ORDINANCE NO. 1036

AN ORDINANCE OF THE CITY COUNCIL OF THE CITY GIG HARBOR, WASHINGTON, RELATING TO LAND USE; INTEGRATING THE CITY'S CRITICAL AREAS REGULATIONS, CHAPTER 18.12, WITH THE WETLAND REGULATIONS, CHAPTER 18.08; ADDING NEW DEFINITIONS TO THE CHAPTER ON CRITICAL AREAS AND WETLANDS; ADOPTING NEW WETLAND RATING CATEGORIES, CONSISTENT WITH THE DOE WETLAND RATINGS; ESTABLISHING NEW WETLAND, RAVINE SIDEWALL AND BLUFF BUFFER WIDTHS; AMENDING THE CRITERIA FOR WETLAND BUFFER ALTERATIONS; ADOPTING A WETLAND BUFFER AVERAGING PROCEDURE; AMENDING THE CRITERIA FOR WETLAND REPLACEMENT; ADOPTING STREAM CLASSIFICATIONS, BUFFER WIDTHS AND STREAM PROTECTION AND MITIGATION REGULATIONS; ADDING NEW PROVISIONS TO FISH AND WILDLIFE HABITAT FOR SPECIAL CONSIDERATIONS FOR SALMONIDS; REPEALING CHAPTER 18.12 OF THE GIG HARBOR MUNICIPAL CODE; AMENDING SECTIONS: 18.08.010, 18.08.020, 18.08.030, 18.08.040, 18.08.050, 18.08.070, 18.08.080, 18.08.090, 18.08.100, 18.08.110, 18.08.120, 18.08.140, 18.08.150, 18.08.160, 18.08.170, 18.08.180; REPEALING SECTIONS: 18.08.060, 18.08.130, 18.08.200, 18.08.220, 18.08.230, 18.08.260; ADDING NEW SECTIONS: 18.08.032, 18.08.034, 18.08.038, 18.08.182, 18.08.183, 18.08.184, 18.08.185, 18.08.186, 18.08.188, 18.08.190, 18.08.192, 18.08.194, 18.08.196, 18.08.200, 18.08.202, 18.08.204, 18.08.206, 18.08.208, 18.08.220 TO THE GIG HARBOR MUNICIPAL CODE.

WHEREAS, the City of Gig Harbor plans under the Washington State Growth Management Act (chapter 36.70A RCW); and

WHEREAS, the City is required to take action to review and, if needed, revise the comprehensive plan and development regulations to ensure the plan and regulations comply with the requirements of the Growth Management Act (GMA) on or before December 1, 2004 (RCW 36.70A.130 (4)(a)); and

WHEREAS, the City adopted a revised comprehensive plan, consistent with the requirements of the Growth Management Act (RCW 36.70A.130 (4)(a)) on December 13, 2004 (Ordinance No. 981); and

WHEREAS, the City is required to consider critical areas ordinances and utilize best available science in designation and protection critical areas as part of the mandated review (RCW 36.70A.130 (1)(a) & .172)

WHEREAS, the City is required to provide public notice of and hold a public hearing on any amendments to the Comprehensive Plan and implementing development regulations (RCW 36.70A.035, RCW 36.70A.130); and

WHEREAS, the City Community Development Director notified the Washington State Office of Community Development of the City's intent to amend the Comprehensive Plan and development regulations on October 21, 2004 and on December 20, 2004 pursuant to RCW 36.70A.106; and

WHEREAS, the City Community Development Director notified the Washington State Department of Ecology of the City's intent to amend Title 18 of the Gig Harbor Municipal Code on January 7, 2005; and

WHEREAS, on October 20, 2004, the City's SEPA Responsible Official issued a Determination of Non-Significance with regards to the proposed adoption of a revised Comprehensive Plan, as well as the amendments to Title 17 and Title 18 of the Gig Harbor Municipal Code; and

WHEREAS, no appeals of the issuance of the Determination of Non-Significance were filed; and

WHEREAS, the City anticipated this requirement the review and revision of the Comprehensive Plan and included an objective in the 2004 Annual Budget for the update of the Comprehensive Plan; and

WHEREAS, on April 12, 2004 the City Council approved a consultant services contract with AHBL, Inc. for the services necessary to assist the City in the review and update of the Comprehensive Plan and development regulations; and

WHEREAS, in order to ensure that the review and update of the Comprehensive Plan is completed in a timely fashion consistent with State law it was necessary to establish a timeline and work program; and

WHEREAS, the City Council adopted Resolution No. 629 on September 13, 2004, which was subsequently revised by Resolution No. 631, which established a timeline and work program for the review and revision of the City of Gig Harbor Comprehensive Plan; and

WHEREAS, the City Planning Commission reviewed the recommendations for the update of the Comprehensive Plan and development regulations as outlined in the scope of work in Resolutions Nos. 629 and 631; and

WHEREAS, the City Planning Commission conducted work-study sessions for the 2004 review and update of the Comprehensive Plan and development regulations on September 16, 2004, October 7, 2004, October 21, 2004 and November 18, 2004; and

WHEREAS, the City Planning Commission held a legally advertised public hearing on the 2004 review and update of the Comprehensive Plan and development regulations on November 4, 2004 and recommended adoption of a revised City of Gig Harbor Comprehensive Plan and certain amendments to Title 17 and Title 18 of the Gig Harbor Municipal Code; and

WHEREAS, the Gig Harbor City Council held a public hearing and first reading of an Ordinance implementing the recommendations of the Planning Commission amending the Comprehensive Plan and development regulations on November 22, 2004; and

WHEREAS, the Gig Harbor City Council held a second public hearing and second reading of an Ordinance implementing the recommendations of the Planning Commission amending the Comprehensive Plan and development regulations on December 13, 2004;

WHEREAS, the Gig Harbor City Council held a third public hearing and first reading of an Ordinance implementing the recommendations of the Planning Commission amending the Critical Areas regulations on November 28, 2005;

WHEREAS, the Gig Harbor City Council moved the recommendations of the Planning Commission amending the Critical Areas regulations be reviewed by the Community Development Committee on January 23, 2006;

WHEREAS, the Gig Harbor City Council Community Development Committee held public meetings on February 7, 2006 and February 21, 2006 to review recommendations of the Planning Commission amending the Critical Areas regulations;

WHEREAS, the Gig Harbor City Council held a fourth public hearing and first reading of an Ordinance implementing the recommendations of the City Council Community Development Committee amending the Critical Areas regulations on March 13, 2006;

WHEREAS, the Gig Harbor City Council held a second reading of an Ordinance implementing the recommendations of the City Council Community Development Committee amending the Critical Areas regulations on March 27, 2006;

THE CITY COUNCIL OF THE CITY OF GIG HARBOR, WASHINGTON, ORDAINS AS FOLLOWS:

<u>Section 1. Critical Areas Findings of Fact.</u> The City Council hereby adopts the Critical Areas Findings of Fact, as set forth in Exhibit A, which are incorporated herein by reference.

Section 2. Implementing Development Regulations.

A. **Notice.** The City Clerk confirmed that public notice of the public hearing held by the City Council was provided.

B. **Hearing Procedure**. The City Council's consideration of the comprehensive land plan and amendments to the Gig Harbor Municipal Code is a legislative act. The Appearance of Fairness doctrine does not apply.

C. **Testimony.**

The following persons testified/submitted written testimony at the November 22, 2004 public hearing:

James A. Wright, testified and submitted a letter for consideration by the Council regarding the use of Planned Residential Developments; and

The Washington State Department of Ecology submitted a letter dated November 22, 2004 regarding the draft Critical Areas Ordinance via facsimile.

The following person's testified/submitted written testimony at the December 13, 2004 public hearing:

Jim Wright, submitted a letter dated December 8, 2004 regarding densities and diversity of housing;

The Puget Sound Regional Council submitted a letter dated December 8, 2004 regarding the Transportation Element;

The Olympic Property Group submitted a letter dated December 10, 2004 regarding wetland buffer width averaging;

Marilyn Owel submitted a letter dated December 13, 2004 regarding wetland buffer width recommendations;

The Friends of Pierce County submitted a letter dated December 13, 2004 regarding low impact development techniques and wetlands;

Carl Halsan testified that the City likely has very few Category I wetlands;

John Chadwell, Olympic Property Group referenced the December 10, 2004 letter and commented on wetland buffers width averaging;

Dennis Reynolds, Davis Wright Tremaine submitted a letter written on behalf of four clients regarding the wetland issues;

Chris Wright, Raedeke Associates, Inc. referenced his December 10, 2004 letter attached to the Olympic Property Group correspondence regarding wetland buffer width averaging;

Doug Sorenson testified that his wetland consultant indicated that he has a Category I wetland; and

Scott Wagner testified regarding the wetland buffer issues.

The Washington State Department of Ecology submitted a letter dated February 1, 2005 regarding the amendments to the draft Critical Areas Ordinance.

The following person's testified/submitted written testimony at the November 28, 2005 public hearing:

Doug Sorensen commented on the buffer widths and setbacks and recommended a delay action.

Eric Barta asked how salmon runs affect wetland category ratings.

Maureen Barta voiced concern that not enough people knew about the amendments and they should be delayed.

Carl Halsan asked whether estuarine areas are considered wetlands and if they will fall under the jurisdiction of the Shoreline Management Act. He asked about best science for estuarine wetlands.

David Fisher discussed the creation of wetlands by construction. He asked why the city standards should be the same as for rural areas.

Eva Jacobsen was concerned that the wetland process is cumbersome. She recommended the Council obtain more input . She stressed the need to consider the effects on buildable lands as well as parks.

Chuck Meacham suggested adding a Fisheries Biologist to the definitions list.

Beverly Simpson was concerned with the removal of reference to Crescent Creek. She was concerned with the Wheeler street end Category I wetland. She recommended clarification on permitted uses in wetland buffer areas adjacent to a spawning creek.

Matt Halvorsen said that the Category I buffers should not be at the low end of the Department of Ecology recommendations for the most critical of wetlands. Mr. Halvorsen agreed that more time should be taken to consider the impacts of this ordinance as there seems to be many misunderstandings.

Rob Hayden commented that the majority of concerns are from those wanting to build something. He asked if the buffers are effective in protecting the wetlands and then develop the means of pro-rating the buffers in designated.

Wade Perrow addressed conflicting information in the technical report on page 52. He wasn't sure how to score a Category I Wetland as defined by the city. He suggested city should know exactly where the Category I Wetlands are located to determine what buffer should apply. He said the city should consider the "takings" aspect if they determine they need buffers of that size. He said the science doesn't support the proposed buffering requirements.

The Friends of Pierce County submitted a letter dated February 9, 2005 regarding the amendments to the draft Critical Areas Ordinance.

Joel and Lucinda Wingard submitted an e-mail on February 16, 2006 requesting the Council follow the recommendations of Ecology and Friends of Pierce County.

The following person's testified/submitted written testimony at the March 13, 2006 public hearing:

Doug Sorenson did not support the amendment. He asked that the Council ask the Department of Ecology why the current city buffers were not effective. He asked the Council to look at the impacts this ordinance had on his property that had wetlands. He asked if salmon runs have decreased in Crescent Creek.

Del Stutz said that he has four properties within Gig Harbor that are impacted by the ordinance. Mr. Stutz urged Council not to pass this ordinance after the hearing.

Rachael Villa submitted written testimony from Marian Berejikian, Executive Director of Friends of Pierce County, which supports the passage of the critical areas ordinance with the recommendations from the Department of Ecology. She said that this is a very complex issue.

Section 3. Chapter 18.12 of the Gig Harbor Municipal Code is hereby repealed.

Section 4. Chapter 18.08, Wetland Management Regulations is hereby renamed to Chapter 18.08, Critical Areas.

Section 5. Section 18.08.010 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.010 Purpose.

~~This chapter contains guidelines, criteria, standards and requirements designed to analyze and mitigate potential impacts to city wetland resources. The intent of these regulations is to avoid where possible, or in appropriate circumstances, to minimize, rectify, reduce or compensate for impacts arising from land development and other activities affecting wetlands. This chapter also contains planning and implementation requirements for submission and approval of wetland mitigation projects.~~ The ordinance codified in this chapter is intended to promote the maintenance, enhancement and preservation of critical areas and environmentally sensitive natural systems by avoiding or minimizing adverse impacts from construction and development. This chapter implements the goals and objectives of the state Growth Management Act of 1990 through the development and implementation of policies and interim regulations to manage critical areas in the public's interest and welfare. It is not the intent of this chapter to deny a reasonable use of private property, but to assure that development on or near critical areas is accomplished in a manner that is sensitive to the environmental resources of the community.

