville, City of. 2009. City of Woodinville Comprehensive Plan. Revised 01/2009 per Ordinance 465.

Wooster D.E. and S.J. DeBano. 2006. Effect of woody riparian patches in croplands on stream macroinvertebrates. Arch Hydrobiol 165(2):241-68.

Wynn, T. and S. Motsaghimi. 2006. The effects of vegetation and soil type on streambank erosion, southwestern Virginia, USA. Journal of the American Water Resources Association 42(1):69-82.

Yuan, Y.P., R.L. Bingner, and M.A. Locke. 2009. A Review of effectiveness of vegetative buffers on sediment trapping in agricultural areas. Ecohydrology 2(3):321-336.

DRAFT

Zedler, J. B., and S. Kercher. 2004. Causes and Consequences of Invasive Plants in Wetlands: Opportunities, Opportunists, and Outcomes. Critical Reviews in Plant Sciences, 23(5), 431–452.

Zhang, X., X. Liu, M. Zhang, and R.A. Dahlgren. 2010. A review of vegetated buffers and an meta-analysis of their mitigation efficacy in reducing nonpoint source pollution. Journal of Environmental Quality 39:76-84.

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APPENDIX A

City of Woodinville Comprehensive Plan Update – Existing Conditions Report, Section 1.3Critical Areas Excerpt

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See Link to Existing Conditions Report, Revised Draft, November 2014, here:
http://www.ci.woodinville.wa.us/Work/ComprehensivePlan2015.asp

APPENDIX B

WDOE Wetlands & CAO Updates: Guidance for Small Cities

DRAFT

See Link to Wetlands & CAO Updates: Guidance for Small Cities (Western Washington Version), here: https://fortress.wa.gov/ecy/publications/publications/1006002.pdf

ATTACHMENT D-2.
CRITICAL AREAS ORDINANCE GAP ANALYSIS FOR CITY OF WOODINVILLE

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CRITICAL AREAS ORDINANCE GAP ANALYSIS
CITY OF WOODINVILLE

1 INTRODUCTION

With passage of the Growth Management Act (GMA), local jurisdictions throughout Washington State, including the City of Woodinville (City), were required to develop policies and regulations to designate and protect critical areas. Critical areas, as defined by the GMA (Revised Code of Washington (RCW) 36.70A.030(5)), include wetlands; areas with a critical recharging effect on aquifers used for potable water; fish and wildlife habitat conservation areas; frequently flooded areas; and geologically hazardous areas.

An ongoing requirement of the GMA is for local jurisdictions to periodically review and evaluate their adopted critical areas policies and regulations. In accordance with the GMA, the City last completed a comprehensive update of its critical areas policies and regulations in 2004. The City is now required to update its critical areas policies and regulations by July 2015. This includes the requirement to include the best available science (BAS). Any deviations from science-based recommendations should be identified, assessed and explained (Washington Administrative Code (WAC) 365-195-915). In addition, jurisdictions are to give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries.

The City's critical areas policies are currently contained in the Environmental Element (Chapter 12) of the City of Woodinville Comprehensive Plan (Comprehensive Plan). The City's critical areas regulations are currently codified in Chapter 21.24 of the Woodinville Municipal Code (WMC or Code).

This gap analysis provides a review of the current critical areas policies and regulations, noting gaps where existing policies or regulations may not be consistent with BAS or the GMA. The primary intention of this gap analysis is to help guide the update of the City's critical areas policies and regulations.

1.1 Document Organization

Recommendations for updating the City's existing critical areas policies are provided in Section 2 of this document. Recommendations for updating critical area regulations are provided in Sections 3 through 9. For example, Section 7 of this document addresses Code sections 21.24.320 through 21.24.360, which are all related to wetlands. To highlight findings of the gap analysis, a Code review summary table is provided at the beginning of Sections 3 through 9. Where a

potential gap is identified, subsections provide further discussion. Section 10 contains a discussion of clearing and grading and potential ordinance language.

2 CRITICAL AREAS POLICIES

Overall, the policies contained in the Environmental Element of the City's Comprehensive Plan provide a strong foundation for the City's critical areas regulations. The policies address all five types of GMA critical areas and incorporate specific critical areas terminology used in the GMA. The current policies also include both regulatory and non-regulatory measures to protect critical areas.

Nonetheless, some adjustments could potentially be made to better align the City's critical areas policies with the GMA. General and specific recommendations follow.

2.1 General Recommendations

The organizational structure of the Environmental Element does not directly correlate to the five types of critical areas. Moreover, the Environmental Element includes policies that are not appropriately implemented by the critical areas regulations (e.g. ENV-2.1, Support waste reduction/recycling programs for City departments and encourage procurement of recycled content materials). Understanding which policies are intended to apply to a particular type of critical area should be made clear. Consistency with the City's critical areas regulations might be improved by having policies organized by specific critical area type (or types). There might also be a section that includes policies that apply to all types of critical areas.

Additionally, while the Environmental Element generally incorporates the critical areas terminology used in the GMA, policy language could more closely parallel state terminology. For example, while the Environmental Element refers to several types of hazards, the there is no mention of the term "geologically hazardous areas."

2.2 Specific Recommendations

This subsection includes recommendations for updating specific policies.

Policy ENV-3.6: Periodically review and update the Shoreline Master Program and sensitive areas regulations to ensure consistency with the policies of this Comprehensive Plan, the Shoreline Management Act and the Department of Ecology shoreline regulations.

The term "sensitive areas" is a term that was formerly used for "critical areas." Replacing "sensitive areas" with "critical areas" would enhance consistency with the GMA and the City's critical areas regulations. Additionally, as critical areas regulations are a GMA mandate, this policy should indicate that critical areas regulations should be reviewed and updated to ensure consistency with the GMA and Washington State Department of Commerce critical areas regulations.

Policy ENV-3.8: Consider and incorporate the best available science, consistent with the GMA and applicable rules, in developing regulations for fish and wildlife habitat areas, wetlands, and other critical areas.

This policy clearly reflects one of the key critical areas directives of the GMA (enunciated in RCW 36.70.172). However, the GMA directive (enunciated in RCW 36.70.172), for jurisdictions to "give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries," is not clearly reflected in the City's policies. Policy ENV-3.8 could be amended to incorporate this directive. Additionally, Policy ENV-3.8 is listed under Goal ENV-3: To preserve and enhance aquatic and wildlife habitat. Policy ENV-3.8 could potentially be included as part of a broader goal to make it clear that this policy applies to all types of critical areas.

3 GENERAL PROVISIONS (WMC 21.24.010 - 21.24.180)

Code sections 21.24.010 through 21.24.180 include general provisions that are applicable to all types of critical areas. While overall the general provisions contained in these sections are strong, some refinements could be made to further align these sections with the GMA and BAS. Table 1 (General Provisions Review Summary) below provides a summary of recommendations which are described in detail in this Section.

Table 1. General provisions review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.010	Purpose.	• Further demonstrate consistency with Comprehensive Plan.
21.24.020	Applicability.	
21.24.030	Appeals.	
21.24.040	Critical areas rules.	
21.24.050	Alteration.	
21.24.060	Complete exemptions.	• Potential issue: Ag exemption for maintenance and repair of ditches and drainages NOT used by salmonids. Consider implication for those which 1) are used by fish other than salmonids and/or 2) ditches and drainages which drain directly to salmon bearing waterbodies. • Recommend rewording the clearing and grading exemption (6) as needed for consistency with any changes to grading provisions in the WMC.
21.24.070	Partial exemptions.	
21.24.080	Exceptions.	
21.24.085	Density calculations for critical areas.	
21.24.090	Critical area maps and inventories.	• Include map disclaimer. • Ensure process to amend critical areas maps to include BAS is expeditious.
21.24.100	Disclosure by applicant.	
21.24.110	Critical area review.	
21.24.120	Critical area special study requirement.	
21.24.130	Contents of critical area special study.	• Expand content requirements. • Require preparation by a qualified professional.
21.24.140	Mitigation, maintenance, monitoring and contingency.	• Incorporate mitigation sequence. • Describe specific requirements for the contents of mitigation plans. • Include innovative mitigation regulations.
21.24.150	Security to ensure mitigation, maintenance and monitoring.	
21.24.160	Critical area markers and signs.	• Address fencing requirements and provide more detailed signage requirements.
21.24.170	Notice on title.	

Code Section	Title	Review Comment / Recommendations*
21.24.180	Critical area tracts or easements and designations on site plans.	• Recommend requiring site plans to map all critical areas, including CARAs, for all building permits and clearing and grading permit applications (3).

***** See discussion of comments/recommendations in the subparts below this table.

3.1 Purpose (WMC 21.24.010).

3.1.1 Further demonstrate consistency with Comprehensive Plan.

This section of the Code could more clearly demonstrate consistency with the Comprehensive Plan. For example, this section might briefly reference Comprehensive Plan goals and policies that the code implements. This section of the Code also includes some duplicative statements that could be omitted to make a more concise document.

3.2 Critical area maps and inventories (WMC 21.24.090).

3.2.1 Include map disclaimer.

As recommended by WAC 365-190-180, this section could state that maps showing critical areas may be illustrative only and that additional site-specific evaluation may be needed to confirm or modify the information shown on maps.

3.2.2 Ensure process to amend critical areas maps to include BAS is expeditious.

The City should ensure that the process to amend critical areas maps to incorporate BAS is expeditious. Consider allowing updates of critical areas maps through administrative procedures.

3.3 Contents of critical area special study (WMC 21.24.130).

3.3.1 Expand content requirements.

The contents of the critical areas special study identified in this section could be expanded. For instance, an item that could be included in the critical area special study is a written description of how the applicant applied mitigation sequencing (see Subsection 3.4.1 below). This section could also specify that the critical area special study include a mitigation plan to offset any identified impacts to critical areas.

3.3.2 Require preparation by a qualified professional.

This section should specify that critical area special studies must be prepared by a qualified professional (although other sections of the Code require certain studies to be prepared by a qualified professional, this should be made a general

requirement). An all-encompassing definition of "qualified professional" addressing all critical area types could be added to this section; alternatively, multiple definitions for "qualified professional" could be provided in the appropriate sections (e.g. a definition for a "qualified professional for wetlands" could be added to a section dealing with wetlands).

3.4 Mitigation, maintenance, monitoring and contingency (WMC 21.24.140)

3.4.1 Incorporate mitigation sequence.

Mitigation sequencing is a fundamental component to the protection of critical areas and should be prominently incorporated into the Code. When an alteration to a critical area is considered, the mitigation sequence establishes the following preferred order of alternatives:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps, such as project redesign, relocation, or timing, to avoid or reduce impacts;
- Rectifying the impact to wetlands, critical aquifer recharge areas, frequently flooded areas, and habitat conservation areas by repairing, rehabilitating,
- Minimizing or eliminating the hazard by restoring or stabilizing the hazard area through engineered or other methods;
- Reducing or eliminating the impact or hazard over time by preservation and maintenance operations during the life of the action;
- Compensating for the impact to wetlands, critical aquifer recharge areas, frequently flooded areas, and habitat conservation areas by replacing, enhancing, or providing substitute resources or environments; and
- Monitoring the hazard or other required mitigation and taking remedial action when necessary.

3.4.2 Describe specific requirements for the contents of mitigation plans.

This section of the Code could describe specific requirements for the contents of mitigation plans, such as requirements for measurable performance standards and monitoring.

3.4.3 Include innovative mitigation regulations.

General regulations regarding the potential use of innovative mitigation techniques could be included in this section. More detailed regulations specific to a particular type of critical area might be added to later parts of the Code (e.g. language about mitigation banks and in-lieu fee might be added to the wetlands

regulations with a preference for mitigation within the city limits). See the Ecology publication, *Wetlands & CAO Updates: Guidance for Small Cities* (WDOE, Revised 2012) for specific examples.

3.5 Critical area markers and signs (WMC 21.24.160).

3.5.1 Address fencing requirements and provide more detailed signage requirements.

This Code section does not thoroughly address general temporary and permanent fencing requirements (though fencing for native growth protection areas is discussed in WMC 21.24.180). Signage requirements could also be more detailed. For example, sign spacing requirements could be specified (most local jurisdictions require signs to be posted every 50 feet along a critical area buffer). It is also recommended that the City codify fencing (split-rail at least 4 feet high) and sign spacing (100 foot intervals or 1 per lot) requirements as documented in the City's supplemental "Wetland and Stream Mitigation Guidelines."

If the City does not have critical area signs applicants can purchase, then providing standardized language for signs in the Code is recommended. The City may choose to exempt certain critical areas, such as geologically hazardous areas, from signage requirements for practical reasons.

4 CRITICAL AQUIFER RECHARGE AREAS (WMC 21.24.190 - 21.24.200)

To protect critical aquifer recharge areas (CARAs), recommended BAS-based protection measures include identifying and categorizing CARAs, indentifying potential sources of contamination, assessing vulnerability of water resources, imposing protections, and managing CARA withdrawals. The existing Code generally complies with these BAS-based measures. The existing Code could be enhanced by providing specific critical area special study requirements for critical aquifer recharge areas and including general performance standards for development in CARAs.

Table 2. Critical aquifer recharge areas review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.190 - 21.24.200	Critical aquifer recharge areas.	• Specific critical area special study requirements for critical aquifer recharge areas are not included—consider including.
21.24.190	Critical aquifer recharge areas – Designation and rating.	