Section 6. Section 18.08.020 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.020 Goal.

~~The general goal of these regulations is to avoid impacts to wetlands where such avoidance is feasible and reasonable. Where such impacts are unavoidable, the standards of this chapter seek to minimize impacts on wetlands as a result of land development by:~~

~~A. Maintaining and enhancing the biological and physical functions and values of wetlands;~~

~~B. Maintaining the natural value of wetlands to control flooding and stormwater runoff through the storage and regulation of natural flow;~~

~~C. Maintaining the habitat value of wetlands for the many species of fish, wildlife and vegetation which are dependent upon wetlands for their survival;~~

~~D. Providing open space and visual relief from intense development within the urban area;~~

~~E. Providing opportunities for recreation, scientific study and natural resources education;~~

~~F. Providing for reasonable buffers around wetlands in order to stabilize soil, filter suspended solids and excess nutrients, moderate impacts from stormwater runoff, provide a local habitat for wetland plant and animal communities, and to reduce or minimize intrusions from humans and domestic animals;~~

~~G. Implement the goals, objectives and policies of the state Growth Management Act, the state Environmental Policy Act, the city comprehensive land use plan and the city environmental policy ordinance;~~

~~H. Promote and protect the public's health, safety, welfare and interest in maintaining and protecting wetlands as a valuable natural resource;~~

~~I. Protecting private property rights by allowing for a reasonable use of property where wetlands are present.~~

In implementing the purposes stated in GHMC 18.08.010, it is the intent of this chapter to accomplish the following:

A. Protect environmentally sensitive natural areas and the functions they perform by the careful and considerate regulation of development;

B. Minimize damage to life, limb and property due to landslides and erosion on steep or unstable slopes, seismic hazard areas and areas subject to subsidence;

C. Protect wetlands and their functions and values;

D. Protect and maintain stream flows and water quality within the streams;

E. Minimize or prevent siltation to the receiving waters of Gig Harbor Bay for the maintenance of marine water quality and the maintenance and preservation of marine fish and shellfish;

F. Preserve natural forms of flood control and stormwater storage from alterations to drainage or stream flow patterns;

G. Protect aquifer recharge areas from undesirable or harmful development;

H. Protect, maintain and enhance areas suitable for wildlife, including rare, threatened or endangered species;

I. Protect, maintain and enhance fish and wildlife habitat conservation areas within their natural geographic distribution so as to avoid the creation of subpopulations;

J. Implement the goals, policies and requirements of the Growth Management Act.

Section 7. Section 18.08.030 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.030 Definitions.

For purposes of this chapter, the following definitions shall apply:

A. “Alteration” means any activity which materially affects the existing condition of land or improvements.

~~B.~~ “Applicant” means the person, party, firm, corporation, or other legal entity that proposes any activity. The applicant is either the owner of the land on which the proposed activity would be located, a contract vendee, a lessee of the land, the person who would actually control and direct the proposed activity, or the authorized agent of such a person.

“Aquifer” means a subsurface, saturated geologic formation which produces, or is capable of producing, a sufficient quantity of water to serve as a private or public water supply.

“Aquifer recharge areas” means those areas which serve as critical ground water recharge areas and which are highly vulnerable to contamination from intensive land uses within these areas.

B. “Best management plan” means a plan or program developed by the local Soil Conservation District (U.S.D.A.) which specifies best management practices for the control of animal wastes, stormwater runoff and erosion.

“Bluff” means a steeply rising, near vertical slope which abuts and rises from the Puget Sound shoreline. Bluffs occur in the east area of the city, fronting the Tacoma Narrows, and are further identified in the Coastal Zone Atlas, Volume 7, for Pierce County. The toe of the bluff is the beach and the top is typically a distinct line where the slope abruptly levels out. Where there is no distinct break in a slope, the top is the line of vegetation separating the unvegetated slope from the vegetated uplands, or, if the bluff is vegetated, that point where the bluff slope diminishes to 15 percent or less.

"Buffer" means a natural area adjacent to hillsides or ravines which provides a margin of safety through protection of slope stability, attenuation of surface water flows and landslide, seismic and erosion hazards reasonably necessary to minimize risk to the public from loss of life, well-being or property damage from natural disaster.

"Building setback line" means a distance, in feet, beyond which the footprint or foundation of a building or structure shall not extend.

C. "City" means the city of Gig Harbor.

~~D.~~ "Clearing" means the removal of timber, brush, grass, ground cover or other vegetative matter from a site which exposes the earth's surface of the site.

~~E.~~ "Compensatory mitigation" means mitigation for wetland losses or impacts resulting from alteration of wetlands and/or their buffers. It includes, but is not limited to, creation, enhancement and restoration.

"Contaminant" means any chemical, physical, biological or radiological material that is not naturally occurring and is introduced into the environment by human action, accident or negligence.

~~F.~~ "Creation" means the producing or forming of a wetland through artificial means from an upland (nonwetland) site.

"Critical areas" consist of those lands which are subject to natural hazards, contain important or significant natural resources or which have a high capability of supporting important natural resources.

~~G.~~D. "Department" means the city department of community development.

~~H.~~ "Designated wetland" means those lands identified through the classification process established by this chapter.

~~I.~~ "Development" means alteration (see definition for alteration).

"DRASTIC" means a model developed by the National Water Well Association and Environmental Protection Agency and which is used to measure aquifer susceptibility to contamination.

~~J.~~E. "Earth/earth material" means naturally occurring rock, soil, stone, sediment, organic material, or combination thereof.

~~K.~~ "Enhancement" means actions performed to improve the conditions of existing degraded wetlands and/or buffers so that the functions they provide are of a higher quality (e.g., increasing plant diversity, increasing wildlife habitat, installing environmentally compatible erosion controls, removing nonindigenous plant or animal species, removing fill material or garbage).

~~L.~~ "Erosion" means the wearing away of the earth's surface as a result of the movement of wind, water, or ice.

"Erosion hazard areas" means those areas which are vulnerable to erosion due to natural characteristics including vegetative cover, soil texture, slope, gradient or which have been induced by human activity. Those areas which are rated severe or very severe for building site development on slopes or cut banks, in accordance with the United States Department of Agriculture Soil Conservation Service Soil Survey for Pierce County Area
(February 1979), are included within this definition.

~~M.~~ "Excavation" means the mechanical removal of earth material or fill.

~~N.~~ "Existing and on-going agricultural activities" means those activities conducted on lands defined in RCW 84.34.020(2), and those activities involved in the production of crops and livestock, including but not limited to operation and maintenance of farm and stock ponds or drainage ditches, irrigation systems, changes between agricultural activities, and normal operation, maintenance or repair of existing serviceable structures, facilities or improved areas. Activities which bring an area into agricultural use are not part of an on-going activity. An operation ceases to be on-going when the area on which it was conducted has been converted to a non-agricultural use or has lain idle both more than five years and so long that modifications to the hydrological regime are necessary to resume operations, unless the idle land is registered in a federal or state soils conservation program.

~~O.~~ F. "Fill/fill material" means a deposit of earth material, placed by human or mechanical (machine) means, and which is not defined by solid waste according to Chapter 70.95 RCW.

~~P.~~ "Filling" means the act of placing fill material on any surface.

"Fish and wildlife habitat areas" means those areas identified as being of critical importance in the maintenance and preservation of fish, wildlife and natural vegetation including waters of the state, and as further identified in GHMC 18.08.190.

"Flood hazard areas" mean those areas within the city of Gig Harbor which are determined to be at risk of having a one percent or greater chance of experiencing a flood in any one year, with those areas defined and identified on the Federal Emergency Management Administration (FEMA) flood insurance rate maps for the city of Gig Harbor.

~~Q.~~ "Floodplain development permit" means the permit required by the city flood hazard construction ordinance.

G. "Geologically hazardous areas" means those areas as designated in the city of Gig Harbor comprehensive plan as "landslide hazards," in the Washington Department of Ecology Coastal Zone Atlas, Volume 7, and which are further defined in WAC 365-190-080(5) and this title.

~~R.~~ "Grading" means any excavating, filling, clearing, leveling, or contouring of the ground surface by human or mechanical means.

~~S.~~ "Grading permit" means the permit required by the city grading and clearing ordinance.

H. "Habitat management plan" means a report prepared by a qualified wildlife biologist.

"Hazardous substance" means any material that exhibits any of the characteristics or criteria of hazardous waste, inclusive of waste oil and petroleum products, and which further meets the definitions of "hazardous waste" pursuant to Chapter 173-303 WAC.

"Hillsides" means geologic features with slopes of 15 percent or greater. The ordinance codified in this chapter provides four classes of hillsides in order to differentiate between the levels of protection and the application of development standards.

~~T.~~I. "In-kind mitigation" means to replace wetlands with substitute wetlands whose characteristics and functions and values are intended to replicate those destroyed or degraded by a regulated activity.

J. **[Reserved]**

K. **[Reserved]**

L. "Landslide" means an abrupt downslope movement of soil, rock or ground surface material.

"Landslide hazard area" means those areas which are susceptible to risk of mass movement due to a combination of geologic, topographic and hydrologic factors.

~~U.~~ M. "Mitigation" means to avoid, minimize, or compensate for adverse wetland impacts.

N. **[Reserved]**

~~V.~~O. "Out-of-kind mitigation" means to replace wetlands with substitute wetlands whose characteristics do not closely approximate those destroyed or degraded by a regulated activity.

W.P. "Permanent erosion control" means continuous on-site and off-site control measures that are needed to control conveyance or deposition of earth, turbidity or pollutants after development, construction, or restoration.

X. "Person" means an individual, firm, co-partnership, association or corporation.

Q. "Qualified biologist" means a person with a minimum of a four-year degree in wildlife sciences, biology, environmental sciences, soil science, limnology or an equivalent academic background who also has at least two years of experience in stream restoration.

"Qualified wetland specialist" is a person with a minimum of a four-year degree in wildlife sciences, biology, environmental sciences, soil science, limnology or an equivalent academic background who also has experience in performing wetland delineations, analysis of wetland functions and values and project impacts, and wetland mitigation and restoration techniques. The person must be familiar with the Washington State Department of Ecology Wetland Identification and Delineation Manual (1997), which is consistent with the 1987 Federal Manual used by the U.S. Army Corps of Engineers, city grading and clearing regulations and the requirements of this chapter.

"Qualified wildlife biologist" means a person having, at a minimum, a bachelor's degree in wildlife biology, wildlife science, wildlife ecology, wildlife management or zoology, or a bachelor's degree in natural resource or environmental science plus 12 semester or 18 quarter hours on wildlife course works and two years of professional experience.

R. "Ravine sidewall" means a steep slope which abuts and rises from the valley floor of a stream and which was created by the normal erosive action of the stream. Ravine sidewalls are characterized by slopes predominantly in excess of 25 percent although portions may be less than 25 percent. The base of a ravine sidewall is the stream valley floor. The top of a ravine sidewall is a distinct line where the slope abruptly levels out. Where there is no distinct break in slope, the top shall be that point where the slope diminishes to 15 percent or less.

Y. "Restoration" means the reestablishment of a viable wetland from a previously filled or degraded wetland site.

S. "Seismic hazard areas" means those areas which are susceptible to severe damage from earthquakes as a result of ground shaking, slope failure, settlement or soil liquefaction.

Z. "Significant impact" means a meaningful change or recognizable effect to the ecological function and value of a wetland critical area, which is noticeable or measurable, resulting in a loss of wetland function and value.

AA. "Single-family residence" or "dwelling" means a building or structure, or portion thereof, which is designed for and used to provide a place of abode for human beings, including mobile homes, as defined in the city zoning code (GHMC 17.04.300 and 17.04.305).

BB. "Site" means any parcel or combination of contiguous parcels, or right-of-way or combination of contiguous rights-of-way under the applicant's ownership or control where the proposed project impacts a wetland(s)critical area(s).

CC. "Slope" means an inclined earth surface, the inclination of which is expressed as the ratio (percentage) of horizontal vertical distance to vertical horizontal distance by the following formula: V (vertical distance)/H (horizontal distance) x 100 = % slope.

"Species of local importance" means a species of animal which is of local concern due to their population status or their sensitivity to habitat manipulation. This term also includes game species.

DD. "Stockpiling" means the placement of material with the intent to remove at a later time.

“Streams” means those areas where surface waters produce a defined channel or bed, not including irrigation ditches, canals, storm or surface water runoff devices, or other entirely artificial watercourses, unless they are used by salmonids or are used to convey streams naturally occurring prior to construction in such watercourses. For the purpose of this definition, a defined channel or bed is an area which demonstrates clear evidence of the passage of water and includes, but is not limited to, bedrock channels, gravel beds, sand and silt beds, and defined-channel swales. The channel or bed need not contain water year-round.

“Stream buffer zone” means a designated area contiguous or adjacent to a stream that is required for the continued maintenance, function, and structural stability of the stream. Functions of a buffer include shading, input of organic debris and coarse sediments, uptake of nutrients, stabilization of banks, protection from intrusion, or maintenance of wildlife habitat.

EE. “Substrate” means the soil, sediment, decomposing organic matter or combination of those located on the bottom surface of the wetland.

T. **[Reserved]**

FF. U. “Utility line” means pipe, conduit, cable or other similar facility by which services are conveyed to the public or individual recipients. Such services shall include, but are not limited to, water supply, electric power, gas and communications.

V. **[Reserved]**

GG. W. “Wetland” or “wetlands” means areas that are inundated or saturated by surface water or ground water 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, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, retention 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 include those artificial wetlands intentionally created from nonwetland areas created to mitigate conversion of wetlands.

HH. “Wetland buffer zone” means a designated area contiguous or adjacent to a wetland that is required for the continued maintenance, function, and structural stability of the wetland. Functions of a buffer include shading, input of organic debris and coarse sediments, uptake of nutrients, stabilization of banks, protection from intrusion, or maintenance of wildlife habitat. For further information on permitted uses, see GHMC 18.08.020.

II. “Wetland class” means the U.S. Fish and Wildlife Service wetland classification scheme using a hierarchy of systems, subsystems, classes and subclasses to describe wetland types (refer to USFWS, December 1979, Classification of Wetlands and Deepwater Habitats of the United States for a complete explanation of the wetland classification scheme). Eleven class names are used to describe wetland and deepwater habitat types. These include: forested wetland, scrub-shrub wetland, emergent wetland, moss-lichen wetland, unconsolidated shore, aquatic bed, unconsolidated bottom, rock bottom, rocky shore, streambed, and reef.

JJ. “Wetland specialist” is a person with a minimum of a four-year degree in wildlife sciences, biology, environmental sciences, soil science, limnology or an equivalent academic background who also has experience in performing wetland delineations, analysis of wetland functions and values and project impacts, and wetland mitigation and restoration techniques. The person must be familiar with the Federal Manual for

~~Identifying and Delineating Jurisdictional Wetlands, city grading and clearing ordinance, and the city wetlands management ordinance.~~

X. **[Reserved]**
Y. **[Reserved]**
Z. **[Reserved]**

Section 8. A new Section 18.08.032 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.032 Best Available Science

A. The Growth Management Act requires jurisdictions to include the best available science when designating and protecting critical areas. The Growth Management Act also requires the implementation of conservation or protection measures necessary to preserve or enhance anadromous fish and their habitat (WAC 365-195-900 through WAC 365-195-925). Anadromous fish are those that spawn and rear in freshwater and mature in the marine environment, including salmon and char (bull trout).

B. Best available science shall be used in developing policies and development regulations to protect the functions and values of critical areas. Critical area reports and decisions to alter critical areas shall rely on the best available science to protect the functions and values of critical areas. The best available science is that scientific information applicable to the critical area prepared by local, state or federal natural resource agencies, a qualified scientific professional or team of qualified scientific professionals that is consistent with criteria established in WAC 365-195-900 through WAC 365-195-925.

Section 9. A new Section 18.08.034 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.034 Applicability.

A. Critical Area Review. All development proposals in critical areas, whether on public or private property, shall comply with the requirements of this chapter. The Community Development Director or his/her designee shall utilize the procedures and rules established in the city of Gig Harbor environmental policy ordinance, Chapter 18.04 GHMC (Environmental Review (SEPA)) and the applicable provisions of GHMC Title 19, to implement the provisions of this chapter. Development proposals include any development project which would require any of the following:

1. Building permit for any construction,
2. Clearing and grading permit,
3. Any shoreline management permit as authorized under Chapter 90.58 RCW,
4. Site plan review,
5. Subdivision, short subdivision or planned unit development,
6. Zoning variance or conditional use permit.

B. Special Studies Required. When an applicant submits an application for any development proposal, the application shall indicate whether any critical area is located on the site. The Community Development Director or designee shall visit the site, and in conjunction with the review of the information provided by the applicant and any other suitable information, shall make a determination as to whether or not sufficient information is available to evaluate the proposal. If it is determined that the information presented is not sufficient to adequately evaluate a proposal, the planning director shall notify the applicant that additional studies as specified herein shall be provided.

C. Appeals. A decision of the Community Development Director to approve, conditionally approve or deny a permit, or any official interpretation in the administration of this chapter may be appealed in accordance with the procedures established under GHMC Title 19.

Section 10. A new Section 18.08.038 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.038 Wetlands – Designation and mapping.

A. Pursuant to WAC 197-11-908, the city designates wetlands as critical areas defined in this chapter.

B. The approximate location and extent of critical areas are shown on the City's critical area map. These maps are to be used as a guide and may be updated as new critical areas are identified. They are a reference and do not provide final critical area designations. Mapping sources include:

1. Areas designated on the National Wetland Inventory maps;

2. Areas which have been designated as wetlands on the Pierce County wetland atlas.

Section 11. Section 18.08.040 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.040 Wetlands – cClassification guidelines/ ratings.

A. A wWetland rating and classification shall be established based upon the completion of a delineation report prepared by a qualified wetland specialist to determine boundary, size, function and value. Guidelines for preparing a wetland delineation report are defined in GHMC 18.08.070 090 and the Department of Ecology Wetland Identification and Delineation Manual (1997), which is consistent with the 1987 Federal Manual ~~for Identifying and Delineating Jurisdictional Wetlands, in use as of January 1, 1995,~~ used by the U.S. Army Corps of Engineers.

~~A. Wetlands shall be classified as Category I, II, III and IV, in accordance with the following criteria:~~

~~1. Category I.~~

~~a. Documented habitats for sensitive plant, fish or animal species recognized by federal or state agencies, or~~

~~b. Regionally rare wetland communities which are not high quality, but which have irreplaceable ecological functions, including sphagnum bogs and fens, estuarine wetlands, or mature forested swamps, or~~

~~c. Wetland types with significant functions which may not be adequately replicated through creation or restoration. These wetlands may be demonstrated by the following characteristics:~~

~~i. Significant peat systems, or~~

~~ii. Forested swamps that have three canopy layers, excluding monotypic stands of red alder averaging eight inches diameter or less at breast height, or~~

~~iii. Significant spring fed systems, or~~

~~d. Wetlands with significant habitat value based on diversity and size, including wetlands which are:~~

~~i. Ten acres or greater in size; and two or more wetland classes together with open water at any time during a normal year, or~~

~~ii. Ten acres or greater in size; and three or more wetland classes; and five or more subclasses of vegetation in a dispersed pattern, or~~

~~iii. Five acres or greater in size; and 40 to 60 percent open water at any time during a normal year; and two or more subclasses of vegetation in a dispersed pattern, or~~

~~e. Regulated wetlands which are contiguous with both year-round and intermittent salmonid fish-bearing waters, or~~

~~f. Wetlands with significant use by fish and wildlife.~~

~~2. Category II. Regulated wetlands that do not contain features outlined in Category I or III.~~

~~3. Category III.~~

~~a. Regulated wetlands which do not meet the criteria of a Category I or II wetland and which are greater than 10,000 square feet in area; and~~

~~b. Hydrologically isolated wetlands that are greater than 10,000 square feet but less than or equal to one acre in size, and have only one wetland class, and have only one dominant plant species (monotypic vegetation).~~

~~c. Hydrologically isolated wetlands less than 10,000 square feet in area which contain a rare or unique species or which have significant biological function and value.~~

~~4. Category IV Criteria.~~

~~a. All streams designated as Type 3 – 5 waters by the Department of Natural Resources, Forest Practices Rules and Regulations pursuant to WAC 222-16-020 and 222-16-030.~~

B. Wetland ratings. Wetlands shall be rated according to the Washington State Department of Ecology wetland rating system found in the Washington State Wetland Rating System for Western Washington, revised April 2004 (*Ecology Publication #04-06-025)*. These documents contain the definitions and methods for determining if the criteria below are met.

1. Wetland rating categories

a. Category I. Category I wetlands are those wetlands of exceptional resource value based on their functional value and diversity. Category I wetlands are:

i. Undisturbed estuarine wetlands larger than one acre,

ii. Wetlands designated by Washington Natural Heritage Program as high quality,

iii. Bogs,

iv. Mature and old-growth forested wetlands larger than one acre,

v. Wetlands in coastal lagoons,

vi. Wetlands that perform high functions (wetlands scoring 70 points or more on the Ecology wetland rating form).

b. Category II. Category II wetlands are those wetlands of significant resource value based on their functional value and diversity. Category II wetlands are:

i. Estuarine wetlands smaller than one acre or disturbed estuarine wetlands larger than one acre, or

ii. Wetlands scoring between 51 and 69 points on the Ecology wetland rating form.

c. Category III. Category III wetlands are those wetlands of important resource value based on their functional value and diversity. Category III wetlands are wetlands with a moderate to low level of functions (wetlands scoring 30 to 50 points on the wetland rating form).

d. Category IV. Category IV wetlands are those wetlands with the lowest level of functions scoring less than 30 points on the Ecology wetland rating form.

Hydrologically isolated Category IV wetlands less than 1,000 square feet are exempt as per GHMC 18.08.202H.

Section 12. Section 18.08.050 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.050 Wetlands – Regulated activities.

A. Unless specifically exempted by GHMC 18.08.~~060~~202, the following activities in a wetland and/or its associated buffer shall be regulated pursuant to the requirements of this chapter. The regulated activities are as follows:

1. Removing, excavating, disturbing or dredging soil, sand, gravel, minerals, organic matter or materials of any kind;
2. Dumping, discharging or filling with any material;
3. Draining, flooding or disturbing the water level or water table;
4. Constructing, reconstructing, demolishing or altering the size of any structure or infrastructure, except repair of an existing structure or infrastructure, where the existing square footage or foundation footprint is not altered;
5. Destroying or altering vegetation through clearing, harvesting, cutting, intentional burning, shading or planting vegetation that would alter the character of a wetland;
6. Activities from construction or development that result in significant, adverse changes in water temperature, physical or chemical characteristics of wetland water sources, including quantity and pollutants.

B. Activities listed in subsection (A) above which do not result in alteration in a wetland and/or its associated buffer, may require fencing along the outside perimeter of the buffer or erosion control measures~~ as provided in GHMC 18.08.160(B~~).

Section 13. Section 18.08.060 of the Gig Harbor Municipal Code is hereby repealed.

Section 14. Section 18.08.070 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.070 Wetlands – Permitting process.

A. Overview. Inquiries regarding conduct of a regulated activity in a wetland can be made to the ~~city planning d~~Department. The department shall utilize the National Wetlands Inventory (NWI) maps and the ~~Department of Natural Resources Stream Type maps~~ Pierce County wetland atlas to establish general location of wetland sites. If the maps indicate the presence of a wetland, a wetland delineation report shall be filed, unless the department determines that a wetland is not on or within the site. This determination may be based on information provided by the applicant and from other sources. If the map does not indicate the presence of a wetland or wetland buffer zone within the site, but there are other indications that a wetland may be present, the department shall determine whether a wetland analysis report is required.

B. Permit Requirements. No separate application or permit is required to conduct regulated activities within a wetland or its associated buffer. Review of regulated activities within a wetland and buffers is subject to the permit processing procedure for the required permit type as defined under GHMC Title 19. The department shall utilize existing environmental review procedures, city SEPA Ordinance, Chapter 18.04 GHMC, to assess impacts to wetlands and impose required mitigation. Department review of proposed alterations to wetlands and buffer areas and a wetland mitigation plan may be required prior to issuance of a SEPA determination by the city's responsible official.

~~C. This chapter applies to all regulated activities, public or private, which will occur within wetlands, including but not limited to, the following:~~

~~1. Building, grading, filling, special and sanitary sewer permits;~~

~~2. Subdivisions, short plats, and planned unit developments;~~

~~3. Site plan approvals, variance and conditional use permits;~~

~~4. Any activity which is not categorically exempt within the environmental review procedures of the state Environmental Policy Act for environmentally sensitive areas, pursuant to WAC 197-11-908, and the city SEPA Ordinance, Chapter 18.04 GHMC.~~

~~D~~C. Prior to submittal of a wetland delineation report, recommendation on wetland category, proposed alterations to wetlands and buffer areas, or wetland mitigation plan, the applicant may request a ~~prefiling~~ pre-application conference in accordance with the procedures established in GHMC 19.02.001.