Code Section	Title	Review Comment / Recommendations*
21.24.200	Critical aquifer recharge areas – Development regulations.	• Consider including general performance standards.

***** See discussion of comments/recommendations in the subparts below this table.

4.1 Critical aquifer recharge areas (WMC 21.24.190-21.24.200).

4.1.1 Specific critical area special study requirements for critical aquifer recharge areas are not included—consider including.

The sections of the Code addressing critical aquifer recharge areas (WMC 21.24.190 through 21.24.200) do not include requirements for critical area special studies specific to critical aquifer recharge areas. Such requirements might include when a hydrogeologic assessment must be prepared and the professional qualifications necessary to prepare such an assessment. Study requirements may differ based on the mapped CARA designation or category.

4.2 Critical aquifer recharge areas – Development regulations (WMC 21.24.200).

4.2.1 Consider including general performance standards.

This Code section currently includes development regulations that prohibit certain new uses and activities in Category I and II CARAs; provide standards for specific types of development in CARAs such as storage tanks; and reference other regulations that may be applicable. However, this section does not currently include general performance standards that apply broadly to development in CARAs. For example, this section might include a general regulation such as the following:

- Activities may only be permitted in a critical aquifer recharge area if the applicant can show that the proposed activity will not cause contaminants to enter the aquifer and that the proposed activity will not adversely affect the recharging of the aquifer.

5 FLOOD HAZARD AREAS (WMC 21.24.210 - 21.24.280)

The existing Code restricts development within flood hazard areas. Regulations prohibit reductions in the base flood storage volume, and require compensatory storage if a reduction is proposed. This flood hazard management approach is concurrent with BAS findings on this topic. The existing flood hazard areas regulations could be enhanced by providing specific critical area special study requirements for flood hazard areas.

Table 3. Flood hazard areas review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.210 - 21.24.280	Flood hazard areas.	• Specific critical area special study requirements for flood hazard areas not included—consider including. • Require a habitat assessment (FEMA BiOp process) for development in the floodway or floodplain
21.24.210	Flood hazard areas – Components.	
21.24.220	Flood Insurance Study adopted.	
21.24.230	Flood fringe – Development standards and permitted alterations.	
21.24.240	Zero-rise floodway – Development standards and permitted alterations.	
21.24.250	FEMA floodway – Development standards and permitted alterations.	
21.24.260	Flood hazard – Certification by engineer or surveyor.	
21.24.270	Alteration of watercourses, notice and maintenance required.	
21.24.280	Building Official to approve alternate design and methods of construction.	

***** See discussion of comments/recommendations in the subparts below this table.

5.1 Flood hazard areas (WMC 21.24.210 - 21.24.280).

5.1.1 Specific critical area special study requirements for flood hazard areas are not included—consider including.

The sections of the Code addressing flood hazard areas (WMC 21.24.210 through 21.24.280) do not include requirements for a critical area special studies specific to frequently flooded areas. Such requirements might include when a flood hazard assessment must be prepared and the professional qualifications necessary to prepare such an assessment.

The City may either develop specific floodplain regulations or require habitat assessments for development in the floodway or floodplain. As a result of the 2008 National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) on the implementation of the National Flood Insurance Program (NFIP) in the Puget Sound region, the City is required to adopt one of three following approaches to managing development within the floodplain:

1. Adopt the model ordinance;
2. Develop floodplain regulations that protect floodplain functions on a programmatic basis;
3. Require the completion of a floodplain habitat assessment for any development within the floodplain. Habitat assessments must evaluate impacts to stormwater, floodplain capacity, and vegetative habitat.

Unless the City adopts the model ordinance or develops customized floodplain regulations that are reviewed and approved by FEMA, the third option, also referred to as "Door 3" is the default requirement. Option 1, the model ordinance, would likely represent the most conservative approach to protecting floodplain functions, but it also would also be expected to be the most restrictive option in terms of future development and provide the least flexibility in implementation. The second option, or "Door 2," allows local jurisdictions to establish regulations that recognize local conditions and may incorporate programs that enhance floodplain functions into the evaluation of how floodplain functions are maintained. However, FEMA must approve any "Door 2" approach before it is implemented. As of March, 2014, only 5 jurisdictions have chosen to use the model ordinance (Graves, J., personal communication 4/1/2014). Of the 36 jurisdictions that have proposed "Door 2" approaches, only 12 have been approved by FEMA (Graves, J., personal communication 4/1/2014). The timing to get approval for "Door 2" depends on the approach and detail in the application submittal. The remaining 81 jurisdictions are using "Door 3" (Graves, J., personal communication 4/1/2014).

6 GEOLOGICALLY HAZARDOUS AREAS (WMC 21.24.290 - 21.24.310)

The current Code safeguards against potential geologic hazards through several mechanisms, including buffers and rigorous design standards. This Code section is generally in agreement with BAS. However, the Code section might be improved by providing specific critical area special study requirements for geologically hazardous areas, providing an up-to-date map of Citywide geologically hazardous areas, and refining when geotechnical reports are required.

Table 4. Geologically hazardous areas review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.290 - 21.24.310	Geologically hazardous areas.	• Specific critical area special study requirements for geologically hazardous areas are not included—consider including.
21.24.290	Geologically hazardous areas – Designation.	• Provide a single map showing all types of geologically hazardous areas according to the most recent BAS.
21.24.300	Development standards – General requirements.	
21.24.310	Performance standards – Specific hazards.	• Refine geotechnical report requirements.

***** See discussion of comments/recommendations in the subparts below this table.

6.1 Geologically hazardous areas (WMC 21.24.290-21.24.310).

6.1.1 Specific critical area special study requirements for geologically hazardous areas are not included—consider including.

The sections of the Code addressing geologically hazardous areas (WMC 21.24.290 through 21.24.310) do not include requirements for a critical area special studies specific to geologically hazardous areas. Such requirements might include when a geological hazards assessment must be prepared and the professional qualifications necessary to prepare such an assessment.

6.2 Geologically hazardous areas – Designation (WMC 21.24.290).

6.2.1 Provide a single map showing all types of geologically hazardous areas according to the most recent BAS.

The City currently lacks an up-to-date map showing all types of geologically hazardous areas according to the most recent BAS. As noted previously, map updates to incorporate the most current BAS should be able to be performed in an expeditious manner.

6.3 Performance standards – Specific hazards (WMC 21.24.310).

6.3.1 Refine geotechnical report requirements.

Consider identifying whether certain types of geologically hazardous areas might be eligible for a limited analysis. The City may consider whether report requirements can be scaled according to the type of development proposed and the potential risk. For example, the City could codify which site improvements may provide a geotechnical memo in lieu of a full geotechnical report. Minor site improvements to consider for this partial exemption may include decks and

small structural additions located at least 25 feet away from geologic hazard areas. This approach would maintain geologic hazard area protections and analysis, while keeping the permit and review process commensurate with project scale.

7 WETLANDS (WMC 21.24.320 - 21.24.360)

The wetlands sections of the Code could be upgraded to be more consistent with BAS. Notable recommendations include updating to the Ecology Rating System and providing more detailed mitigation regulations.

Table 5. Wetlands review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.320 - 21.24.360	Wetlands.	• Specific critical area special study requirements for wetlands are not included—consider including.
21.24.320	Wetlands – Designation and rating.	• Designation of wetlands must include the Corps Manual and Regional Supplement. • Rate wetlands using Ecology Rating System.
21.24.330	Wetlands – Development standards.	• Update buffer width requirements based on Ecology Rating System and BAS-based buffer alternatives.
21.24.340	Wetlands – Permitted alterations.	• Provide more detailed regulations.
21.24.350	Wetlands – Mitigation requirements.	• Update type and location of mitigation provisions to reflect BAS. • Mitigation requirements should be amended along with the wetland classification system.
21.24.360	Wetlands – Limited exemption.	• Revise exemption criteria.

***** See discussion of comments/recommendations in the subparts below this table.

7.1 Wetlands (WMC 21.24.320 - 21.24.360).

7.1.1 Specific critical area special study requirements for wetlands are not included—consider including.

The sections of the Code addressing wetlands (WMC 21.24.320 through 21.24.360) do not include detailed requirements for critical area special studies specific to wetlands. Such requirements might include specific contents to be included and the professional qualifications necessary to produce such a study. For example, the wetland development standards section (WMC 21.24.330) should clearly reference the required contents of critical area special study as per

WMC 21.24.130. If the critical area special study requirements are referenced in the wetlands section, the professional qualifications for each critical area discipline should be added to WMC 21.24.130.

Although the City's supplemental document, "Wetland and Stream Mitigation Guidelines" provides requirements for compensation plan reports and mitigation plans, this information is not clearly referenced or provided in the current code. To strengthen the City's ability to consistently apply these standards to permit applications, at a minimum the "Wetland and Stream Mitigation Guidelines" should be referenced in the code. This reference should also be readily available to the public; documents of this type are commonly posted on City websites for easy reference.

7.2 Wetlands – Designation and rating (WMC 21.24.320).

7.2.1 Designation of wetlands must include Regional Supplement.

Currently, identification of jurisdictional wetlands in the City is based on the Washington State Department of Ecology *Wetlands Identification and Delineation Manual* (Ecology Manual)(Ecology publication #96-94). In May 2010 the U.S. Army Corps of Engineers (Corps) issued a new guidance document, titled *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)*(Regional Supplement)(Corps Publication #ERDC/EL TR-10-3). The Regional Supplement is intended to be used along with the 1987 Corps Manual to increase accuracy and efficiency of wetland delineation procedures. Updating the City's critical areas regulations to define wetlands based on the Corps Manual <u>and</u> the Regional Supplement is required to be consistent with the GMA.

Per the Washington State Department of Ecology (Ecology) and changes to the WAC, the *Wetlands Identification and Delineation Manual* is no longer in use. Ecology has repealed WAC 173-22-080 (the state delineation manual) and replaced it with a revision of WAC 173-22-035 that states delineations should be done according to the currently approved federal manual and supplements. Ecology recommends the following language for CAO updates to the delineation provisions:

- Identification of wetlands and delineation of their boundaries pursuant to this Chapter shall be done in accordance with the approved federal wetland delineation manual and applicable regional supplements. All areas within the [City or County] meeting the wetland designation criteria in that procedure are hereby designated critical areas and are subject to the provisions of this Chapter.

7.2.2 Rate wetlands using Ecology Rating System.

The current Code rates wetlands using a three-tiered system based on specific physical attributes, such as the presence of endangered or threatened species, connectivity to other waterbodies, wetland size, and vegetation characteristics. This approach, which was a commonly used prior to 2004, has been replaced by a more refined rapid-assessment tool.

The current BAS tool for wetland classifications is the *Washington State Wetland Rating System for Western Washington* (Ecology Rating System) (Ecology Publication #04-06-025). The Ecology Rating System is a four-tiered rating system, with wetland categories (I through IV) based on a functional score that evaluates the water quality functions, hydrologic functions, and habitat functions provided by a given wetland. This system also recognizes how wetland functions and values are linked to a wetland's landscape position or hydrogeomorphic class.

Ecology continues to review current scientific knowledge of wetland functions and values and periodically new information is integrated into key publications, including the *Washington State Wetland Rating System for Western Washington*. To keep City regulations in step with adopted BAS, adding language to this section of the Code stating that "Ecology Publication #04-06-025 or as revised and approved by Ecology shall be used to rate wetlands" is recommended.

7.3 Wetlands – Development standards (WMC 21.24.330).

7.3.1 Update buffer width requirements based on Ecology Rating System and BAS-based buffer alternatives.

A direct comparison of wetland buffer width requirements in the current Code (WMC 21.24.330) and BAS is not possible because the underlying rating systems are different. Standard wetland buffers under the current Code are listed in Table 6 below.

Table 6. Wetland class and buffer widths under current city code.

Wetland Class	Standard Wetland Buffer (feet)
Class 1	150
Class 2	100
Class 3	50

As discussed above in Subsection 7.2.2, the current BAS tool for wetland classifications has been updated compared with the tool the City currently uses. Accordingly, if the City updates its wetland classification system, the current wetland buffer requirements will also need to be updated in order to work with the new classification system.

Effective wetland buffer widths vary depending on the targeted wetland functions, intensity of surrounding land use, and buffer characteristics. The City may continue to assign a single standard fixed buffer width for each wetland category or to vary buffer widths according to land use intensity and/or habitat functions. Three BAS-based wetland buffer options, Buffer Alternatives 1, 2 and 3, from the Ecology publication *Wetlands in Washington State – Volume 2* (see Appendix C), are discussed below.

Buffer Alternative 1 assigns a standard buffer width based only on wetland category (the current approach used by the City). While this is a simple approach, it does not account for wetland functions and surrounding land use in determining buffer width. As a result, buffers must be set at the most protective level to be inclusive of all conditions that may exist (Table 7).

Table 7. Wetland buffer widths under Buffer Alternative 1.

Wetland Category[1]	Buffer Width (feet)
I	300
II	300
III	150
IV	50

[1] Wetland Categories based on Ecology Rating System.