~~E~~D. Request for Official Determination. A request for an official determination of whether a proposed use or activity at a site is subject to this chapter must be in writing and made to the city office of community development. The request can be accompanied by a SEPA environmental checklist. The request shall contain plans, data and other information in sufficient detail to allow for determination, including a wetland delineation report. The applicant shall be responsible for providing plans and the wetland delineation report to the department.

F. A wetland analysis report shall be submitted to the department for review of a proposal for activity which lies within a wetland, or within ~~150~~ 300 feet of a wetland. The purpose of the wetland analysis report is to determine the extent and function of wetlands to be impacted by the proposal. ~~This analysis and report may be waived for Category IV wetlands if the proposed activity includes the required minimum streamside buffer as established under GHMC 18.08.100~~.

G. Preliminary Site Inspection. Prior to conducting a wetland analysis report, the applicant may request that the department conduct a preliminary site inspection to determine if a wetland may be present on the proposal site. Upon receipt of the appropriate fee, the department shall make a site inspection. If the department determines that a wetland is not on the site, this shall be indicated to the applicant in writing, and a wetland analysis report shall not be required.

H. Prior to submittal of the wetland analysis report or the development of a lot which has a classified wetland ~~as identified on the city wetland map~~, boundaries of wetlands ~~2,500 square feet or more~~ shall be staked and flagged in the field by a qualified wetland specialist and surveyed by a licensed professional surveyor registered in the state. Field flagging shall be distinguishable from other survey flagging on the site.

I. If alteration of a wetland or buffer is proposed, a wetland mitigation plan shall be submitted pursuant to requirements of this chapter, subsequent to staff review of the wetland analysis report. In no event will a wetland mitigation plan be required prior to a determination of whether a designated wetland is present on a site.

Section 15. Section 18.08.080 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.080 Wetlands – Administration.

A. Filing Fees. A wetland regulatory processing fee in an amount established under the city's development fee ordinance, GHMC Title 3, shall be paid at the time of a request for official determination of whether a proposed use or activity at a site is subject to this chapter. The fee shall be paid prior to administrative review, including environmental review. It shall include all costs of administrative and environmental review, including the preliminary site inspection, and review and approval of a wetland analysis report. It shall be in addition to any other fees for environmental assessment and environmental impact review, provided by the city environmental policy ordinance, Chapter 18.04 GHMC.

B. Notice and Title.

1. Notice. Upon submission of a complete application for a wetland development approval, notice shall be provided in accordance with the city zoning code for site plan review for notification of property owners within 300 feet of the subject property.

2. Notice of Title. The owner of any property with field verified presence of wetland or wetland buffer on which a development proposal is submitted shall file for record with the Pierce County auditor a notice approved by the department in a form substantially as set forth below. Such notice shall provide notice in the public record of the presence of a wetland or wetland buffer, the application of this chapter to the property, and that limitations on actions in or affecting such wetlands and their buffers may exist. The notice shall be notarized and shall be recorded prior to approval of any development proposal for such site. The notice shall run with the land and shall be in the following form:

WETLAND AND/OR
WETLAND BUFFER NOTICE
Legal Description:

____
____
Present Owner:__________________

NOTICE: This property contains wetlands or their buffers as defined by City of Gig Harbor Ordinance. Restrictions on use or alteration of the wetlands or their buffers may exist due to natural conditions of the property and resulting regulations.

______________ _____________
Date Signature Owner

C. Other Laws and Regulations. No approval granted pursuant to this chapter shall remove an obligation to comply with the applicable provisions of any other federal, state or local law or regulation.

D. Atlas. As part of its review, the department shall include the appropriately designated wetland in the Pierce County wetlands atlas or in the city wetland atlas, as may be adopted.

Section 16. Section 18.08.090 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.090 Wetlands – ~~a~~Analysis report requirements.

A. A wetland analysis report shall be prepared by a qualified wetland specialist and submitted to the department as part of the SEPA review process established by the city of Gig Harbor environmental policy ordinance, Chapter 18.04 GHMC. A wetlands analysis report is not required for those wetlands mapped and classified per the city of Gig Harbor wetlands map. A wetlands analysis report is required with all annexation petitions and land use applications for properties which do not have wetlands mapped and classified per the city of Gig Harbor wetlands map.

B. The wetland analysis report shall be prepared in accordance with the ~~Uniform Federal Methods for Wetland Delineation~~ methods outlined in the Ecology 1997 wetland Identification and Delineation Manual and submitted to the department for review for any proposals that are within ~~150~~300 feet of a wetland.

C. Within 30 days of receipt of the wetland analysis report and other information, the department shall determine the appropriate wetland category, buffering requirement, and required mitigation. The report shall be accorded substantial weight and the department shall approve the report's findings and approvals, unless specific, written reasons are provided which justify not doing so. Once accepted, the report shall control future decision-making related to designated wetlands unless new information is found demonstrating the report is in error.

Section 17. Section 18.08.100 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.100 Wetlands – Buffer areas.

A. Following the department's determination of the category for a wetland associated with a proposal, the department shall determine appropriate buffer widths. Wetland buffer zones shall be evaluated for all development proposals and activities adjacent to wetlands to determine their need to protect the integrity, functions and values of the wetland. Wetland buffer widths are determined by the category of wetland, the intensity of impacts of a land use and the functions or special characteristics of the wetland that need to be protected as determined by the rating system. All wetland buffer zones are measured perpendicular from the wetland ~~edge as marked in~~ boundary as surveyed in the field. Except as otherwise permitted by this chapter, wetland buffers ~~they~~ shall consist of ~~an undisturbed area of~~ a relatively intact native vegetation ~~and existing non-native vegetation.~~ community adequate to protect the wetland functions and values at the time of proposed activity. If the vegetation is inadequate than the buffer width shall be planted to maintain the buffer width. ~~The following buffer widths are required:~~

~~**Wetland Category**~~	~~**Buffer Width**~~
~~Category I~~	~~100 feet~~
~~Category II~~	~~50 feet~~
~~Category III~~	~~25 feet~~
~~Category IV~~	~~Type 3 water: 35 feet~~
~~(as measured from~~	~~Type 4 water: 25 feet~~
~~ordinary high water)~~	~~Type 5 water: 15 feet~~

B. Impact of land use. Different uses of land can result in a high, moderate or low level of impact to adjacent wetlands. Types of land use are categorized into impact levels as shown on the following table:

Level of impact from land use.	**Types of land uses based on common use categories.**
High	Residential uses (greater than 1 unit per acre); schools; churches; public facilities, public/private services and government administrative uses (excluding parks, right-of-way and utilities); lodging uses; personal, professional, product and automotive services; health care services; commercial and sales uses; animal clinics and kennels; marine-related uses; industrial uses; restaurant uses; museum, club

	and recreation hall uses; high-intensity parks, outdoor and indoor recreation (golf courses, ballfields, tennis clubs, swimming pools etc.); conversion to high-intensity agriculture (dairies, nurseries, greenhouses, growing and harvesting crops requiring annual tilling and raising and maintaining animals, etc.); hobby farms.
Moderate	Residential uses (less that 1 unit per acre); moderate-intensity parks and outdoor recreation (parks with biking, jogging, etc.); conversion to moderate-intensity agriculture (orchards, hay fields, etc.) and paved trails; building of logging roads; utility corridor or right-of-way shared by several utilities and including access/maintenance road.
Low	Forestry (cutting of trees only); Low-intensity parks and open space (hiking, bird-watching, preservation of natural resources, etc.) and unpaved trails; utility corridor without a maintenance road and little or no vegetation management.

C. If a wetland meets more than one of the wetland characteristics listed in the tables of subsections D,E, F or G below, the buffer width required to protect the wetland is the widest buffer width.

D. Category I wetlands. The following buffer widths for Category I wetlands are required:

Wetland Characteristics	**Buffer Widths by Impact of Land Use**	**Other Protection Measures Required**
Natural Heritage Wetlands	Low - 125 feet Moderate – 190 feet High – 250 feet	No additional surface discharges to wetland or its tributaries No septic systems within 300 feet of wetland Restore degraded parts of buffer
Bogs	Low - 125 feet Moderate – 190 feet High – 250 feet	No additional surface discharges to wetland or its tributaries Restore degraded parts of buffer
Forested	Buffer width to be based on score for habitat functions or water quality functions	If forested wetland scores high for habitat, need to maintain connections to other habitat areas Restore degraded parts of buffer
Estuarine	Low - 100 feet Moderate – 150 feet High – 200 feet	None required
Wetlands in Coastal Lagoons	Low - 100 feet Moderate – 150 feet High – 200 feet	None required
High level of function for habitat (score for habitat 29 - 36 points)	Low – 150 feet Moderate – 225 feet High – 300 feet	Maintain connections to other habitat areas Restore degraded parts of buffer

Wetland Characteristics	**Buffer Widths by Impact of Land Use**	**Other Protection Measures Required**
Moderate level of function for habitat (score for habitat 20 - 28 points)	Low – 75 feet Moderate – 110 feet High – 150 feet	None required
High level of function for water quality improvement (24 – 32 points) and low for habitat (less than 20 points)	Low – 50 feet Moderate – 75 feet High – 100 feet	No additional surface discharges of untreated runoff
Not meeting any of the above characteristics	Low – 50 feet Moderate – 75 feet High – 100 feet	N/A

E. Category II wetlands. The following buffer widths for Category II wetlands are required:

Wetland Characteristics	**Buffer Widths by Impact of Land Use**	**Other Protection Measures Required**
High level of function for habitat (score for habitat 29 - 36 points)	Low - 150 feet Moderate – 225 feet High – 300 feet	Maintain connections to other habitat areas
Moderate level of function for habitat (score for habitat 20 - 28 points)	Low - 75 feet Moderate – 110 feet High – 150 feet	None required
High level of function for water quality improvement and low for habitat (score for water quality 24 - 32 points; habitat less than 20 points)	Low - 50 feet Moderate – 75 feet High – 100 feet	No additional surface discharges of untreated runoff
Estuarine	Low - 75 feet Moderate – 110 feet High – 150 feet	None required
Interdunal	Low - 75 feet Moderate – 110 feet High – 150 feet	None required
Not meeting above characteristics	Low - 50 feet Moderate – 75 feet High – 100 feet	None required

F. Category III wetlands. The following buffer widths for Category III wetlands are required:

Wetland Characteristics	**Buffer Widths by Impact of Land Use**	**Other Protection Measures Required**
Moderate to high level of function for habitat (score for habitat 20 - 36 points)	Low - 75 feet Moderate – 110 feet High – 150 feet	None required
Not meeting above characteristic	Low - 40 feet Moderate – 60 feet High – 80 feet	None required

G. Category IV wetlands. The following buffer widths for Category IV wetlands are required:

Wetland Characteristics	**Buffer Widths by Impact of Land Use**	**Other Protection Measures Required**
Score for all 3 basic functions is less than 30 points	Low - 25 feet Moderate – 40 feet High – 50 feet	None required

~~B.~~H. ~~Landscape buffering between the wetland boundary and the building setback will be evaluated. If it is determined that such uses could cause secondary impacts to the wetlands, a maximum 15 feet setback may be imposed.~~ A 15-foot building setback is required from the edge of a wetland buffer.

I. Where a legally established developed roadway transects a wetland buffer, the Director may approve a modification of the minimum required buffer width to the edge of the roadway if the part of the buffer on the other side of the road does not provide any buffer functions to protect the wetland in question.

J. Where a legally established bulkhead transects a wetland buffer, the Director may approve a modification of the minimum required buffer width as long as the biologic, hydrologic and water quality functions of the wetland are protected. This modification would be evaluated on a case-by-case basis and rely upon a sensitive areas study provided by a qualified biologist where it can be demonstrated that an equal or greater protection of the wetland would occur. Measures may include bioengineering of shoreline protection, revegetation with native species, or other shoreline or buffer enhancement measures.

Section 18. Section 18.08.110 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.110 Wetlands – Alteration of buffers.

Alteration of a buffer may occur in two ways: (1) quantitative alteration, in which the boundaries of the designated buffer area are adjusted, so that the actual area within the buffer is altered ~~from the parameters of subsection A of this section~~; and (2) qualitative alteration, in which permitted activities within the buffer area alter its character. In determining appropriate buffer alterations, quantitative and qualitative alterations are generally reviewed concurrently.

~~A. Buffer zones may be modified under the following conditions (quantitative alteration):~~

~~1.~~ A. Wetland buffer reductions. Buffer width reductions shall be considered on a case-by-case basis to take varying values of individual portions of a given wetland into consideration. Buffers shall not be reduced where the buffer has been degraded as a result of a documented code violation. Reductions may be allowed where the applicant demonstrates to the department that the wetland contains variations in sensitivity due to existing physical characteristics and that reducing the buffer width would not adversely affect the wetland functions and values~~, and the minimum buffer shall not be less than 50 percent of the widths established in GHMC 18.08.100~~;

1. Maximum Buffer Reductions. The buffer widths required for uses of land with “high” impacts to wetlands can be reduced to those required for “moderate” impacts under the conditions below:

a. For wetlands that score moderate or high for habitat (20 points or more for the habitat functions), the width of the buffer can be reduced if both of the following conditions are met:

i. A relatively undisturbed, vegetated corridor at least 100 feet wide is protected between the wetland and any other Priority Habitats as defined by the Washington State Department of Fish and Wildlife. Priority Habitats include, but may not be limited to, wetlands, riparian zones, aspen stands, cliffs, prairies, caves, stands of Oregon White Oak, old-growth forests, estuaries, marine/estuarine shorelines, eelgrass meadows, talus slopes and urban natural open space. The corridor must be protected for the entire distance between the wetland and the Priority Habitat via some legal protection such as a conservation easement; and

ii. Measures to minimize the impacts of different land uses on wetlands are applied, as summarized in the following table:

Examples of Disturbance	**Activities that Cause Disturbances**	**Examples of Measures to Minimize Impacts**
Lights	Parking lots, warehouses, manufacturing, residential	Direct lights away from wetland.
Noise	Manufacturing, residential	Locate activity that generates noise away from wetland.
Toxic runoff[1]	Parking lots, roads, manufacturing, residential areas, application of agricultural pesticides, landscaping	Route all new, untreated runoff away from wetland while ensuring wetland is not dewatered. Establish covenants limiting use of pesticides within 150 ft of wetland. Apply integrated pest management.
Stormwater runoff	Parking lots, roads, manufacturing, residential areas, commercial, landscaping	Retrofit stormwater detention and treatment for roads and existing adjacent development. Prevent channelized flow from lawns that directly enters the buffer.
Change in water regime	Impermeable surfaces, lawns, tilling	Infiltrate or treat, detain, and disperse into buffer new runoff from impervious surfaces and new lawns.

Examples of Disturbance	Activities that Cause Disturbances	Examples of Measures to Minimize Impacts
Pets and human disturbance	Residential areas	Use privacy fencing; plant dense vegetation to delineate buffer edge and to discourage disturbance using vegetation appropriate for the ecoregion; place wetland and its buffer in a separate tract.
Dust	Tilled fields	Use best management practices to control dust.
This is not a complete list of mitigation measures. Additional mitigation measures that minimize impacts may be proposed.		

[1] These examples are not necessarily adequate for minimizing toxic runoff if threatened or endangered species are present at the site

b. For wetlands that score less than 20 points for habitat functions, the width of the buffer can be reduced if measures to minimize the impacts of different uses of land are applied, as summarized in the table in subsection a above.

~~2. Buffer widths may be increased by the department on a case-by-case basis provided that the maximum buffer for Category II or III wetlands shall not exceed 100 feet;~~

2. Decision Criteria. Prior to approval, a buffer reduction proposal shall meet all of the decisional criteria listed below. The buffer modification will be approved in a degraded wetland buffer only if:

a. It will provide an overall improvement in water quality protection for the wetland; and

b. It will not adversely affect fish or wildlife species and will provide an overall enhancement to fish and wildlife habitat; and

c. It will provide a net improvement in drainage and/or storm water detention capabilities; and

d. All exposed areas are stabilized with native vegetation, as appropriate; and

e. It will not lead to unstable earth conditions or create an erosion hazard; and

f. It will not be materially detrimental to any other property or the City as a whole.

3. Buffer Enhancement Plan. As part of the buffer reduction request, the applicant shall submit a buffer enhancement plan prepared by a qualified wetland specialist. The report shall assess the habitat, water quality, storm water detention, ground water recharge, shoreline protection, and erosion protection functions of the buffer; assess the effects of the proposed modification on those functions; and address the six (6) criteria listed in this subsection. The buffer enhancement plan shall also provide the following:

a. A map locating the specific area of enhancement;

b. A planting plan that uses native plant species indigenous to this region including groundcover, shrubs, and trees;

c. Provisions for monitoring and maintenance over the monitoring period.

B. Wetland buffer width averaging. Buffer width averaging shall be considered on a case-by-case basis when the proposed averaging is in accordance an approved wetland mitigation plan and the best available science. Buffer averaging shall not be used in conjunction with the provisions for buffer reductions in this section. Averaging of buffer widths may only be allowed where a qualified wetland specialist demonstrates that:

1. It will not reduce wetland functions or values;

2. The wetland contains variations in sensitivity due to existing physical characteristics or the character of the buffer varies in slope, soils, or vegetation, and the wetland would benefit from a wider buffer in places and would not be adversely impacted by a narrower buffer in other places;

3. The buffer is increased adjacent to the higher-functioning area of habitat or more sensitive portion of the wetland and decreased adjacent to the lower-functioning or less sensitive portion.

4. The total area contained in the buffer area after averaging is no less than that which would be contained within the standard buffer; and

5. The buffer width is not reduced, at any single point, to less than seventy-five percent (75%) of the standard buffer width.

~~3.~~ C. Wetland buffer increases. The department may require increased buffer widths in accordance with the recommendations of a qualified wetland specialist and the best available science on a case-by-case basis when a larger buffer is necessary to protect wetland functions and values based on ~~local conditions~~ site-specific characteristics. This determination shall be reasonably related to protection of the functions and values of the regulated wetland. Such determination shall demonstrate that:

a. A larger buffer is necessary to maintain viable populations of existing species, or

b. The wetland is used by species listed by the federal government or the state as endangered, threatened, sensitive or as documented priority species or habitats, or essential or outstanding potential sites such as heron rookeries or raptor nesting areas, or

c. The adjacent land is susceptible to severe erosion and erosion control measures will not effectively prevent adverse wetland impact, or

d. The adjacent land has minimum vegetative cover or slopes greater than ~~15~~30 percent.

B. Alteration of Character of Buffer (Qualitative Alteration).

1. Qualitative alteration of buffer for Categories II ~~and~~ ,III and IV wetlands shall be allowed when it is demonstrated that modification of the existing character of the buffer would not reduce the functions and values of the wetland; and

2. That the alteration does not include structures associated with the development unless identified in GHMC 18.08.120(A)(2) and (3), i.e. wells and associated access; and

3. No net loss of wetland acreage due to the alteration occurs.

Section 19. Section 18.08.120 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.120 Wetlands – Permitted uses in buffer areas.

The following activities are permitted within the wetland buffer provided that any impacts are mitigated through the requirements of this chapter:

A. Wells and necessary appurtenances associated with single-family dwellings, including a pump and appropriately sized pump house, including a storage tank, may be allowed on each site in a wetland buffer if all the following conditions are met:

1. The well is either an individual well (serving only one residence) or a Class B well (a maximum of 15 connections including necessary storage tanks);

2. For Category I and II wetlands, the minimum distance from the well and appurtenances to the wetland edge is not less ~~50~~75 percent of the buffer widths

established ~~in the table~~ in GHMC 18.08.100. A decrease in the required buffer width through buffer reduction or buffer width averaging or other means does not indicate a corresponding decreased distance is allowed from the wetland edge to the well and appurtenances;

3. Access to the well and pump house shall be allowed.

B. Pervious trails and associated viewing platforms, provided that, in the case of Category I wetlands, the minimum distance from the wetland edge is not less than ~~50~~75 percent of the Category I buffer width established ~~in the table~~ in GHMC 18.08.100. A decrease in the required buffer width through buffer width averaging or other means does not indicate a corresponding decreased distance from a Category I wetland edge for trails and viewing platforms.

C. The placement of underground utility lines, on-site septic drainfields meeting the requirements of the Pierce County health code, and grass-lined swales and detention/retention facilities for water treated by biofiltration or other processes prior to discharge, provided the minimum distance from the wetland edge is not less than ~~50~~75 percent of the buffer widths established ~~in the table~~ in GHMC 18.08.100.

D. Placement of access roads and utilities across Category II, III and IV wetland-buffers, if the department determines that there is no reasonable alternative location for providing access and/or utilities to a site and mitigation is provided as designated in this chapter.

Section 20. Section 18.08.130 of the Gig Harbor Municipal Code is hereby repealed.

Section 21. Section 18.08.140 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.140 Wetlands –Alteration of wetlands and ~~S~~sequence of mitigation actions.

A. Alteration of Category I wetlands is prohibited.

~~A.~~B. Alteration of Category II, III and IV wetlands may be allowed when all ~~significant~~ adverse impacts to wetland functions and values can be shown to be fully mitigated. Criteria to be considered by the applicant or the property owner are:

1. Avoiding the impact altogether by not taking a certain action or parts of actions;

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. Compensating for the impact by replacing or providing substitute resources or environments.

~~B.~~C. Mitigation may include a combination of the above measures and may occur concurrently, unless a phased schedule is agreed.

Section 22. Section 18.08.150 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.150 Wetlands – Mitigation plan submittal requirements.

A. Following submittal of any proposed alterations to wetland and buffer areas, the applicant shall submit to the department a wetland mitigation plan substantially in the following form:

1. Conceptual Phase. A conceptual ~~compensatory~~ wetland mitigation plan shall be submitted to the department. In cases in which environmental review is required, a threshold determination may not be made prior to department review of the conceptual wetland mitigation plan. The conceptual wetland mitigation plan shall include:

a. General goals of the ~~compensatory~~ wetland mitigation plan, including an overall goal of no net loss of wetland function and acreage, and to strive for a net resource gain in wetlands over present conditions,

b. A review of literature or experience to date in restoring or creating the type of wetland proposed,

c. Approximate site topography following construction,

d. Location of proposed wetland compensation area,

e. General hydrologic patters on the site following construction,

f. Nature of compensation, including wetland types (in-kind and out-of-kind), general plant selection and justification, approximate project sequencing and schedule, and approximate size of the new wetland buffer,

g. A conceptual maintenance plan,

h. Conceptual monitoring and contingency plan.

2. Detailed Phase. Following approval of the conceptual wetland mitigation plan by the department, a detailed wetland mitigation plan shall be submitted to the department. The detailed wetland mitigation plan shall contain, at a minimum, the following components, and shall be consistent with the standards in GHMC 18.08.~~180~~160 and 18.08.~~190~~180:

a. Text and map of the existing condition of the proposed compensation area, including:

i. Existing vegetation community analysis,

ii. Hydrological analysis, including topography, of existing surface and significant subsurface flows into and out of the area in question,

iii. Soils analysis providing both Soil Conservation Service mapping and data provided by on-site verified determinations,

iv. Detailed description of flora and fauna existing on the site,

v. Description of existing site conditions in relation to historic conditions for those sites which have been recently altered or degraded;

b. Text and map of the proposed alterations to the compensation area, including:

i. Relationship of the project to the watershed and existing water bodies,

ii. Topography of site using one foot contour intervals,

iii. Water level data, including depth and duration of seasonally high water table,

iv. Water flow patterns,

v. Grading, filling and excavation, including a description of imported soils,

vi. Irrigation requirements, if any,

vii. Water pollution mitigation measures during construction,

viii. Aerial coverage of planted areas to open water areas (if any open water is to be present),

ix. Appropriate buffers; The ~~compensation~~ wetland mitigation plan shall include detailed site diagrams, scaled cross-sectional drawings, topographic maps showing slope percentage and final grade elevations, and any other drawings appropriate to show construction techniques or anticipated final outcome. The wetland mitigation plan shall provide for elevations which are appropriate for the desired habitat type(s) and which provide sufficient tidal prism and circulation data;

c. As part of the ~~compensation~~ wetland mitigation plan, a landscaping plan shall be designed by a registered landscape architect or contractor working with a qualified wetland ~~scientist/ecologist~~ specialist, describing what will be planted where and when. The landscape plan shall include the following:

i. Soils and substrate characteristics,

ii. Specification of substrate stockpiling techniques,

iii. Planting instructions, including species, stock type and size, density or spacing of plants, and water and nutrient requirement,

iv. Specification of where plant materials will be procured. Documentation shall be provided which guarantees plant materials are to be procured from licensed regional nurseries, or from wetlands on site which are part of the wetland mitigation plan;

d. A schedule shall be provided showing dates for beginning and completing the mitigation project, including a sequence of construction activities;

e. A monitoring and maintenance plan, consistent with GHMC 18.08.180. The plan shall include all the following:

i. Specification of procedures for monitoring and site maintenance,

ii. A schedule for submitting monitoring reports to the department;

f. A contingency plan, consistent with GHMC 18.08.180;

g. A detailed budget for implementation of the wetland mitigation plan, including monitoring, maintenance and contingency phases;

h. A guarantee that the work will be performed as planned and approved, consistent with GHMC 18.08.180;

i. The wetland mitigation plan shall be signed by the qualified wetland specialist to indicate that the plan is according to specifications determined by the qualified wetland specialist. A signed original wetland mitigation plan shall be submitted to the department.