Buffer Alternative 2 modifies the buffer width in accord with adjacent land use, while Buffer Alternative 3 considers both adjacent land use and wetland habitat functions when determining an appropriate buffer width for each wetland category. Buffers under these alternatives are shown below in Table 8. In the table, land use intensity is characterized as high, moderate or low. Examples of high intensity land uses are commercial, institutional, dense residential (>1 unit/acre), and high-intensity recreation, such as ball fields. Moderate intensity land uses include residential (≤ 1 unit/acre), moderate-intensity open space, paved trails, and maintained utility corridors. Low intensity land uses include low-intensity open space, unpaved trails, and low maintenance utility corridors.

Table 8. Wetland buffer widths under Buffer Alternatives 2 and 3.

Wetland Category[1]	Buffer Alternative 2			Buffer Alternative 3			
	Land Use Impact			Habitat Score	Land Use Impact		
	Low	Moderate	High		Low	Moderate	High
I	150 ft	225 ft	300 ft	29-36	150 ft	225 ft	300 ft
				20-28	75 ft	110 ft	150 ft
				< 20	50 ft	75 ft	100 ft
II	150 ft	225 ft	300 ft	29-36	150 ft	225 ft	300 ft
				20-28	75 ft	110 ft	150 ft
				< 20	50 ft	75 ft	100 ft

III	75 ft	110 ft	150 ft	20-28	75 ft	110 ft	150 ft
				< 20	40 ft	60 ft	80 ft
IV	25 ft	40 ft	50 ft	N/A	25 ft	40 ft	50 ft

[1] Wetland Categories based on Ecology Rating System.

Yet another BAS-based approach to wetland buffers, similar to Buffer Alternative 3 above, is provided in sample CAO language in *Wetlands Guidance for Small Cities Western Washington Version*, page A-6 (Ecology publication # 10-06-002). A summary of buffer widths for wetlands in Woodinville using this approach (called Buffer Alternative 4 in this report) is provided in Table 9 below.

Table 9. Wetland buffer widths under Buffer Alternative 4.

	Buffer Width according to Habitat Score			
Wetland Category[1]	**< 21 points**	**21-25 points**	**26-29 points**	**30-36 points**
Category I: Based on total score	75 ft	105 ft	165 ft	225 ft
Category I: Forested	75 ft	105 ft	165 ft	225 ft
Category I: Bogs	190 ft			225 ft
Category II	75 ft	105 ft	165 ft	225 ft
Category III	60 ft	105 ft	165 ft	165 ft
Category IV	40 ft			

[1] Wetland Categories based on Ecology Rating System.

For further details and examples see the following guidance documents (Appendices B and C, respectively).

- *Wetlands and CAO Updates: Guidance for Small Cities* (Ecology 2012)
- *Wetlands in Washington State – Volume 2, Appendix 8C* (Ecology 2005)

It should be noted that Ecology is in the process of reviewing current science on wetland buffers and revisions to the *Washington State Wetland Rating System for Western Washington*, specifically the habitat functions scoring values, are anticipated (Pers. Com. Tom Hruby 2014). In light of this pending change, Buffer Alternatives 1, 2 or 3 may be easier to implement while allowing the City to use the revised wetland rating form as it becomes available.

7.4 Wetlands – Permitted alterations (WMC 21.24.340).

7.4.1 Provide more detailed regulations.

In general, this section could provide more detailed regulations regarding permitted alterations. The Code could better clarify which types of alterations

require or do not require a critical areas special study. For example, WMC 21.24.340(1)(a) allows alteration of wetlands that do "…not serve any of the valuable functions of wetlands…" However, all wetlands provide some level of functions. To ensure wetland functions and values are maintained, wetland and wetland buffer alterations should be reviewed through the Critical Area Special Study process.

The Code could also clarify what uses are allowed in a wetland buffer and the process necessary to authorize specific uses. BAS supports allowing discrete tasks in wetlands and buffers, including activities conducted under the Forest Practices Act (WAC 222-12-030), wild crop harvest, utility drilling, removal of invasive plants, education and scientific research, and routine maintenance of an existing facility.

Additionally, the language for some specific uses that are currently allowed will need to be updated. For example, language in WMC 21.24.320(6) will need to be updated to reflect that stormwater management facilities may only be allowed in the outer buffer of lower classes of wetlands (Category III or IV only).

7.5 Wetlands – Mitigation requirements (WMC 21.24.350).

7.5.1 Update type and location of mitigation provisions to reflect BAS.

The type and location of mitigation provisions (WMC 21.24.350(5)) should be updated to reflect BAS. For example, these provisions do not explicitly address newer innovate approaches such as mitigation banking or in-lieu fee programs. Example code language for BAS mitigation options is provided in *Wetlands and CAO Updates: Guidance for Small Cities* (Ecology 2012).

7.5.2 Mitigation requirements should be amended along with the wetland classification system.

Currently, since wetland mitigation ratios in the Code are based on an outdated wetland rating system, a direct comparison with BAS mitigation ratios is not possible. For reference, existing mitigation ratios in WMC 21.24.350(7)(a) are listed in Table 10 below.

Table 9. Wetland mitigation ratios under the current city code.

Wetland Class	Creation or Restoration Ratio
Class 1	4 to 1
Class 2	2 to 1
Class 3	1.5 to 1

Current BAS-based wetland mitigation ratios (Appendix C, Table 8C-11) are tied to the current Ecology Rating System. Compensatory mitigation ratios for a wetland can be determined by wetland category and mitigation approach. This

gives the applicant more mitigation options while focusing on maintaining wetland functions and values. See the summary in Table 11 below.

Table 100. Wetland mitigation ratios recommended by Ecology[1].

Category of Impact Wetland[2]	Creation or Re-establishment	Rehabilitation	Enhancement
Category I: based on total score	4:1	8:1	16:1
Category I: Forested	6:1	12:1	24:1
Category I: Bogs	Not possible	Case-by-case	Case-by-case
Category II	3:1	6:1	12:1
Category III	2:1	4:1	8:1
Category IV	1.5:1	3:1	6:1

[1] *Wetlands and CAO Updates: Guidance for Small Cities* (Ecology 2012).
[2] Wetland categories based on Ecology Rating System.

Finally, buffer requirements for created wetlands are not clearly stated in the Code. To adequately protect mitigation wetlands, they should be subject to the same buffer requirements as existing wetlands.

7.6 Wetlands – Limited exemption (WMC 21.24.360).

7.6.1 Revise exemption criteria.

This section indicates that Class 3 wetlands less than 1,000 square feet may be exempted from City wetland regulations if determined "that the cumulative impacts do not unduly counteract the purposes of this chapter and are mitigated pursuant to an approved mitigation plan."

However, BAS does not support exempting wetlands that are below a certain size. The reason for this is that it is not possible based on size alone to determine what functions a particular wetland may be providing. However, Ecology has developed a strategy for exempting wetlands less than 1,000 square feet when other criteria besides size are considered. Under this strategy, isolated Category III and IV wetlands less than 1,000 square feet that are not associated with riparian areas or buffers, are not part of a wetland mosaic, and do not contain essential habitat, may be exempted when a critical areas report demonstrates the above. See Appendix B, *Wetlands Guidance for Small Cities Western Washington Version*,pages A-3 and A-4 for more specific model language.

8 STREAMS (WMC 21.24.370 - 21.34.400)

The City's stream regulations should be updated to better align with current BAS. Several considerations for updates to stream designation and rating and development are discussed below.

Table 11. Streams review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.370	Streams – Designation and rating.	• Consider updating stream classification to use the Permanent Water Typing System (WAC 222-16-030).
21.24.380	Streams – Development standards.	• If Permanent Water Typing System is adopted, amend stream buffer protocol. • Consider allowing stream buffer averaging. • Clarify where the "urban" stream designation might apply.
21.24.390	Streams – Permitted alterations.	• Review permitted alterations to determine if common alterations consistent with BAS are permitted.
21.24.400	Streams – Mitigation requirements.	

***** See discussion of comments/recommendations in the subparts below this table.

8.1 Streams – Designation and rating (WMC 21.24.370).

8.1.1 Consider updating stream classification to use the Permanent Water Typing System (WAC 222-16-030).

To standardize stream classifications across the State, the Department of Natural Resources recommends adopting the Permanent Water Typing System (WAC 222-16-030). The Permanent Water Typing System is more descriptive and inclusive than the stream classification system defined in the current Code. Table 13 below describes the Permanent Water Typing System.

Table 112. Permanent Water Typing System (WAC 222-16-030).

Permanent Water Typing	Brief Description	Full Description
Type S	Shoreline of the State	All waters, within their bank-full 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.
Type F	Fish bearing stream (may be	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

Permanent Water Typing	Brief Description	Full Description
	perennial or seasonal)	greater at seasonal low water and which in any case contain fish habitat or are described by one of the following four categories: (a) 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; (b) Waters, which are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type F Water upstream from the point of diversion for 1,500 feet, including tributaries if highly significant for protection of downstream water quality. The department may allow additional harvest beyond the requirements of Type F Water designation provided the department determines after a landowner-requested on-site assessment by the department of fish and wildlife, department of ecology, the affected tribes and interested parties that: (i) The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and (ii) Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery; (c) 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; (d) 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 the following criteria: (i) The site must be connected to a fish habitat stream and accessible during some period of the year; and (ii) The off-channel water must be accessible to fish.
Type Np	Non-fish bearing perennial stream	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	Non-fish bearing seasonal stream	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.

It should be noted that the current City Code requires greater buffers on streams used by salmonids (Type 2), than streams containing other non-salmonid fish (Type 3). The permanent water typing system would result in equal treatment of all fish-bearing streams. Presence or absence of fish habitat should be determined using a current BAS approach consistent with WAC 222-16-030 and the Washington State Forest Practices Board Manual, Section 13.

8.2 Streams – Development standards (WMC 21.24.380).

8.2.1 If Permanent Water Typing System is adopted, amend stream buffer protocol.

As mentioned above in Subsection 8.1.1, the Department of Natural Resources recommends adopting the Permanent Water Typing System. If the City chooses to adopt the Permanent Water Typing System, the City will also need to amend its stream buffer protocol. Table 14 below provides sample buffer ranges under the Permanent Water Typing System derived from BAS and other local jurisdictions.

Table 123. Appropriate buffer ranges by stream type per BAS.

Stream Type	Sample Buffer Ranges (feet)
S	115 - 165
F	100 - 165
Np	50 - 65
Ns	50 - 65

Current stream types and buffer widths under City Code are compared to the BAS recommendation in the table below.

Table 14. A comparison of current and recommended stream types and buffer widths.

Stream Type		Sample Buffer Ranges (feet)	
Per City Code	Recommended by DNR	Per City Code	Recommended, BAS-based
1	S	115[1] - 150	115 - 165
2, 3	F	50 - 115	100 - 165
4	Np	35 - 50	50 - 65
4	Ns	35 - 50	50 - 65

[1] A 100-foot buffer may be allowed by the Development Services Director when a special study (based on BAS) determines that functions achieved in 100 feet are equal to the functions achieved in 115 feet for the site in question.
[2] Type S streams are regulated as Shorelines of the State under the City's Shoreline Master Program (SMP). Under the SMP, existing conditions may warrant the use of buffers which more appropriately match the current land cover and land use conditions. This may be further evaluated in the Comprehensive Plan EIS.

Under the current City code, narrower buffer widths are allowed when the buffer is enhanced with native trees, shrubs and groundcover plants. This same approach may be used with the recommended BAS-based buffer width ranges listed in Table 15 above.

Additionally, among the more developed areas within the City of Woodinville, where existing development (e.g., roads or structures) interrupt buffer functions, it may be appropriate to limit the buffer requirement to the width waterward of the development.

8.2.2 Consider allowing stream buffer averaging.

Currently, the only general method for reducing a stream buffer is through buffer enhancement. Similar to the wetland regulations, the City could also allow stream buffer averaging as another alternative to provide applicants with more flexibility. Buffer averaging is particularly effective where wider buffers are applied to areas that would benefit from additional protections. For example, wider buffers would be beneficial in areas with steeper slopes, along a flowpath that concentrates runoff that may require broader areas for effective filtration, or to protect areas of large trees that contribute to temperature regulation and future large woody debris loading. Buffer averaging could also be used to help account for potential future channel migration.

8.2.3 Clarify where the "urban" stream designation might apply.

Currently the Code provides four criteria that must be met in order for a stream to be considered "urban." However, the Code provides no indication of where in the City the "urban" designation might apply. Consider providing more clarity to applicants and City staff where the "urban" designation might apply (e.g. sub-basins where restoration opportunities are limited) or consider eliminating the urban designation and relying on non-conforming use standards and a standard that allows for buffer reduction where intervening structures or roadways truncate buffer functions. This alternative approach would better allow redevelopment in areas where buffer functions are already impaired by structures, while protecting buffer functions elsewhere.

8.2.4 Review permitted alterations to determine if common alterations are permitted.

The existing Code does not appear to allow certain common alterations that may occur with only minor impacts to buffer functions. Such alterations might include road expansion where no other feasible alternative exists or utility line placement provided there is restoration of conditions. Such alterations could occur consistent with BAS if sufficient mitigation is provided.

9 FISH AND WILDLIFE HABITAT CONSERVATION AREAS (WMC 21.24.410 - 21.24.440)

To better incorporate BAS into the fish and wildlife habitat conservation areas (FWHCAs) Code section several Code revisions are recommended (see Table 15).