3. ~~Approval of the detailed mitigation plan~~ Following the approval of the detailed wetland mitigation plan by the department, the plan shall be ~~signified by a notarized memorandum of agreement~~ signed and notarized by the applicant and ~~director of the department~~ Community Development Director, and recorded with the Pierce County auditor. ~~The agreement shall refer to all mitigation requirements for the project.~~

4. Approval of the detailed wetland mitigation plan shall occur prior to the issuance of building permits or other development permits. No development activity shall occur on the site prior to approval. Required mitigation may also be required prior to issuance of permits or prior to commencing development activity. Timing of required mitigation shall be determined on a case by case basis.

Section 23. Section 18.08.160 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.160 Wetlands – Criteria for compensatory mitigation/location ~~criteria~~ and timing of compensatory mitigation.

A. The applicant shall develop a wetland mitigation plan that provides for construction, maintenance, monitoring and contingencies of the replacement wetland. In addition, the applicant and landowner shall meet the following criteria:

1. The restored, created, or enhanced wetland shall be as persistent as the wetland it replaces;

2. The applicant shall demonstrate sufficient capability to carry out the compensation project;

3. The compensation area shall be provided with permanent protection and management to avoid further development or degradation and to provide for the long term persistence of the compensation area as designed.

B. In cases in which it is determined that compensatory mitigation is appropriate, the following shall apply:

1. Compensatory mitigation shall be provided on-site, except where on-site mitigation is not scientifically feasible or practical due to physical features of the site. The burden of proof shall be on the applicant to demonstrate that mitigation cannot be provided on-site.

2. When compensatory mitigation cannot be provided on-site, mitigation shall be provided in the immediate vicinity of and within the same watershed as the permitted activity.

3. Compensatory mitigation shall duplicate the overall functions and values ~~and standards~~ of the wetland to be replaced and shall include at least 50 percent in-kind compensation mitigation unless it can be demonstrated by the applicant that the overall wetland values of the mitigation area and adjacent or connecting wetlands can be enhanced by a higher percentage of out-of-kind mitigation.

4. Only when it is determined by the department that ~~subdivisions~~ subsections 1, 2 and 3 above are inappropriate and/or impractical shall off-site, compensatory mitigation be considered.

5. Mitigation projects shall be completed concurrent with other activities on the site, unless a phased schedule is agreed upon between the department and the applicant. Refer to GHMC 18.08.170 for guidelines on determining wetland acreage replacement ratios.

Section 24. Section 18.08.170 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.170 Wetlands – ~~r~~Replacement criteria.

A. Where wetlands are altered, the applicant shall meet the minimum requirements of this section.

B. When it is proposed to alter or eliminate a wetland and the department is considering the alteration or elimination, the applicant shall be required to replace or ~~preferably~~ enhance the function~~al~~s and ~~biological~~ values of the affected wetland. The wetland values will be based on an approved evaluation procedure ~~such as Wetlands Evaluation Technique (WET), Habitat Evaluation Procedure (HEP) etc~~. ~~A reduction in overall wetland acres is allowed if the conditions in subsection E of this section are met.~~ The recommended ratios for replacement/compensation are as established in the following table:

Wetland Type	**Replacement Ratio**
~~Category I: (No Alteration or Replacement)~~	
~~Category II:~~	
~~Forested:~~	~~2:1~~
~~Scrub/Shrub:~~	~~1.5:1~~
~~Emergent:~~	~~1:1~~
~~Open Water:~~	~~1:1~~
~~Category III:~~	

~~Forested: 1.5:1~~
~~Scrub/Shrub: 1:1~~
~~Emergent: 1:1~~
~~Open Water: 1:1~~
~~Category IV: 1:1~~

~~Note that within Category II and III wetlands replacement ratios vary depending on wetland class. For example, it will be required to replace the forested portion of a wetland at a higher ratio that the other portions of the wetland.~~

Category I	6-to-1 (for unauthorized wetland impact only)
Category II	3-to-1
Category III	2-to-1
Category IV	1.5-to-1

C. Ratios provided are for proposed projects with on-site, in-kind replacement which occurs prior to development of the site. Replacement ratio for unauthorized wetland ~~elimination~~ impact requires ~~resurface~~ replacement at a ratio two times that listed for the wetland categorical type. The increased ratio is based on the uncertainty of probable success of proposed replacement, projected losses of wetland function~~al~~s and values, or significant period of time between elimination and replacement of wetland. Such required increases in replacement ratios will be made by the department after review of all pertinent data relating to the proposed or committed alteration.

D. The department will allow the ratios to be decreased if the applicant provides findings of special studies coordinated with agencies with expertise which demonstrate to the satisfaction of the department that no net loss of wetland function or value is attained under the decreased ratio.

E. The replacement ratio may be decreased to a ratio of ~~less than~~ 1:1, if the following criteria are met:

1. The applicant shows to the satisfaction of the department that a replacement ratio of greater than 1:1 is either not feasible on-site, would be likely to result in substantial degradation of other natural features or results in an increase of wetland function and values; and

2. The applicant submits to the department a wetland mitigation plan according to requirements of GHMC 18.08.150 and 18.08.160 which shows to the satisfaction of the department that a net increase in wetland function~~al~~s and values will result from the mitigation; and

3. The mitigation is completed and monitored by the department for one year after completion of the mitigation. After one year the department shall make a determination of whether or not the mitigation has been successful.

a. If the department is satisfied that the mitigation will successfully meet the anticipated final outcome of the wetland mitigation plan, development permits may be issued and development activity on the site may begin.

b. If the department is not satisfied that the mitigation will successfully meet the anticipated final outcome of the wetland mitigation plan, development permits shall not be issued and development activity on the site shall not begin. Modifications to the wetland mitigation plan and further monitoring may be required until the department is satisfied that the mitigation will be successful.

F. In-kind compensation shall be provided except where the applicant can demonstrate to the satisfaction of the department that:

1. The wetland system is already significantly degraded and out-of-kind replacement will result in a wetland with greater functional value; or

2. Scientific problems such as exotic vegetation and changes in watershed hydrology make implementation of in-kind compensation impossible; or

3. Out-of-kind replacement will best meet identified regional goals (e.g., replacement of historically diminished wetland types);

4. Where out-of-kind replacement is accepted, greater acreage replacement ratios may be required to compensate for lost function~~al~~s and values.

G. Site specific quantifiable criteria shall be provided for evaluating whether or not the goals and objectives for the proposed compensation are being met. Such criteria include but are not limited to water quality standards, survival rates for planted vegetation, habitat diversity indices, species abundance or use patterns, hydrological standards including depths and durations of water patterns. Detailed performance standards for mitigation planning shall include the following criteria:

1. Use only plants indigenous to Pierce County (not introduced or foreign species);

2. Use plants appropriate to the depth of water at which they will be planted;

3. Use plants available from local sources;

4. Use plant species high in food and cover value for fish and wildlife;

5. Plant mostly perennial species;

6. Avoid committing significant areas of site to species that have questionable potential for successful establishment;

7. Plant selection must be approved by a qualified wetland ~~scientist/ecologist~~ specialist;

8. Water depth is not to exceed 6.5 feet (two meters);

9. The grade or slope that water flows through the wetland is not to exceed six percent;

10. Slopes within the wetland basin and the buffer zone should not be steeper than 3:1 (horizontal to vertical);

11. The substrate should consist of a minimum of one foot, in depth, of clean (uncontaminated with chemicals, or solid/hazardous wastes) inorganic/organic materials;

12. Planting densities and placement of plants shall be determined by a qualified wetland~~s biologist/ ecologist~~ specialist and shown on the design plans;

13. The wetland (excluding the buffer area) should not contain more than 60 percent open water as measured at the seasonal high water mark;

14. The planting plan must be approved by a qualified wetland ~~scientist/ecologist~~ specialist;

15. Stockpiling shall be confined to upland areas and contract specifications should limit stockpile durations to less than four weeks;

16. Planting instructions shall describe proper placement, diversity, and spacing of seeds, tubers, bulbs, rhizomes, sprigs, plugs, and transplanted stock;

17. Apply controlled release fertilizer at the time of planting and afterward only as plant conditions warrant (determined during the monitoring process), and only to the extent that the release would be conducted in an environmentally sound manner;

18. Install an irrigation system, if necessary, for initial establishment period;

19. Construction specifications and methods shall be approved by a qualified wetland ~~scientist/ecologist~~ specialist and the department;

20. All mitigation shall be consistent with requirements of ~~the city flood hazard construction ordinance~~ Chapter 15.04 GHMC and city storm drainage comprehensive plan;

21. As appropriate, and if impacts to natural wetland function~~al~~s and values can be fully mitigated, capacity of the wetland to store surface water should be equal to or greater than surface water storage capacity prior to the proposed activity;

22. As appropriate, and if impacts to natural wetland function~~al~~s and values can be fully mitigated, ability of the wetland to intercept surface water runoff on the site should be equal to or greater than such ability prior to the proposed activity;

23. As appropriate, and if impacts to natural wetland function~~al~~s and values can be fully mitigated, the ability of the wetland to perform stormwater detention functions should be equal to or greater than such functions prior to the proposed activity.

H. Wetland mitigation shall occur according to the approved wetland mitigation plan, and shall be consistent with all provisions of this regulation.

I. On completion of construction required to mitigate for impacts to wetlands, the wetland mitigation project shall be signed off by an approved qualified wetland ~~scientist/ecologist~~ specialist and the ~~county's~~ city's environmental official. Signature will indicate that the construction has been completed as planned.

Section 25. Section 18.08.180 of the Gig Harbor Municipal Code is hereby amended, to read as follows:

18.08.180 Wetlands – Monitoring program and contingency plan.

A. If the wetland mitigation plan includes compensatory mitigation, a monitoring program shall be implemented to determine the success of the compensatory mitigation project.

B. Specific criteria shall be provided for evaluating the mitigation proposal relative to the goals and objectives of the project and for beginning remedial action or contingency measures. Such criteria may include water quality standards, survival rates of planted vegetation, species abundance and diversity targets, habitat diversity indices, or other ecological, geological or hydrological criteria.

C. A contingency plan shall be established for compensation in the event that the mitigation project is inadequate or fails. ~~A cash deposit, assignment of funds, or other acceptable security device is required for the duration of the monitoring period specified in the approved mitigation plan, to ensure the applicant's compliance with the terms of the mitigation agreement. The amount of the security device shall equal 125 percent of the cost of the mitigation project.~~

D. Requirements of the monitoring program and contingency plan are as follows:

1. During monitoring, use scientific procedures for establishing the success or failure of the project;

2. For vegetation determinations, permanent sampling points shall be established;

3. Vegetative success equals 80 percent per year survival of planted trees and shrubs and 80 percent per year cover of desirable understory or emergent species;

4. Submit monitoring reports of the current status of the mitigation project to the department. The reports are to be prepared by a qualified wetland ~~biologist/ ecologist~~ specialist and shall include monitoring information on wildlife, vegetation, water quality, water flow, stormwater storage and conveyance, and existing or potential degradation, and shall be produced on the following schedule:

a. At time of construction,
b. Thirty days after planting,
c. Early in the growing season of the first year,
d. End of the growing season of first year,
e. Twice the second year,
f. Annually;

5. Monitor a minimum of three and up to 10 growing seasons, depending on the complexity of the wetland system. The time period will be determined and specified in writing prior to the implementation of the site plan;

6. If necessary, correct for failures in the mitigation project;

7. Replace dead or undesirable vegetation with appropriate plantings;

8. Repair damages caused by erosion, settling, or other geomorphological processes;

9. Redesign mitigation project (if necessary) and implement the new design;

10. Correction procedures shall be approved by a qualified wetland~~s~~ ~~biologist/ecologist~~ specialist and the ~~Pierce County~~ city's environmental official.

Section 26. A new Section 18.08.182 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.182 Streams – Designation and rating of streams.

A. Streams are waterbodies with a defined bed and banks and demonstrable flow of water as defined in the chapter. Streams are designated as environmentally critical areas.