Table 135. Fish and wildlife habitat conservation areas review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.410	Fish and wildlife habitat conservation areas – Designation.	• Definition of "fish and wildlife habitat conservation areas" needs updating to match GMA definition. • Code does not currently include a list of species of local importance.
21.24.420	Fish and wildlife habitat conservation area report requirements.	• Specific critical area special study requirements for fish and wildlife habitat conservation areas are not included—consider including.
21.24.430	Fish and wildlife habitat conservation areas – Performance standards.	• Consider relocating existing regulations concerning habitat management plans. • Apply BAS in the decision to require an HMP. • Strengthen HMP requirements to better reflect BAS.
21.24.440	Fish and wildlife habitat conservation areas – Performance standards for specific habitats.	

* See discussion of comments/recommendations in the subparts below this table.

9.1 Fish and wildlife habitat conservation areas – Designation (WMC 21.24.410).

9.1.1 Definition of "fish and wildlife habitat conservation areas" needs updating to match GMA definition.

The Code needs to be updated to reflect a revised version of the GMA definition of "fish and wildlife habitat conservation areas." The GMA definition now states that FWHCAs "does not include such artificial features or constructs as irrigation delivery systems, irrigation infrastructure, irrigation canals, or drainage ditches that lie within the boundaries of and are maintained by a port district or an irrigation district or company."

9.1.2 Consider including a list of species of local importance.

While the current Code includes some specific priority species and habitats, a list of specific species and habitats of local importance is not provided. Species that

BAS suggests for consideration may include those that require a special habitat feature, PHS species, and high-risk (non-listed) species. Other jurisdictions include snag-dependent species: pileated woodpecker, Vaux's swift (both State candidate species), and *myotis* bats. Riparian environments are unique habitat components and several Washington species of interest occur in the City.

A list of potential vulnerable species within the City that could be considered as species of local importance is provided in Table 16 below. Species of local importance are considered priorities for conservation and management. Species on the list below are likely to occur in Woodinville. Generating a list of species of local importance would accomplish several purposes. First, it would help planners to identify species that may possibly occur in the City and exclude those that are highly unlikely to. Second, species that have "candidate" or "monitor" status could be considered for inclusion, preempting continued declines and future listing. Finally, a list would clarify the status of species and simplify the definition of FWHCA to some extent.

Table 146. Recommended species of local importance list for the City of Woodinville.

Common Name	Scientific Name	Rationale or Species Status
Bald eagle	*Haliaeetus leucocephalus*	State status: sensitive Federal status: species of concern
Peregrine falcon	*Falco peregrines*	State status: sensitive Federal status: species of concern
Common loon	*Gavia immer*	State status: sensitive
Pileated woodpecker	*Dryocopus pileatus*	State status: candidate
Vaux's swift	*Chaetura vauxi*	State status: candidate
Purple martin	*Progne subis*	State status: candidate
Western grebe	*Aechmophorus occidentalis*	State status: candidate
Great blue heron	*Ardea herodias*	WDFW - Priority species
Green heron	*Butorides striatus*	State status: monitor species
Western big-eared bat	*Plecotus townsendii*	State status: sensitive Federal status: species of concern
Keen's myotis	*Myotis keenii*	WDFW - Priority species
Long-legged myotis	*Myotis volans*	WDFW - Priority species
Long-eared myotis	*Myotis evotis*	State status: candidate
Oregon spotted frog	*Rana pretiosa*	State status: endangered Federal status: candidate
Osprey	*Pandion haliaetus*	State status: monitor species
Western pond turtle	*Clemmys marmorata*	State status: endangered Federal status: species of concern
Chinook salmon	*Oncorhynchus tshawytscha*	State status: sensitive Federal status: threatened
Bull trout	*Salvelinus confluentus*	State status: candidate Federal status: threatened
Coho salmon	*Oncorhynchus kisutch*	Federal status: species of concern

Common Name	Scientific Name	Rationale or Species Status
River lamprey	*Lampetra ayresi*	State status: candidate Federal status: species of concern

9.2 Fish and wildlife habitat conservation area report requirements (WMC 21.24.420).

9.2.1 Specific critical area special study requirements for fish and wildlife habitat conservation areas are not included—consider including.

This section states that requirements for critical areas reports for FWHCAs are available at the City planning department. Consider including the requirements directly into the Code to elevate their status and promote ease of access. And, as mentioned below, consider locating the first three regulations in Section WMC 21.24.430, which concern the preparation of habitat management plans, with the requirements for critical areas reports.

9.3 Fish and wildlife habitat conservation areas – Performance standards (WMC 21.24.430).

9.3.1 Consider relocating existing regulations concerning habitat management plans.

The first three regulations in Section WMC 21.24.430 concern the preparation of habitat management plans (HMPs). These regulations might be relocated with the critical areas report requirements.

9.3.2 Apply BAS in the decision to require an HMP.

Currently, an HMP is required when a FWHCA is on-site or within 200 feet of the subject property (WMC 21.24.430(3)(a)(ii)). However, recommended nest-site buffers for a number of PHS and listed species exceed this minimum, and thus 200 feet is not adequate for protection of these species. BAS should be applied in the decision to require an HMP. WDFW management recommendations exist for some species and may be used for guidance in requiring HMPs.

9.3.3 Strengthen HMP requirements to better reflect BAS.

The HMP requirements in this section could be strengthened to better reflect BAS. WDFW management recommendations may be useful in defining site- and species-specific performance standards. Performance standards refer to benchmarks by which effectiveness of implemented protection actions are measured. Performance standards in HMPs should focus specifically on pertinent habitat components, e.g., a plan that requires retained vegetation of a specific height should set a minimum height standard for retained trees. Other factors regarding habitat protection and management should be addressed in HMPs and may include mitigation sequencing, construction timing restrictions,

disturbance limits, line-of-sight standards, corridor preservation, and an analysis of habitat quality and distribution in the surrounding area.

10 Clearing and Grading Regulations

Since City staff is already preparing to address known gaps in their clearing and grading regulations, this review of clearing and grading looks at both the existing CAO and proposed grading code provided by the City.

10.1 Clearing and grading regulations in the CAO

Clearing and grading activities are mentioned in a few sections of the City's critical areas regulations. Those citations are summarized in the table below.

Table 17. Clearing and grading regulations, CAO review summary.

Code Section	Title	Review Comment / Recommendations*
21.24.050	Alteration	• Vegetation removal is included as a modification, but the word clearing is not used, consider adding
21.24.060	Complete exemptions	• Since critical areas are not exempt from a clearing and grading permit, consider removing (6) from the complete exemptions
21.24.180	Critical area tracts or easements and designations on site plans	
21.24.230	Flood fringe – Development standards and permitted alterations	
21.24.310	Performance standards – Specific hazards	• If adopted, the clearing and grading ordinance should be clearly referenced for further details regarding limits and restrictions.
21.24.440	Fish and wildlife habitat conservation areas – Performance standards for specific habitats	

As Ecology notes, unauthorized clearing and grading impacts, particularly in wetlands, often occur prior to permit applications. Ecology recommends ensuring adequate clearing and grading requirements in the critical areas ordinance or a separate clearing and grading ordinance (Ecology 2012). Since the City is considering a adopting a grading ordinance, comments on clearing and grading provisions within the CAO are relatively minor. The following comments and recommendations are provided for City review. WMC 21.24.050, Alteration, indicates that grading and removing vegetation are alterations. The

term "clearing" could be added to this section due to its common usage. Additionally, this Code section should clearly state that the listed alterations, including clearing and grading, may require City approval. Consider removing the complete exemption for clearing and grading activities in WMC 21.24.060(6). Clearing and grading restrictions within Erosion and Landslide Hazard Areas are provided in WMC 21.24.310(1). The design standards properly limit disturbance of existing natural slopes and vegetation removal is restricted. If adopted, regulations under the clearing and grading ordinance should be cited for further detail on area limits and other restrictions.

10.2 Proposed Clearing and grading ordinance

City staff have expressed general dissatisfaction with the way grading is currently regulated. To address this issue, City staff has been working on a solution intermittently over the past few years. Proposed grading code was drafted by City planning staff and presented to City Council members in March 2012. That process resulted in the following documents, which were reviewed for this gap analysis:

- *City of Woodinville Proposed grading code, proposed requirements and limitations*, dated November 14, 2011 with hand-written comments dated December 13, 2011 and January 20, 2012, and email comments dated December 11, 2011.
- *Discussion of Grading Permit Thresholds*. Presentation to City Council. March 13, 2012.

The following comments are generated based on a review of the proposed grading code. These include an evaluation of the section content and the general code framework as well as specific comments which relate to the effects on other topics such as critical areas and surface water management.

Purpose

- A clearing and grading ordinance manages the hydrologic effects of excavation, grading, and vegetative alteration on the landscape. These effects may be due to changes in interception, infiltration, and runoff but include changes in storage, routing, and ultimately recharge of surface water. A clearing and grading ordinance can prevent or minimize reductions in interception and infiltration of precipitation, loss of soil moisture storage, loss of surface water detention, and associated increases in erosion of soils, scour and erosion of runoff channels, and downstream sedimentation.
- A clearing and grading ordinance can minimize disturbance of existing soils and vegetation and maintain or restore pre-project hydrologic functioning of a site with resulting stormwater control, water quality protection, and fish and wildlife habitat benefits.

Definitions

Consider making the ***clearing and grading ordinance definitions*** more specific to include (or not include) ***related practices*** such as***:***

- clearing and grubbing of vegetation, stumps, and root wads;
- scraping, piling and removal of fallen wood, branches, or logging slash or debris;
- demolition, piling, or burial of derelict or abandoned structures, foundations, fencerows, driveways and roads, or other structures;
- conversion of trees, shrubs, and herbaceous areas to lawns;
- conversion of woodland to pastures;
- removal of duff and organic soils, particularly topsoil mining;
- excavation of soils and rock ;
- filling with excavated or imported soils, rock, or other fill materials;
- construction or reinforcement of embankments and earthen walls or barriers; and
- grading, leveling, or other alteration of existing topography

Applicability

- Grading plans required for constructed slopes could consider a 3:1 threshhold, since that is the slope generally regarded as a limit for humans to easily climb. This threshold could apply to constructed slopes anywhere on the site.

Proposed Exemptions

- For areas outside of critical areas or their buffers, provide a list of maintenance activities which may qualify as exempt. For example, drainage maintenance (i.e. roadside ditch), minor landscape maintenance, road work (pavement maintenance, gravel shoulders), and routine clearing along road right-of-ways.
- Critical areas should not be exempt from clearing and grading permits or restrictions.
    - Partial exemptions may be granted for critical areas meeting other exemption or permitted alteration criteria in the critical area regulations. For example, invasive plant removal may be listed as a permitted alteration in WMC 21.24.340; however, replanting may still be required to maintain soil stability.
- Remove "Area of proposed grading is not within a critical area." This would apply only if other exemption requirements are also met.
- Within R/W, note that this would not include clearing or grading that expands further into a critical area or its buffer.
- Consider including fish habitat enhancement projects by public agencies, utilities, or tribes.

- Consider revising the list of exemptions for consistency with exemptions described in the proposed GRADING, LAND CLEARING AND TREE CUTTING CODE (PSP,2005) (www.psp.wa.gov/downloads/LID.../Model_Grading_Clearing/). For example, exemption for digging of graves can be clarified to mean the excavation of individual graves in a permitted graveyard (to not exempt a large facility); or, the exemption for farming could be clarified to mean agricultural crop management on existing and ongoing farmed areas as defined per RCW 84.34.020 (and not exempt a large land conversion or the construction of 10,000 sq. ft. of new greenhouses).
- The listing of "Gardening and farming" as categorically exempt may be too general and could include damaging projects that should be reviewed under CAO concerns and, if nothing else, possible LID practices

Proposed grading permit (applicability)

- Consider combining the list of when a clearing and grading permit would apply to the list of exemptions. Ensure that they are consistent with one another, but otherwise avoid duplication.

Preparation by professionals

- If use of the term "minor work" is to be used to describe work in critical areas, then it should be accompanied by a clear definition of what would qualify.
- Clearing and grading plans within a wetland, stream, and/or fish and wildlife habitat conservation area should be reviewed by a qualified professional, such as a biologist or ecologist.
    - This review may include an assessment of stormwater changes projected to alter outflows to proximate streams or wetlands.

Performance Standards

- Clear performance standards other than those inferred by the proposed Decision Criteria are not included but should be added for clarity. Examples include:
    - Seasonal restrictions for erosion and sediment control
    - Place a time limit on planting following approved clearing and grading activities. For example, CTED recommends replanting within 15 days during the growing season or placing mulch/straw outside of the growing season.
    - Post a bond to ensure successful revegetation of disturbed areas. This should include maintenance and monitoring to ensure plant establishment. For critical areas, the standard maintenance and monitoring period is five years (WMC 21.24.350(7)).
    - Specifically encourage Low Impact Development techniques.

    - Review plans for: SEPA thresholds, consistency with NPDES Municipal Stormwater Permits, and Fish and Wildlife Habitat Conservations Plans.

Decision Criteria

- Recommend rewording the following grading permit 'Decision Criteria' as follows:
    - Change text "Critical areas not affect or mitigated" to "Critical areas not affected or compensatory critical area mitigation provided"
    - Strengthen the statement, "Minimize or no impacts to geological sensitive areas." The sequencing process the City expects applicants to follow when critical area impacts are proposed should be clearly stated. The standard BAS-based practice is to 1) avoid critical area impacts, 2) minimize critical area impacts, and 3) mitigate for unavoidable critical area impacts in a compensatory manner.
    - Decision criteria could include an appraisal of the net hydrologic effects of proposed clearing and grading projects, that is "would the project increase runoff volumes or peak flows, change the timing of storage and discharge of surface waters from the site, or reduce groundwater recharge as a result of removing vegetation, changing the topography, or changing surface drainage patterns on the site?" In general, projects should minimize the concentration of flow in pipes and culverts and grade along existing contours to maintain travel time for surface runoff.

10.3 General comments

- Code Format. Consider a format which specifically includes the following topics:
    - Purpose
    - Definitions (those specific to Clearing and Grading which are not defined elsewhere)
    - Applicability (i.e when is a permit required)
    - Exemptions
    - Performance standards
    - Decision Criteria
- Naming. Retitle the section to Clearing and Grading. To adequately protect existing landforms from identified geological hazards, grading should be regulated concurrently with clearing. This is commonly achieved through a clearing and grading ordinance or code section.
- Other. Consider offering a programmatic permit option for sites requiring routine clearing and grading maintenance, if conducted in accordance with an approved maintenance program.

REFERENCES

City of Woodinville. 2009. City of Woodinville Comprehensive Plan. Accessed online at: http://www.ci.woodinville.wa.us/Work/ComprehensivePlan.asp.

City of Woodinville. City of Woodinville Municipal Code. Accessed online at: http://www.codepublishing.com/wa/woodinville/.

CTED (Washington State Department of Community, Trade, and Economic Development). 2007. Critical Areas Assistance Handbook: Protecting Critical Areas Within the Framework of the Washington Growth Management Act.

CTED (Washington State Department of Community, Trade, and Economic Development). 2005. Technical Guidance Document for Clearing and Grading in Western Washington.

Ecology (Washington State Department of Ecology). 2012. Wetlands & CAO Updates: Guidance for Small Cities. Ecology Publication No. 10-06-002. Accessed online at: https://fortress.wa.gov/ecy/publications/publications/1006002.pdf

Granger, T., Hruby, T., McMillan, A., Peters, D., Rubey J., Sheldon, D., Stanley, S., Stockdale, E. 2005. Wetlands in Washington State, Volume 2 – Guidance for Protecting and Managing Wetlands. Washington State Department of Ecology Publication No. 05-06-008.

The Watershed Company. 2013. City of Woodinville Comprehensive Plan Update, Best Available Science Review DRAFT.

APPENDIX A

City of Woodinville Critical Areas Maps

See Revised Draft Existing Conditions Report, November 2014, available here:
http://www.ci.woodinville.wa.us/Work/ComprehensivePlan2015.asp

APPENDIX B

Wetlands and CAO Updates: Guidance for Small Cities

(Ecology 2012)

See link, here: http://www.ecy.wa.gov/programs/sea/wetlands/gma/guidance.html

APPENDIX C

Wetlands in Washington State – Volume 2, Appendix 8C

(Ecology 2005)

https://fortress.wa.gov/ecy/publications/publications/0506008.pdf

TECHNICAL MEMORANDUM

Date: November 13, 2014 **Project No.:** 14-05198.004

To: Lisa Grueter **Company:** Berk Consulting

From: David P. Findley, LG, LEG and Jill E. DeKoekkoek, LG

RE: **CITY OF WOODINVILLE GEOLOGIC HAZARD AREAS AND CRITICAL AQUIFER RECHARGE AREAS**

1.0 INTRODUCTION

The following presents the results of our work in completing the geologic hazard mapping for the City of Woodinville. We understand this work will be included in the Comprehensive Plan document that Berk Consulting is completing for the City of Woodinville.

At the request of the City of Woodinville, the following maps have been prepared:

- Landslide Hazard Areas
- Liquefaction Hazard Area
- Erosion Hazard Areas
- Problem Soil Areas
- Fault Hazard Areas

In addition to the Geologically Hazardous Areas defined by WMC 21.24.290 – 21.24.310, the City has requested a review of the Woodinville Critical Aquifer Recharge Areas (CARAs; WMC 21.24.190 – 21.24.200).

The following presents the rationale and details behind each of the Geologic Hazard Maps. Figure 1 is a general location map for the City of Woodinville and surrounding areas; Figure 2 is the Landslide Hazard Areas Map; Figure 3 is the Liquefaction Hazard Area map; Figure 4 is the Erosion Hazard Areas map; Figure 5 is the Problem Soil Areas map; Figure 6 is the Fault Hazard Area map; and Figure 7 is the Critical Aquifer Recharge Area (CARA) map. Details related to each of the hazard map areas are presented in Section 3.0.

2.0 METHODOLOGY

The Geologic Hazard maps were created by collecting and reviewing data available within the limits of the City of Woodinville. Geologic Hazards were reviewed based on current definitions of the geologic hazards, existing geologic hazard mapping, and interpretation of surficial mapping. The Woodinville Municipal Codes (WMC) 21.24.290 – 21.24.310 for Geologically Hazardous Areas and WMC 21.24.190 – 21.24.200 for CARAs provided definitions of Geological Hazard areas for landslide hazard areas, erosion

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hazard areas, and CARAs (accessed September 15, 2014). The geologic hazard mapping and surface mapping were collected from the City of Woodinville, King County, the United States Geological Survey (USGS), the Washington Department of Natural Resources (DNR), Tetra Tech, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The various maps used are described in the description of each individual Geologic Hazard map. The base layer for each Geologic Hazard Area map is a digital elevation model (DEM) hillshade image created from the 2003 King County LiDAR data.

3.0 GEOHAZARD MAPS

3.1 Landslide Hazard Map

The objective of the Landslide Hazard Areas shown in Figure 2 is to capture the most likely type of landslide hazards that may occur in the City of Woodinville. Landslides involve the down slope movement of earth materials under certain conditions such as low soil strength; high groundwater pore pressures; prolonged or shorter, heavy periods of precipitation; rain-on-snow events; and local geologic conditions for example. Landslide activity within the Puget Sound region generally consists of three primary types of landslides: 1) shallow colluvial slides that involve movement of the shallow (generally less than 10 feet) of loose topsoil, weathered disaggregated glacial soils, and vegetation, 2) deeper seated, rotational landslides, and 3) debris flows that involve mobilization of accumulated loose, slope debris in steep sided well developed drainages.

The City of Woodinville WMC 21.06.353 defines Landslide Hazard Areas as:

21.06.350 **Landslide.** Landslide: episodic downslope movement of a mass including, but not limited to, soil, rock or snow.

21.06.353 **Landslide hazard areas.** Landslide hazard areas: those areas in City of Woodinville subject to severe risks of landslides, including the following:

(1) Any area with a combination of:
  (a) Slopes steeper than fifteen (15) percent,
  (b) Impermeable soils, such as silt and clay, frequently interbedded with granular soils, such as sand and gravel, and
  (c) Springs or ground water seepage.
(2) Any area which has shown movement during the Holocene epoch, from 10,000 years ago to the present, or which is underlain by mass wastage debris from that epoch.
(3) Any area potentially unstable as a result of rapid stream incision, stream bank erosion or undercutting by wave action,
(4) Any area which shows evidence of or is at risk from snow avalanches.
(5) Any area located on an alluvial fan, presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments.

The updated Landslide Hazard Area map was produced by using current surficial maps and by reviewing previous landslide hazard maps (from TetraTech, King County, DNR, and Watershed Company). The surficial maps included existing geologic maps (DNR 2010; Minard 1985a, 1985b, 1983) and a DEM of the 2003 LiDAR imagery. The 2003 LiDAR DEM was the basis for the review of geomorphic evidence of past landslide events and for extracting slope data as described in WMC 21.06.353 and WMC 21.06.628. The geologic mapping review included analysis of geologic stratigraphic contacts that are known to be associated with landslides in the Puget Sound region.

Five layers within the geographic information systems (GIS) mapping program were created to produce the landslide hazard area map shown in Figure 2. These layers include:

1. Slopes greater than 15 percent and located in areas containing other slope hazard parameters as defined by the WMC 21.06.353. The other parameters included in this layer are stratigraphic contacts where permeable soils overlie lower permeable soils, springs and groundwater seepage.
2. Steep slopes (slopes greater than 40 percent). This layer captures slopes defined as steep slopes in WMC 21.06.628.
3. Areas of known or suspected landslides were mapped by evaluation of the geomorphological features in the DEM.
4. Debris flow hazard source areas were mapped by evaluation of the geomorphological features in the DEM.
5. Geologic contacts layer captures the slope parameter for landslide hazard areas from WMC 21.06.353 that accounts for local geologic conditions where permeable soils overlie less permeable soils.

These five layers were incorporated to produce Figure 2. The Landslide Hazard Areas shaded in purple illustrates slopes greater than 15 percent and incorporates elements from WMC 21.06.353 that include the geologic stratigraphic slope parameter delineating the contact (shown in yellow) between granular, more permeable advance glacial outwash, overlying lower permeability fine grain transition beds. Slopes greater than 40 percent are presented in WMC 21.06.628 as steep slope hazards and appear in green in Figure 2. The dark orange cross-hatched area in Figure 2 shows one area that exhibits geomorphic evidence of older landslide terrain. The geomorphic expression consists of an arcuate irregular topographic scarp with subdued hummocky topography within the slide area. The subdued nature of the geomorphic expression suggests an older landslide feature, possibly earliest Holocene in age (around 10,000 years ago). The light orange cross-hatched areas displays where accumulated colluvium and alluvium provide potential source areas for debris flows. Upon completion of the mapping, site visits were made to selected locations to verify suspect geomorphic features.

3.2 Liquefaction Areas

Liquefaction is a geologic process where loose, saturated or partially saturated sediments substantially loses strength and stiffness in response to an applied stress, usually the result of strong earthquake ground motion or other sudden change in stress condition, causing it to behave like a liquid resulting in loss of bearing strength of the soil mass.

The liquefaction hazard areas map was created by evaluating the following sources:

- King County mapped seismic hazards as defined by the King County Sensitive Areas Ordinance (SAO) – GIS data (accessed September 15, 2014)
- Washington State Department of Natural Resources (DNR) mapped liquefaction susceptibility layer – GIS data (Palmer et al. 2004)
- Review of geological maps (DNR 2010; Minard 1985a, 1985b, 1983), comparing Quaternary Alluvium to mapped liquefaction hazards by DNR and King County
- Review of DNR water bodies that may indicate the presence of saturated sediments in areas of geographical depressions – GIS data
- Site visits were completed at select locations to verify presence of possible saturated liquefiable soils

Figure 3 delineates areas of potential liquefaction. The largest area is the Sammamish River Valley and Bear Creek areas. Several smaller areas such as the area around Lake Leota are included as well as areas underlain by potentially liquefiable soils.

3.3 Erosion Hazard Areas

Soil erosion potential is a function of soil type and slope inclination and how easily the soil may be mobilized by erosive agents such as water and wind. The WMC 21.06.215 defines the soils from the USDA NRCS that are particularly sensitive to erosion and includes the slope inclination greater than 15 percent in the definition. The guidelines from the Washington Administrative Code (WAC) include the following:

21.06.213 **Erosion.** Erosion: the process by which soil particles are mobilized and transported by natural agents such as wind, rain splash, frost action or surface water flow.

21.06.215 **Erosion hazard areas.** Erosion hazard areas: those areas in City of Woodinville underlain by soils, which are subject to severe erosion when disturbed. Such soils include but are not limited to those classified as having a severe to very severe erosion hazard according to the USDA Natural Resource Conservation Service (NRCS), the 1973 King County Soils Survey or any subsequent revisions or addition by or to these sources. These soils include, but are not limited to, any occurrence of River Wash (Rh) and the following when they occur on slopes fifteen per cent or steeper:

(1) The Alderwood gravely sandy loam (AgD),
(2) The Alderwood and Kitsap soils (AkF),
(3) The Beausite gravely sandy loam (BeD and BeF),
(4) The Kitsap silt loam (KpD),
(5) The Ovall gravely loam (OvD and OvF),
(6) The Ragnar fine sandy loam (RaD), and
(7) The Ragnar-Indianola Association (RdE).

The NRCS soils mapping for King County were processed and queried (United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Soil Survey Geographic (SSURGO) for King and Snohomish Counties, accessed September 15, 2014) in GIS to identify soils when they occurred on slopes that are 15 percent or greater. These areas are shown in Figure 4.

3.4 Problem Soil Areas

The problem soil areas are those interpreted to present potential construction issues. These issues are interpreted to include local accumulations of peat and compressible organic silt and clay deposits and other soils that present bearing strength capacity challenges. The Problem Soils Areas correspond quite closely to those outlined on the Liquefaction Areas because of the shared common characteristics and depositional history. Problematic soils will be those composed of peat, compressible organic soils, and saturated or partially saturated sediments that can result in differential settlement of structures if the foundations and subgrade are not designed properly.

The Problem Soil Areas map was created by combining the previously mapped Liquefaction Areas with areas that may contain peat and compressible organic soils. The geologic map did not note organic soils, but several small ponds were mapped by the DNR. Closed topographic depressions that may have accumulated peat or organic materials were included in the mapped area of Problem Soil Areas shown in Figure 5. Site visits were conducted at selected sites to verify the likely presence of inferior soils.

Figure 5 delineates the areas that present the potential for problem soils. As on the Liquefaction Hazard Area map (Figure 3), the largest area is the Sammamish River Valley and Bear Creek areas. Several smaller areas such as the area around Lake Leota are included as well as areas underlain by potentially peaty or soft compressible soils.