B. Stream Classification. Streams shall be designated Type 1, Type 2, Type 3, and Type 4 according to the criteria in this subsection.

1. Type 1 Streams are those streams identified as "Shorelines of the State" under Chapter 90.58 RCW.

2. Type 2 Streams are those streams which are:

a. natural streams that have perennial (year-round) flow and are used by salmonid fish, or

b. natural streams that have intermittent flow and are used by salmonid fish.

3. Type 3 Streams are those streams which are:

a. natural streams that have perennial flow and are used by fish other than salmonids, or

b. natural streams that have intermittent flow and are used by fish other than salmonids.

4. Type 4 Streams are those natural streams with perennial or intermittent flow that are not used by fish.

C. Ditches. Ditches are artificial drainage features created in uplands through purposeful human action, such as irrigation and drainage ditches, grass-lined swales, and canals. Purposeful creation must be demonstrated through documentation, photographs, statements and/or other evidence. Ditches are excluded from regulation as streams under this section. Artificial drainage features with documented fish usage are regulated as streams. Drainage setbacks are required as per the City's Surface Water Manual.

Section 27. A new Section 18.08.183 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.183 Streams – Critical areas report.

A. A stream analysis report shall be prepared by a qualified biologist and submitted to the department as part of the SEPA review process established by the city of Gig Harbor environmental policy ordinance, Chapter 18.04 GHMC.

B. The stream analysis report shall be prepared in accordance with the methods provided by Washington Department of Fish and Wildlife or Pierce County Planning and

Land Services or other acceptable scientific method and submitted to the department for review for any proposals that are within 200 feet of a stream.

C. Within 30 days of receipt of the stream analysis report and other information, the department shall determine the appropriate stream category, buffering requirement, and required mitigation. The report shall be accorded substantial weight and the department shall approve the report's findings and approvals, unless specific, written reasons are provided which justify not doing so. Once accepted, the report shall control future decision making related to designated streams unless new information is found demonstrating the report is in error.

Section 28. A new Section 18.08.184 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.184 Streams – Performance Standards - General.

A. Establishment of stream buffers. The establishment of buffer areas shall be required for all development proposals and activities in or adjacent to streams. The purpose of the buffer shall be to protect the integrity, function, and value of the stream. Buffers shall be protected during construction by placement of a temporary barricade, on-site notice for construction crews of the presence of the stream, and implementation of appropriate erosion and sedimentation controls. Native vegetation removal or disturbance is not allowed in established buffers.

Required buffer widths shall reflect the sensitivity of the stream or the risks associated with development and, in those circumstances permitted by these regulations, the type and intensity of human activity and site design proposed to be conducted on or near the sensitive area. Buffers or setbacks shall be measured as follows:

B. Stream Buffers

1. The following buffers are established for streams:

Stream Type	**Buffer Width (feet)**
Type 1	200
Type 2	100
Type 3	50
Type 4	25

2. Measurement of stream buffers. Stream buffers shall be measured perpendicularly from the ordinary high water mark.

3. Increased stream buffer widths. The Director shall require increased buffer widths in accordance with the recommendations of a qualified biologist and the best available science on a case-by-case basis when a larger buffer is necessary to protect stream functions and values based on site-specific characteristics. This determination shall be based on one or more of the following criteria:

a. A larger buffer is needed to protect other critical areas;

b. The buffer or adjacent uplands has a slope greater than thirty percent (30%) or is susceptible to erosion and standard erosion-control measures will not prevent adverse impacts to the wetland.

4. Buffer conditions shall be maintained. Except as otherwise specified or allowed in accordance with this Title, stream buffers shall be retained in an undisturbed condition.

5. Degraded buffers shall be enhanced. Stream buffers vegetated with non-native species or otherwise degraded shall be enhanced with native plants, habitat features or other enhancements.

6. Buffer uses. The following uses may be permitted within a stream buffer in accordance with the review procedures of this Chapter, provided they are not prohibited by any other applicable law and they are conducted in a manner so as to minimize impacts to the buffer and adjacent stream:

a. Conservation and restoration activities. Conservation or restoration activities aimed at protecting the soil, water, vegetation, or wildlife;

b. Passive recreation. Passive recreation facilities designed in accordance with an approved critical area report, including:

i .Walkways and trails, provided that those pathways that are generally parallel to the perimeter of the stream shall be located in the outer twenty-five percent (25%) of the buffer area;

ii. Wildlife viewing structures; and

iii. Fishing access areas.

c. Stormwater management facilities. Grass lined swales and dispersal trenches may be located in the outer 25% of the buffer area. All other surface water management facilities are not allowed within the buffer area.

7. Building setback. A 15-foot building setback is required from the edge of the stream buffer.

C. Stream crossings. Stream crossings may be allowed and may encroach on the otherwise required stream buffer if:

1. All crossings use bridges or other construction techniques which do not disturb the stream bed or bank, except that bottomless culverts or other appropriate methods demonstrated to provide fisheries protection may be used for Type 2 or 3 streams if the applicant demonstrates that such methods and their implementation will pose no harm to the stream or inhibit migration of fish:

2. All crossings are constructed during the summer low flow and are timed to avoid stream disturbance during periods when use is critical to salmonids;

3. Crossings do not occur over salmonid spawning areas unless the City determines that no other possible crossing site exists;

4. Bridge piers or abutments are not placed within the FEMA floodway or the ordinary high water mark;

5. Crossings do not diminish the flood-carrying capacity of the stream;

6. Underground utility crossings are laterally drilled and located at a depth of four feet below the maximum depth of scour for the base flood predicted by a civil engineer licensed by the state of Washington. Temporary bore pits to perform such crossings may be permitted within the stream buffer established in this Title; and

7. Crossings are minimized and serve multiple purposes and properties whenever possible.

D. Stream relocations.

1. Stream relocations may be allowed only for:

a. All Stream types as part of a public project for which a public agency and utility exception is granted pursuant to this Title; or

b. Type 3 or 4 streams for the purpose of enhancing resources in the stream if:

i. appropriate floodplain protection measures are used; and

ii. the location occurs on the site except that relocation off the site may be allowed if the applicant demonstrates that any on-site relocation is impracticable, the applicant provides all necessary easements and waivers from affected property owners and the off-site location is in the same drainage sub-basin as the original stream.

2. For any relocation allowed by this section, the applicant shall demonstrate, based on information provided by a civil engineer and a qualified biologist, that:

a. The equivalent base flood storage volume and function will be maintained;

b. There will be no adverse impact to local groundwater;

c. There will be no increase in velocity;

d. There will be no interbasin transfer of water;

e. There will be no increase in the sediment load;

f. Requirements set out in the mitigation plan are met;

g. The relocation conforms to other applicable laws; and

h. All work will be carried out under the direct supervision of a qualified biologist.

E. Stream enhancement. Stream enhancement not associated with any other development proposal may be allowed if accomplished according to a plan for its design, implementation, maintenance and monitoring prepared by a civil engineer and a qualified biologist and carried out under the direction of a qualified biologist.

F. Minor stream restoration. A minor stream restoration project for fish habitat enhancement may be allowed if:

1. The project results in an increase in stream function and values.

2. The restoration is sponsored by a public agency with a mandate to do such work;

3. The restoration is not associated with mitigation of a specific development proposal;

4. The restoration is limited to removal and enhancement of riparian vegetation, placement of rock weirs, log controls, spawning gravel and other specific salmonid habitat improvements;

5. The restoration only involves the use of hand labor and light equipment; or the use of helicopters and cranes which deliver supplies to the project site provided that they have no contact with sensitive areas or their buffers; and

6. The restoration is performed under the direction of a qualified biologist.

Section 29. A new Section 18.08.185 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.185 Streams – Mitigation Requirements.

A. Stream mitigation. Mitigation of adverse impacts to riparian habitat areas shall result in equivalent functions and values on a per function basis, be located as near the alteration as feasible, and be located in the same sub drainage basin as the habitat impacted.

B. Alternative mitigation for stream areas. The performance standards set forth in this Subsection may be modified at the City's discretion if the applicant demonstrates that greater habitat functions, on a per function basis, can be obtained in the affected sub-drainage basin as a result of alternative mitigation measures.

Section 30. A new Section 18.08.186 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.186 Critical fish and wildlife habitat areas.

Critical fish and wildlife habitat areas are those areas identified as being of critical importance in the maintenance and preservation of fish, wildlife and natural vegetation. Areas which are identified or classified as fish and wildlife habitat areas subject to this section shall be subject to the requirements of this section.

A. General. Critical fish and wildlife habitat areas are identified as follows:

1. Areas with which federal or state endangered, threatened and sensitive species of fish, wildlife and plants have a primary association and which, if altered, may reduce the likelihood that the species will maintain and reproduce over the long term;

2. Habitats and species of local importance, including:

a. Areas with which state-listed monitor or candidate species or federally listed candidate species have a primary association and which, if altered, may reduce the likelihood that the species will maintain and reproduce over the long term,

b. Special habitat areas which are infrequent in occurrence in the city of Gig Harbor and which provide specific habitats as follows:

i. Old growth forests,

ii. Snag-rich areas,

iii. Category 2 wetland areas,

iv. Significant stands of trees which provide roosting areas for endangered, threatened, rare or species of concern as identified by the Washington Department of Wildlife;

3. Commercial and public recreational shellfish areas;

4. Kelp and eelgrass beds;

5. Herring and smelt spawning areas;

6. Naturally occurring ponds under 20 acres and their submerged aquatic beds that provide fish or wildlife habitat;

7. Lakes, ponds and streams planted with fish by a governmental agency, and agency-sponsored group or tribal entity;

8. State natural area preserves and natural resource conservation areas;

B. Classification. Critical fish and wildlife habitat areas are identified in the following documents:

1. Puget Sound Environmental Atlas (Puget Sound Water Quality Authority);

2. Coastal Zone Atlas of Washington, Volume IV, Pierce County (Washington Department of Ecology);

3. Commercial and Recreational Shellfish Areas in Puget Sound (Washington Department of
Health);

4. The Department of Natural Resources stream typing maps and natural heritage data base;

5. The Washington Department of Wildlife priority habitats and species program, the Nongame data base, and the Washington rivers information system.

C. Regulation.

1. Habitat Assessment. For all regulated activity proposed on a site which contains or is within 300 feet of critical fish and wildlife habitat, a habitat assessment shall be prepared by a qualified wildlife biologist. The habitat assessment shall include, at a minimum, the following:

a. An analysis and discussion of species or habitats known or suspected to be located within 300 feet of the site;

b. A site plan which clearly delineates the critical fish and wildlife habitats found on or within 300 feet of the site.

2. Habitat Assessment Review. A habitat assessment shall be forwarded for review and comment to agencies with expertise or jurisdiction on the proposal, including, but not limited to:

a. Washington Department of Fish and Wildlife;

b. Washington Department of Natural Resources;

c. United States Fish and Wildlife Service.

Comments received by the requested review agencies within 45 days of the submittal of the assessment shall be considered by the department. If it is determined, based upon the comments received, that critical fish and wildlife habitat does not occur on or within 300 feet of the site, the development may proceed without any additional requirements under this section. If it is determined that a critical fish and wildlife habitat is on or within 300 feet of the site, a habitat management plan shall be prepared.

3. Habitat Management Plan. Habitat management plans required under this section shall be prepared in coordination with the Washington Department of Fish and Wildlife by a qualified wildlife biologist. A habitat management plan shall contain, at a minimum, the following:

a. Analysis and discussion on the project's effects on critical fish and wildlife habitat;

b. An assessment and discussion on special management recommendations which have been developed for species or habitat located on the site by any federal or state agency;

c. Proposed mitigation measures which could minimize or avoid impacts;

d. Assessment and evaluation of the effectiveness of mitigation measures proposed;

e. Assessment and evaluation of ongoing management practices which will protect critical fish and wildlife habitat after development of the project site, including proposed monitoring and maintenance programs;

f. Assessment of project impact or effect on water quality in Crescent or Donkey (north) Creeks, and any proposed methods or practices to avoid degradation of water quality. Upon a review of the habitat management plan by appropriate federal and state agencies, comments received by the agencies within 45 days of the submittal of the proposed plan shall be considered by the city and, if mitigation is recommended, may be incorporated into conditions of project approval, as appropriate. If it is determined, based upon the comments received, that a project or proposal will result in the extirpation or isolation of a critical fish or wildlife species, including critical plant communities, the project or proposal may be denied.