3.5 Fault Hazard Areas

Figure 6 shows the inferred locations of known or suspected Quaternary faults within the City of Woodinville. These lineaments are defined largely by subsurface geophysical profiles conducted by the DNR that suggest disrupted quaternary stratigraphy. No surface expression of the suspected features was observed on the LiDAR imagery.

The Fault Hazard area map was created by reviewing available published geologic data by the DNR (accessed September 12, 2014) and the USGS (2006; accessed September 15, 2014). The USGS data did not show any faults within the area of the City of Woodinville. The DNR mapping showed six known or suspected faults within the city limits.

4.0 CRITICAL AQUIFER RECHARGE AREAS

Critical aquifer recharge areas (CARA) as defined in the City of Woodinville's WMC 21.24.200 are those areas designated by Chapter 365-190-080(2) WAC that have been determined to have 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.

Critical aquifer recharge areas within Woodinville (WMC 21.24.190) are categorized as follows:

a. Category I critical aquifer recharge areas include those areas designated on the critical aquifer recharge area map as highly susceptible to ground water contamination and that are located within a sole source aquifer or wellhead protection area.
b. Category II critical aquifer recharge areas include those mapped areas designated that:
    i. Have a medium susceptibility to ground water contamination and are located in a sole source aquifer or wellhead protection area; or
    ii. Are highly susceptible to ground water contamination and are not located in a sole source aquifer or wellhead protection area.

The City of Woodinville regulations allow for variances under prescribed conditions:

> "An applicant can request that the Development Services Director declassify a specific area included in the map adopted under subsection (1) of this section. The request must be supported by a critical areas report that includes a hydro-geologic assessment. The request to declassify an area shall be reviewed by the Development Services Director following the procedure in WMC 21.24.110. (Ord. 465 § 27, 2008; Ord. 375 § 3, 2004)"

(1) The following new uses or activities are not allowed in Category I critical aquifer recharge areas:

a. Hazardous liquid transmission pipelines;
b. Sand and gravel, and hard rock mining on land that is not zoned for mining as of December 1, 2004;
c. Mining of any type below the ground water table;
d. Processing, storage, and disposal of radioactive wastes;
e. Hydrocarbon extraction;
f. Commercial wood treatment facilities on permeable surfaces;
g. Golf courses;
h. Cemeteries;
i. Wrecking yards;
j. Landfills for hazardous waste, municipal solid waste, or special waste; and
k. On-site septic systems on lots smaller than one acre without a treatment system that results in effluent nitrate-nitrogen concentrations below 10 milligrams per liter.

(2) The following new uses and activities are not allowed in a Category II critical aquifer recharge area:

a. Mining of any type below the water table;
b. Processing, storage, and disposal of radioactive substances;
c. Hydrocarbon extraction;
d. Commercial wood treatment facilities on permeable surfaces;
e. Wrecking yards;
f. Landfills for hazardous waste, municipal solid waste, or special waste; and
g. On-site septic systems on lots smaller than one acre without a treatment system that results in effluent nitrate-nitrogen concentrations below 10 milligrams per liter.

(3) The following standards apply to any development proposal in a critical aquifer recharge area:

6. All storage tanks proposed to be located in a critical aquifer recharge area must comply with local building code requirements and must conform to the International Fire Code requirements for secondary containment.
7. Commercial vehicle repair and servicing must be conducted over impermeable pads and within a covered structure capable of withstanding normally expected weather conditions. Chemicals used in the process of vehicle repair and servicing must be stored in a manner that protects them from weather and provides containment should leaks occur.
8. No dry wells shall be allowed in critical aquifer recharge areas on sites used for vehicle repair and servicing. Dry wells existing on the site prior to facility development must be abandoned using techniques approved by the Washington State Department of Ecology prior to commencement of the proposed activity.
9. The activities listed below shall be conditioned in accordance with the applicable State and Federal regulations as necessary to protect critical aquifer recharge areas.

Activity	Applicable State and Federal Regulations
Above-ground storage tanks	WAC 173-303-640
Animal feedlots	Chapter 173-216 WAC, Chapter 173-220 WAC
Automobile washers	Chapter 173-216 WAC, Best Management Practices for Vehicle and Equipment Discharges (WDOE WQ-R-95-56)
Chemical treatment storage and disposal facilities	WAC 173-303-182
Hazardous waste generator (boat repair shops, biological research facility, dry cleaners, furniture stripping, motor vehicle service garages, photographic processing, printing and publishing shops, etc.)	Chapter 173-303 WAC
Injection wells	Federal 40 CFR Parts 144 and 146, Chapter 173-218 WAC
Junk yards and salvage yards	Chapter 173-304 WAC, Best Management Practices to Prevent Storm Water Pollution at Vehicles Recycler Facilities (WDOE 94-146)
Oil and gas drilling	WAC 332-12-450, Chapter 173-218 WAC
On-site sewage systems (large scale)	Chapter 173-240 WAC
On-site sewage systems (< 14,500 gal/day)	Chapter 246-272 WAC, Local Health Ordinances
Pesticide storage and use	Chapter 15.54 RCW, Chapter 17.21 RCW
Sawmills	Chapter 173-303 WAC, Chapter 173-304 WAC, Best Management Practices to Prevent Storm Water Pollution at Log Yards (WDOE 95-53)
Solid waste handling and recycling facilities	Chapter 173-304 WAC
Surface mining	WAC 332-18-015
Underground storage tanks	Chapter 173-360 WAC
Wastewater application to land surface	Chapter 173-216 WAC, Chapter 173-200 WAC, WDOE Land Application Guidelines, Best Management Practices for Irrigated Agriculture

The CARA map from the Woodinville Comprehensive Update, dated May 29, 2014, was reviewed and evaluated with the mapped surficial geology map from the City of Woodinville dated September 2014. The mapped CARA areas correspond with particular mapped geology units. Aquifer recharge areas have been identified as those mapped as either Vashon advance outwash (map symbol Qva) or Vashon recessional outwash (map symbol Qvr). The outwash deposits are generally granular in nature and permeable. The advance outwash forms the local aquifer. In a complete intact stratigraphic sequence, Vashon lodgment till separates the underlying advance outwash and the overlying recessional outwash, thus the lower permeability lodgment till serves as an aquitard between these two outwash deposits. Locally however, the till may be missing because it was not deposited at a particular location or erosion

has removed it and the recessional outwash may be in direct contact with the advance outwash, thus allowing hydrologic communication between the two different outwash deposits.

Figure 7 shows the CARA delineated areas within the City of Woodinville.

GOLDER ASSOCIATES INC.

Jill E. DeKoekkoek, LG
Project Geologist

Dave P. Findley, LG, LEG
Associate Engineering Geologist

Attachments:

Figure 1	City of Woodinville Geohazards - Overview
Figure 2	City of Woodinville Geohazards - Potential Landslide Hazard Areas
Figure 3	City of Woodinville Geohazards - Potential Liquefaction Hazard Areas
Figure 4	City of Woodinville Geohazards - Potential Erosion Hazard Areas
Figure 5	City of Woodinville Geohazards - Potential Problem Soil Areas
Figure 6	City of Woodinville Geohazards - Potential Fault Hazards
Figure 7	City of Woodinville Geohazards - Critical Aquifer Recharge Areas

JED/DPF/tp

5.0 REFERENCES

City of Woodinville Municipal Code, accessed September 15, 2014 from the City of Woodinville website: http://www.ci.woodinville.wa.us/Documents/CityHall/Ordinances/Ordinance%20375.pdf

King County Critical Areas Ordinance, accessed September 15, 2014 from the King County website: http://www.kingcounty.gov/property/permits/codes/CAO.aspx. King County Sensitive Areas Ordinance seismic GIS mapping, accessed September 12, 2014 from King County GIS Center website: http://www5.kingcounty.gov/gisdataportal/

Minard, J.P., 1985a, Geologic Map of the Maltby Quadrangle, Washington: United States Geological Survey, Miscellaneous Field Studies Map MF-1746, 1:24,000.

Minard, J.P., 1985b, Geologic Map of the Bothell Quadrangle, Washington: United States Geological Survey, Miscellaneous Field Studies Map MF-1747, 1:24,000.

Minard, J.P., 1983, Geologic Map of the Kirkland Quadrangle, Washington: United States Geological Survey, Miscellaneous Field Studies Map MF-1543, 1:24,000.

Palmer, Stephen P.; Magsino, Samantha L; Bilderback, Eric L.; Poelstra, James L.; Folger, Derek S., and Niggemann, Rebecca A., 2004, Liquefaction Susceptibility and Site Class Maps of Washington State, by County; Washington State Department of Natural Resources; Open File Report 2004-20, 78 plates, with 45 p. text.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Soil Survey Geographic (SSURGO) for King and Snohomish Counties, accessed September 15, 2014 from USDA Data Gateway website: http://datagateway.nrcs.usda.gov/

United States Geological Survey (USGS), 2006, Quaternary fault and fold database for the United States, accessed September 15, 2014, from USGS website: http//earthquake.usgs.gov/regional/qfaults/

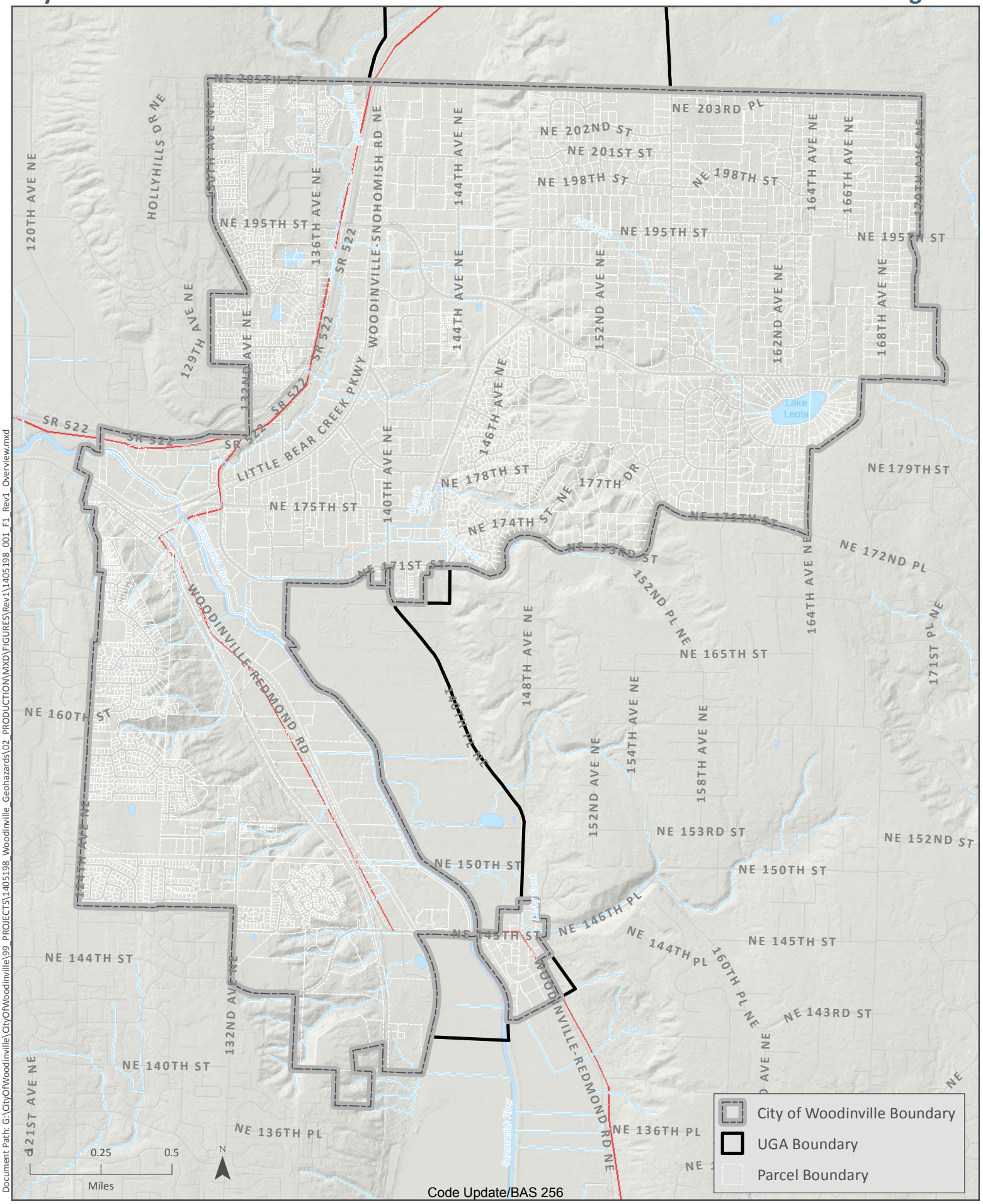
Washington State Department of Natural Resources (DNR), 2010, Surface Geology, 1:100,000, accessed September 12, 2014 from the DNR website: http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html

Washington State Department of Natural Resources (DNR), hydrographical GIS mapping, accessed September 12, 2014 from DNR website: http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html

ATTACHMENTS

City of Woodinville Geohazards - Overview

Figure 1



Code Update/BAS 256

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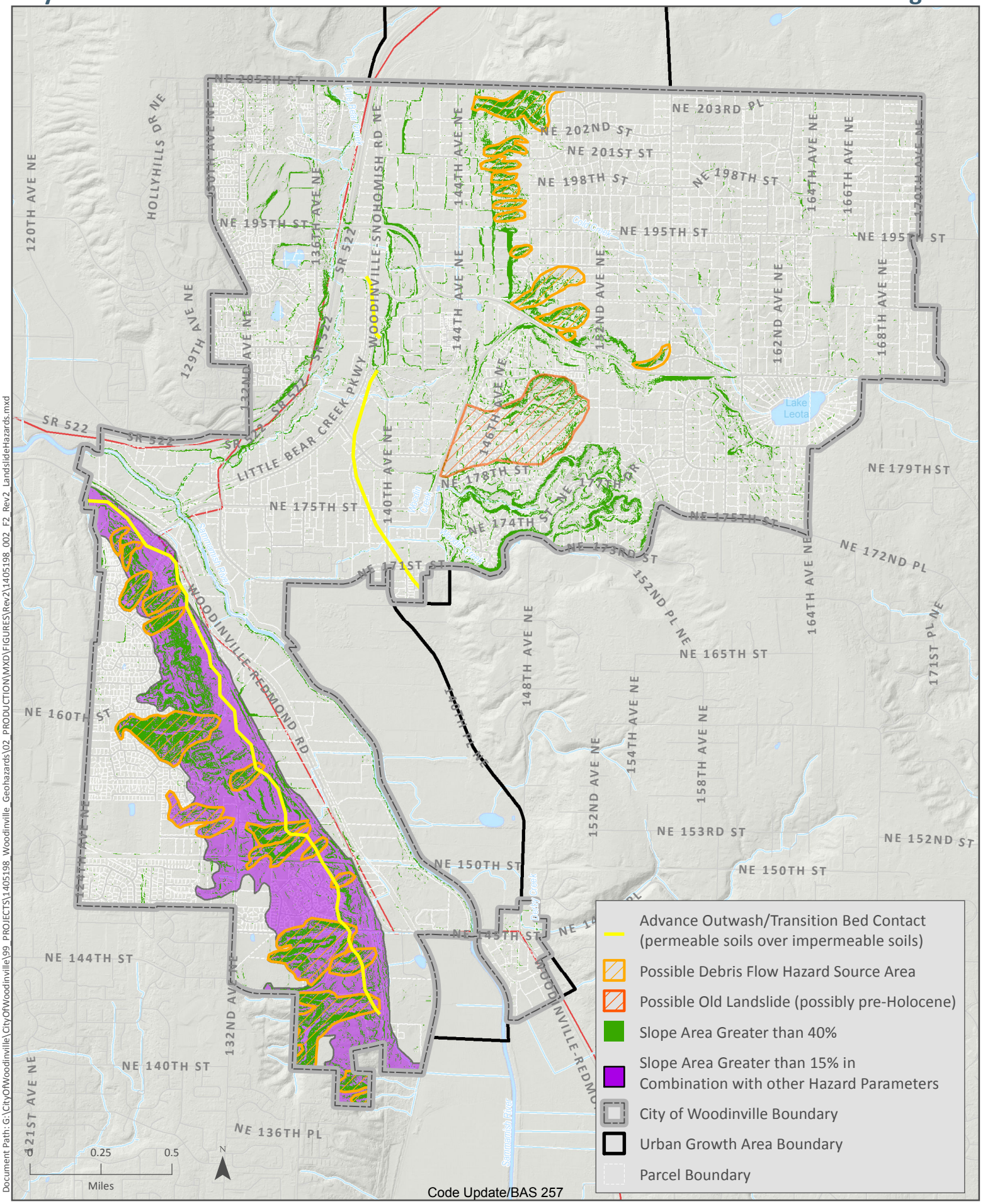
Date: October, 2014
Source: City of Woodinville, King County

Golder Associates

City of Woodinville Geohazards - Potential Landslide Hazard Areas

Figure 2



Code Update/BAS 257

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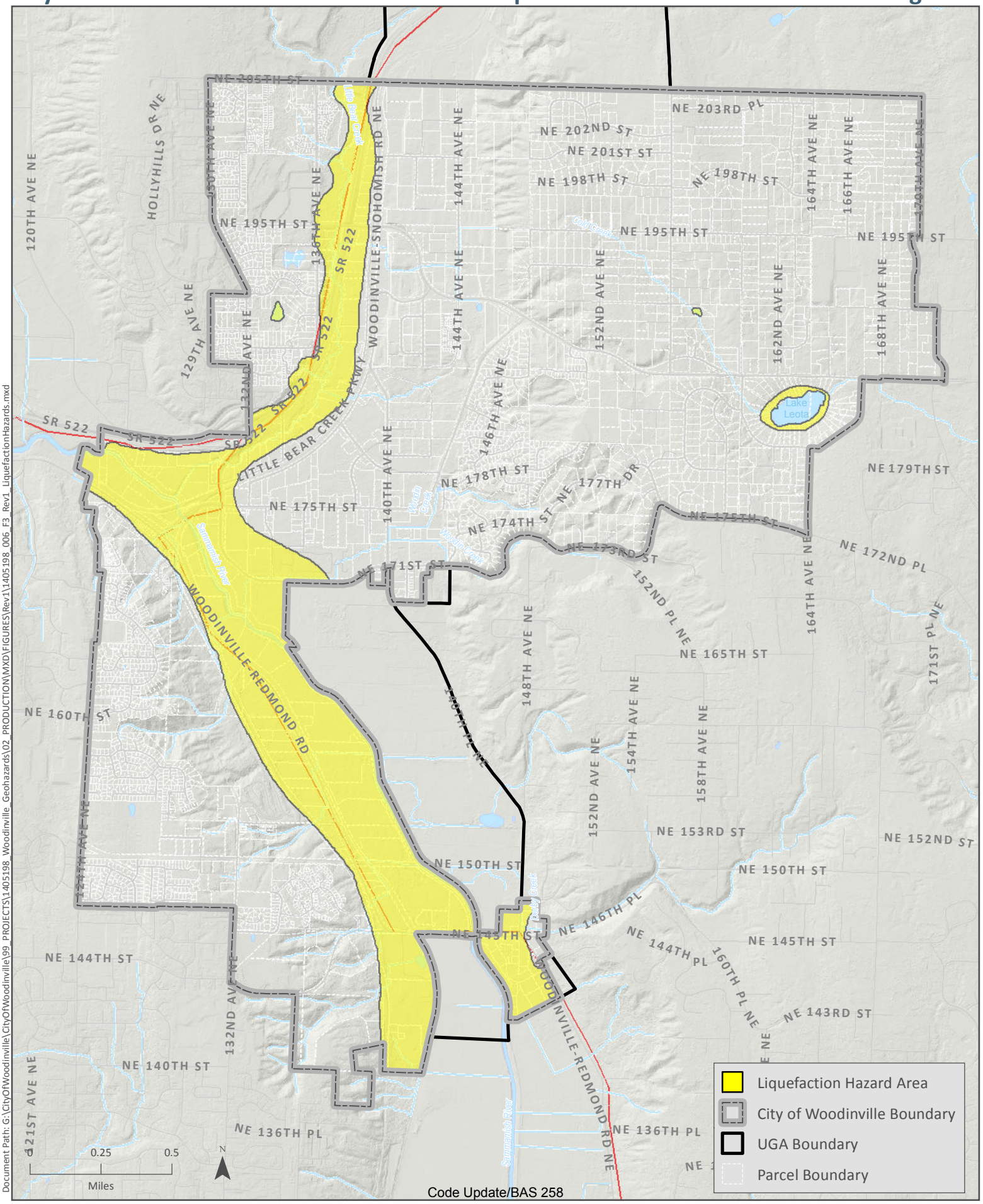
Date: November, 2014
Source: City of Woodinville, King County, Washington DNR, Golder Associates Inc.

City of Woodinville Geohazards - Potential Liquefaction Hazard Areas

Figure 3



Code Update/BAS 258

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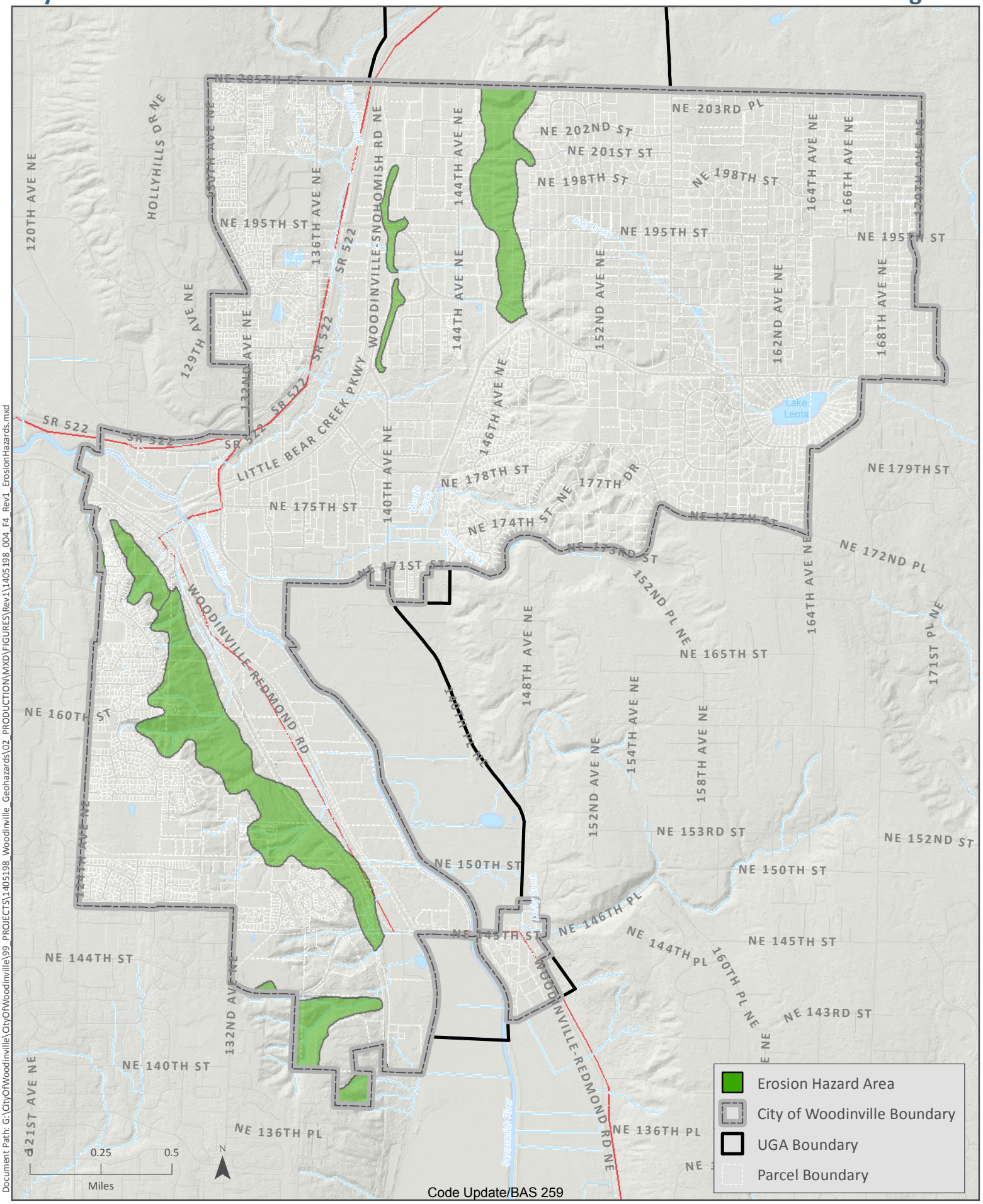
Date: October, 2014
Source: City of Woodinville, King County, Golder Associates Inc.

City of Woodinville Geohazards - Potential Erosion Hazard Areas

Figure 4



Code Update/BAS 259

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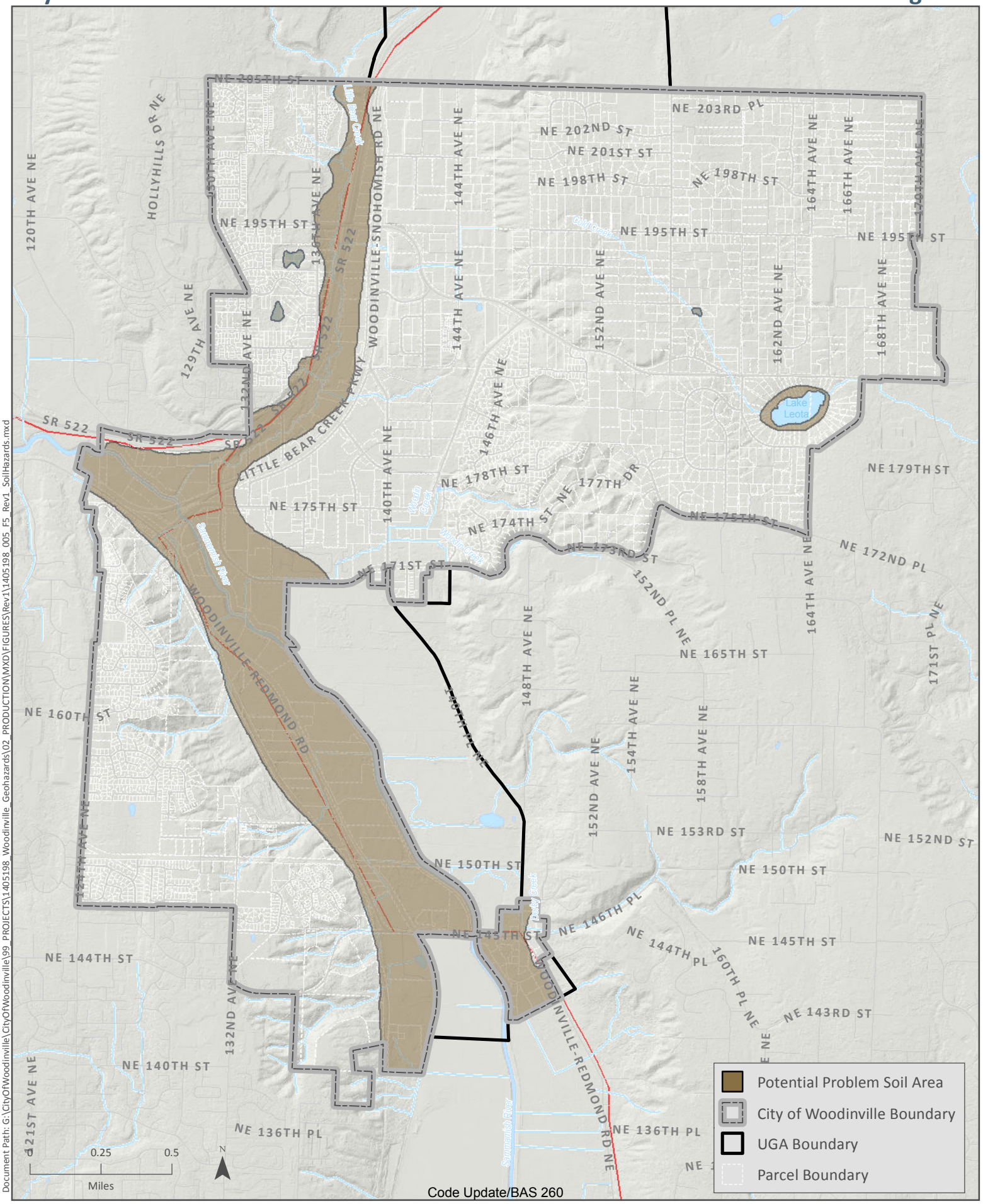
Date: October, 2014
Source: City of Woodinville, King County, U.S. Dept. of Agriculture - NRCS

Golder Associates

City of Woodinville Geohazards - Potential Problem Soil Areas

Figure 5



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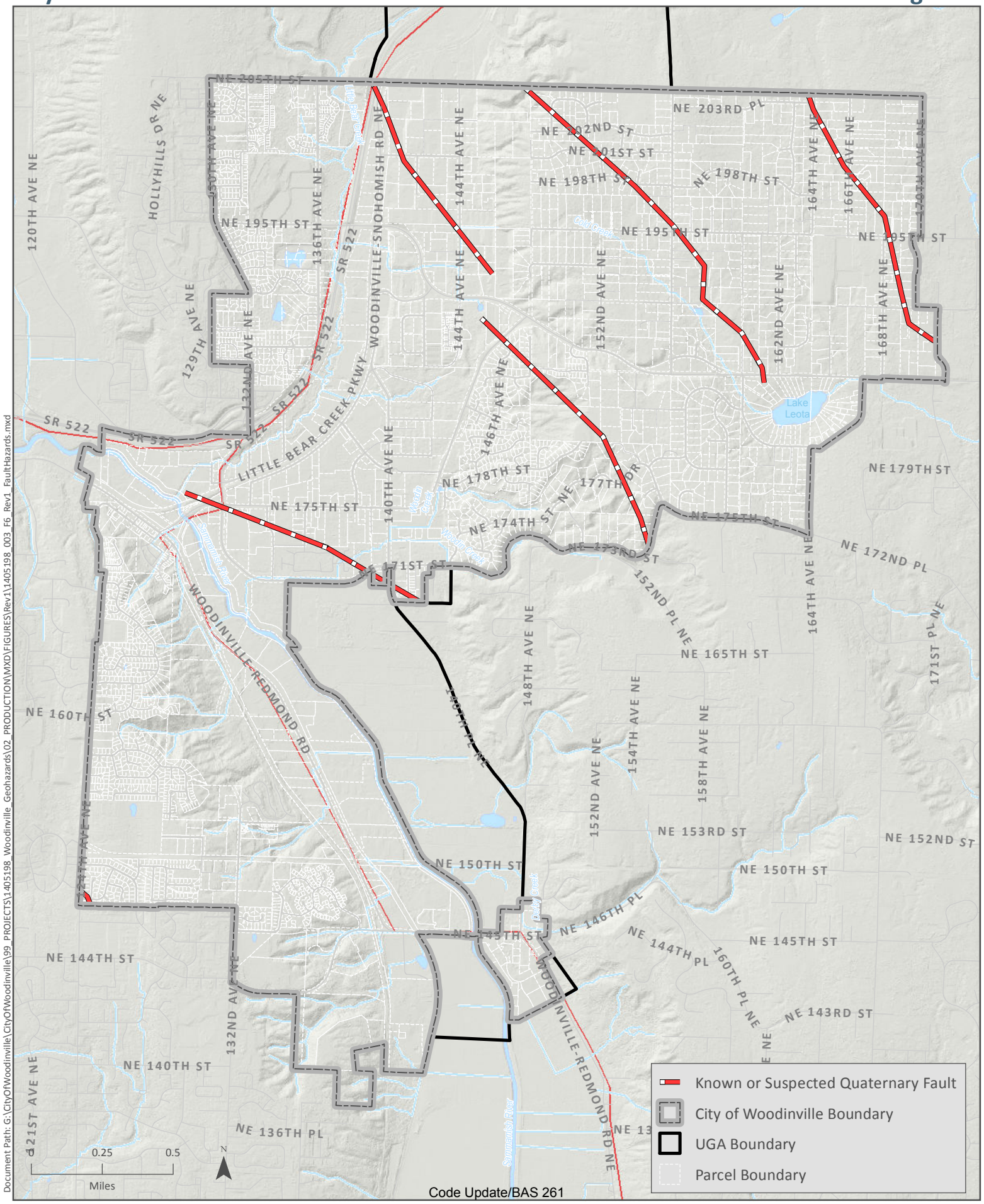
Date: October, 2014
Source: City of Woodinville, King County, Golder Associates Inc.

City of Woodinville Geohazards - Potential Fault Hazards

Figure 6



Code Update/BAS 261

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Date: October, 2014
Source: City of Woodinville, King County, Washington DNR

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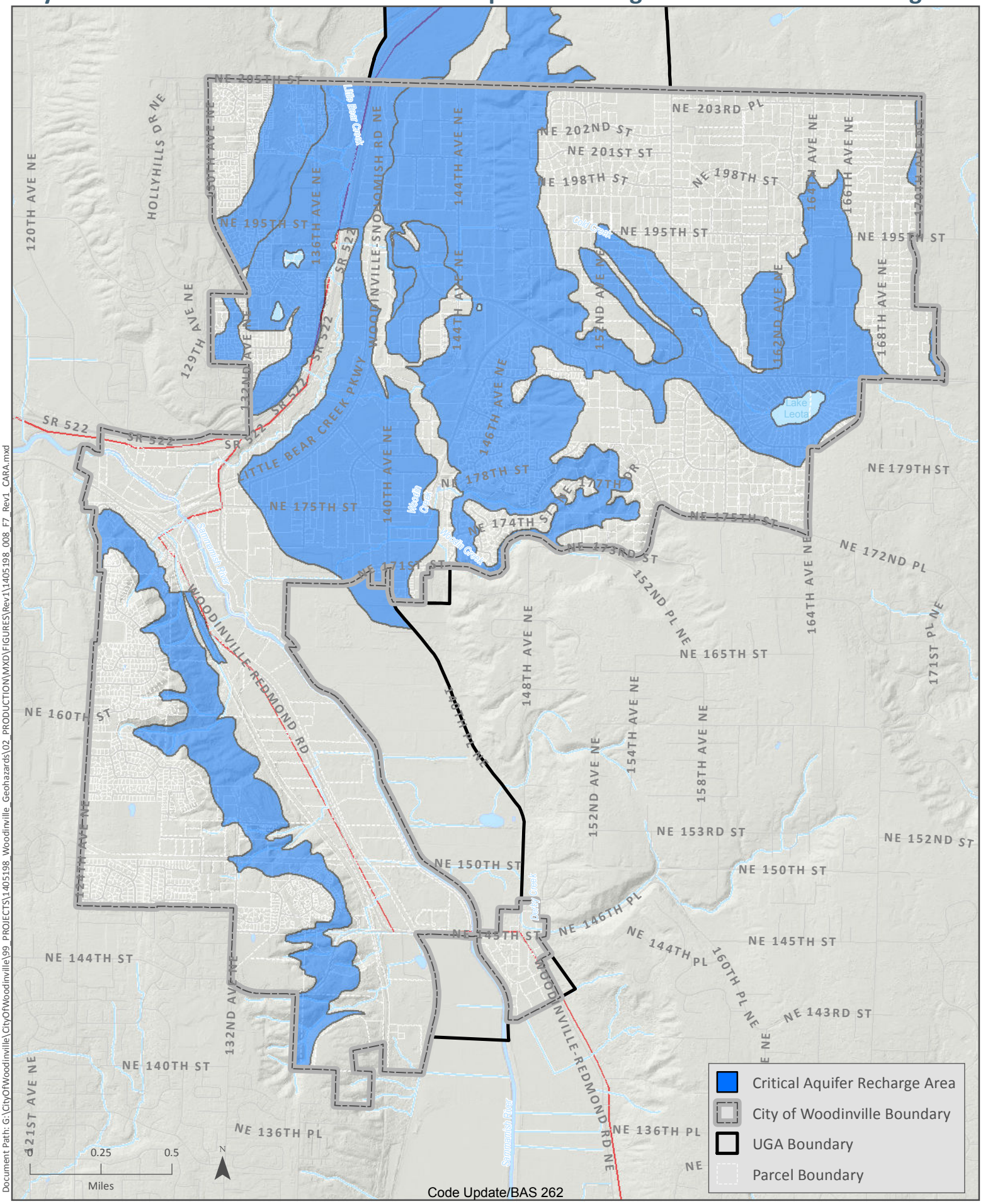
City of Woodinville Geohazards - Critical Aquifer Recharge Areas

Figure 7



Code Update/BAS 262

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Date: October, 2014
Source: City of Woodinville, King County, The Watershed Company

Golder Associates

Golder Associates

TECHNICAL MEMORANDUM

Date:	October 17, 2014	**Project No.:**	14-05198.004
To:	Lisa Grueter	**Company:**	Berk Consulting
From:	Dave P. Findley, LG, LEG		
cc:		**Email:**	dfindley@golder.com

RE: CITY OF WOODINVILLE – COMMENTS ON ORDINANCE 275 GEOLOGICALLY HAZARDOUS AREAS SECTION 21.24.290 THROUGH 21.24.310

The following comments are provided at your request regarding r the City of Woodinville's Ordinance 375 for Geologically Hazardous Areas (Sections 21.24.290 through 21.24.310).

1.0 COMMENTS

1.1 Section 21.24.300 Development Standards: General Requirements

Under Development Standards general requirements section (1) paragraph (b):

> "Alterations of geologically hazardous areas or associated buffers may only occur for activities that ….. Will not adversely impact other critical areas and are designed so that the hazard to the project is eliminated or mitigated to a level where there is: no reasonable chance of harm to the project or its associated land use."

How is "reasonable" defined in terms of harm? This is a subjective condition. It would be preferable to use a baseline statement such as "no increased adverse impacts beyond the pre-development condition".

1.2 Section 21.24.310 Performance Standards: Specific Hazards

1.2.1

Section (1) Paragraph (a) states:

> "The size of the buffer shall be determined by the City to eliminate or minimize the risk of property damage ……."

The risk level can be reduced but never eliminated, suggest dropping the word "eliminated"

1.2.2

Section (1), Paragraph C (Design Standards) seems prescriptive and unnecessarily limiting. For example:

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> "The requirement for long term slope stability shall exclude designs that require regular and periodic maintenance to maintain their level of function."

This limitation removes several commonly used techniques for slope stability mitigation such as horizontal drains. Horizontal drains can be very effective in slope stability mitigation and have been used effectively by numerous public agencies and private sector owners.

1.2.3

Section (1) Paragraph (c) (i) states:

> "The proposed development shall not decrease the factor of safety for landslide occurrences below the limits of 1.5 for static conditions and 1.2 for dynamic conditions. Analysis of dynamic conditions shall be based on a minimum horizontal acceleration as established by the current version of the International Building Code."

What about natural slope that have an existing Factor of Safety (FOS) of less than 1.5 but are currently stable? Suggest something like "proposed development shall not decrease the Factor of Safety below pre-development levels based on demonstrated geotechnical back analysis by a qualified geotechnical professional subject to review and approval by the City."

GOLDER ASSOCIATES INC.

David P. Findley, LG, LEG
Associate

Andrew J. Walker, PE
Principal

DPF/AJW/km