D. Buffer Requirements. If it is determined, based upon a review of the comments received on the habitat management plan, that a buffer would serve to mitigate impacts to a critical fish or wildlife habitat, an undisturbed buffer shall be required on the development site. The width of the buffer shall be based upon a recommendation of at least one of the appropriate review agencies but, in no case, shall exceed 150 feet, nor be less than 25 feet.

E. Buffer Reduction. A buffer required under this section may be reduced or eliminated if the local conservation district has approved a best management plan (BMP) for the site which would provide protection to a critical fish or wildlife habitat.

F. Specific Habitats - Anadromous fish

1. All activities, uses, and alterations proposed to be located in water bodies used by anadromous fish or in areas that affect such water bodies shall give special consideration to the preservation and enhancement of anadromous fish habitat, including, but not limited to, adhering to the following standards:

a. Activities shall be timed to occur only during the allowable work window as designated by the Washington Department of Fish and Wildlife for the applicable species;

b. An alternative alignment or location for the activity is not feasible;

c. The activity is designed so that it will not degrade the functions or values of the fish habitat or other critical areas; and

d. Any impacts to the functions or values of the habitat conservation area are mitigated in accordance with an approved critical area report.

2. Structures that prevent the migration of salmonids shall not be allowed in the portion of water bodies currently or historically used by anadromous fish. Fish bypass facilities shall be provided that allow the upstream migration of adult fish and shall prevent fry and juveniles migrating downstream from being trapped or harmed.

3. Fills, when authorized by the City of Gig Harbor's Shoreline Management Master Program, SEPA review or clearing and grading, shall not adversely impact anadromous fish or their habitat or shall mitigate any unavoidable impacts, and shall only be allowed for a water-dependent use.

Section 31. A new Section 18.08.188 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.188 Aquifer recharge areas.

Aquifer recharge areas are particularly susceptible to contamination and degradation from land use activities. Areas which have a high potential for ground water resource degradation are identified as aquifer recharge areas under this section and shall be subject to the requirements herein.

A. Designation/Classification. For the purposes of this section, the boundaries of any aquifer recharge areas within the city shall consist of the two highest DRASTIC zones which are rated 180 and above on the DRASTIC index range. Any site located within these boundaries is included in the aquifer recharge area.

B. Regulation.

1. Hydrogeologic Assessment Required. The following land uses shall require a hydrogeologic assessment of the proposed site if the site is located within an aquifer recharge area:

a. Hazardous substance processing and handling;

b. Hazardous waste treatment and storage facility;

c. Wastewater treatment plant sludge disposal categorized as S-3, S-4 and S-5;

d. Solid waste disposal facility.

2. Hydrogeologic Assessment Minimum Requirements. A hydrogeologic assessment shall be submitted by a firm, agent or individual with experience in hydrogeologic assessments and shall contain, at a minimum, and consider the following parameters:

a. Documentable information sources;

b. Geologic data pertinent to well logs or borings used to identify information;

c. Ambient ground water quality;

d. Ground water elevation;

e. Depth to perched water table, including mapped location;

f. Recharge potential of facility site, respective to permeability and transmissivity;

g. Ground water flow vector and gradient;

h. Currently available data on wells and any springs located within 1,000 feet of the facility site;

i. Surface water location and recharge potential;

j. Water supply source for the facility;

k. Analysis and discussion of the effects of the proposed project on the ground water resource;

l. Proposed sampling schedules;

m. Any additional information that may be required or requested by the Pierce County environmental health department.

3. Review of Hydrogeologic Assessment. A hydrogeologic assessment prepared under this section shall be submitted to the Pierce County department of environmental health for review and comment. Comments received by the department of health within 60 days of submittal of the assessment shall be considered by the city in the approval, conditional approval or denial of a project.

4. Findings for Consideration of Approval. A hydrogeologic assessment must clearly demonstrate that the proposed use does not present a threat of contamination to the aquifer system, or provides a conclusive demonstration that application of new or improved technology will result in no greater threat to the ground water resource than the current undeveloped condition of the site. Successful demonstration of these findings warrants approval under this section.

Section 32. A new Section 18.08.190 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.190 Hillsides, ravine sidewalls and bluffs.

A. Disturbance Limitations. If a hillside, ravine sidewall or bluff is located on or adjacent to a development site, all activities on the site shall be in compliance with the following requirements:

1. Ravine Sidewalls and Bluffs.

a. Buffers. An undisturbed buffer of natural vegetation equal to the height of the ravine sidewall or bluff shall be established and maintained from the top, toe and sides of all ravine sidewalls and bluffs. All buffers shall be measured on a horizontal plane.

b. Buffer Delineation. The edge of a buffer shall be clearly staked, flagged and fenced prior to any site clearing or construction. Markers shall be clearly visible and weather resistant. Site clearing shall not commence until such time that the project proponent or authorized agent for the project proponent has submitted written notice to the city that the buffer requirements of this section have been met. Field marking of the buffer shall remain in place until all phases of construction have been complete and an occupancy permit has been issued by the city.

c. Buffer Reduction. A buffer may be reduced upon verification by a qualified professional and supporting environmental information, to the satisfaction of the city that the proposed construction method will:

i. Not adversely impact the stability of ravine sidewalls;

ii. Not increase erosion and mass movement potential of ravine sidewalls;

iii. Use construction techniques which minimize disruption of existing topography and vegetation;

iv. Includes measures to overcome any geological, soils and hydrologic constraints of the site. The buffer may be reduced to no less than the minimum rear yard setback established in the respective zoning district, pursuant to GHMC Title 17.

d. Building Setback Lines. A building setback line of 10 feet is required from the edge of any buffer of a ravine sidewall or bluff.

2. Hillsides of 15 Percent Slope and Greater – Studies Required. Developments on hillsides shall comply with the following requirements:

a. Site Analysis Reports Required. The following chart sets forth the level of site analysis report required to be developed based upon the range of the slope of the site and adjacent properties:

Slope of Site and/or Adjacent Properties	Length of Slope (feet)	Parameters of Report (see key)	Report Prepared by
0% to 15%	No limit	Report not required	
15% to 25%	> 50	1, 2, 3	Building contractor or other technical consultant
25% to 40%	> 35	1, 2, 3, 4	Registered civil engineer
40% +	> 20	1, 2, 3, 4	Registered engineer or geotechnical engineer

Report Key Contents

1. Recommended maximum site ground disturbance.
2. Estimate of storm drainage (gpm) for preconstruction, during construction and post-construction.
3. Recommended methods to minimize erosion and storm water runoff from site during construction and post-construction.
4. Seismic stability of site, preconstruction, during construction and post-construction.

b. Development Location. Structures and improvements shall be located to preserve the most sensitive portion of the site, its natural land forms and vegetation.

c. Landscaping. The disturbed areas of a development site not used for buildings and other developments shall be landscaped according to the landscape standards of the zoning code (Chapter 17.78 GHMC).

d. Project construction shall be required to implement all recommended requirements of the report referenced in subsection A2a of this section, and any additional requirements as determined by city staff. In addition, should adjacent properties be adversely impacted by the implementation or construction, additional mitigation measures necessary to minimize or eliminate these impacts shall be implemented by the applicant.

Section 33. A new Section 18.08.192 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.192 Landslide and erosion hazard areas.

Areas which are identified as landslide or erosion hazard areas shall be subject to the requirements established in this section.

A. Regulation. Applications for regulated activities proposed within designated landslide and erosion hazard areas shall be accompanied by a geotechnical report prepared by a geologist or geotechnical engineer licensed as a civil engineer with the state. If it is satisfactorily demonstrated to the Community Development Director that a landslide or erosion hazard potential does not exist on the site, the requirements of this section may be waived.

B. Geotechnical Report Requirements. A geotechnical report required under this section shall include, at a minimum, the following information:

1. Topographic data at a minimum scale of 1:240 (1 inch = 20 feet). Slope ranges shall be clearly delineated in increments of 15 percent to 25 percent, 25 percent to 40 percent and greater than 40 percent;

2. Subsurface data, including boring logs and exploratory methods, soil and rock stratigraphy, ground water levels and any seasonal variations of ground water levels;

3. Site history, including description of prior grading and clearing, soil instability or slope failure.

If a geotechnical report has been prepared and accepted by the Community Development Director within the previous two years for a specific site and the proposed land use development and site conditions have not changed, the report may be utilized without the requirement for a new report.

C. Development Standards. Upon submission of a satisfactory geotechnical report or assessment, site development may be authorized by the director subject to the following:

1. Buffers shall comply with the requirements of GHMC 18.08.060(A);

2. Approved erosion-control measures are in place prior to, or simultaneous, with site clearing or excavation;

3. Such other conditions as deemed appropriate by the administrator to ensure compliance with the provisions of this chapter.

Section 34. A new Section 18.08.194 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.194 Seismic hazard areas.

Designated seismic hazard areas shall be subject to the requirements of this section. At a minimum, seismic hazard areas shall include areas of alluvial and recessional outwash surficial geologic units as identified in "Water Resources and Geology of the Kitsap Peninsula and Certain Adjacent Lands, Water Supply Bulletin Number 18, Plate One," U.S. Department of the Interior, Geological Survey, Water Resources Division, and any lot, tract, site or parcel which has been modified by imported or excavated earthen fill material.

A. Regulation. Applications for regulated activities proposed within designated seismic hazard areas shall be accompanied by a geotechnical report prepared by a geologist or geotechnical engineer licensed as a civil engineer with the state. If it is satisfactorily demonstrated that a seismic hazard potential does not exist on the site, the requirements of this section may be waived.

B. Geotechnical Report Requirements. The required report shall evaluate the existing site conditions, including geologic, hydrologic and site capability to accommodate the proposed activity. At a minimum, the following shall be included:

1. Analysis of subsurface conditions;

2. Delineation of the site subject to seismic hazards;

3. Analysis of mitigation measures which may be employed to reduce or eliminate seismic risks, including an evaluation of the effectiveness of mitigation measures.

If a proposal is required to submit a seismic risk analysis pursuant to any requirements of the most recently adopted edition of the International Building Code by the city of Gig Harbor, the report requirements of this section may be waived by the department.

Section 35. A new Section 18.08.196 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.196 Flood hazard areas.

Areas which are prone to flooding and which are identified in the Federal Emergency Management Administration flood insurance rate maps for the city of Gig Harbor (September 2, 1981) shall be subject to the requirements of this section.

A. Regulation. All development within flood hazard areas shall be subject to the requirements of the city of Gig Harbor flood hazard construction standards (Chapter 15.04 GHMC).

Section 36. Section 18.08.200 of the Gig Harbor Municipal Code is hereby repealed.

Section 37. A new Section 18.08.200 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.200 Maintenance of existing structures and developments.

Structures and developments lawfully existing prior to the adoption of this section shall be allowed to be maintained and repaired without any additional review procedures under this title; provided, that the maintenance or repair activity itself remains consistent with the provisions of this chapter and does not increase its nonconformity of such structures or development. Additionally, such construction activity shall not prove harmful to adjacent properties. Maintenance consists of usual actions necessary to prevent a decline, lapse or cessation from a lawfully established condition. Repair consists of the restoration of a development comparable to its original condition within two years of sustaining damage or partial destruction. Maintenance and repair shall include damage incurred as a result of accident, fire or the elements. Total replacement of a structure or development which is not common practice does not constitute repair. In addition to the requirements of this section, the requirements of Chapter 17.68 GHMC (Nonconformities) shall apply.

Section 38. A new Section 18.08.202 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.202 Exemptions from development standards.

Certain activities and uses may be of such impact and character or of such dependency to the maintenance and welfare of a lawfully permitted use that the requirements of this title shall not apply and may be waived at the discretion of the department. Notwithstanding the requirements of Title 17 GHMC, the following uses and activities are exempt from the requirements of this chapter:

A. Emergency actions which must be undertaken immediately or for which there is insufficient time for full compliance with this chapter where necessary to:

1. Prevent an imminent threat to public health or safety, or
2. Prevent an imminent danger to public or private property, or
3. Prevent an imminent threat of serious environmental degradation.

The department shall determine on a case-by-case basis emergency action which satisfies the general requirements of this subsection. In the event a person determines that the need to take emergency action is so urgent that there is insufficient time for review by the department, such emergency action may be taken immediately. The person undertaking such action shall notify the department within one working day of the commencement of the emergency activity. Following such notification the department shall determine if the action taken was within the scope of the emergency actions allowed in this subsection. If the department determines that the action taken or part of the action taken is beyond the scope of allowed emergency action, enforcement action according to provisions of this chapter is warranted

B. Public and private pedestrian trails which consist of a pervious surface not exceeding four feet in width;

C. Science research and educational facilities, including archaeological sites and attendant excavation, which do not require the construction of permanent structures or roads for vehicle access;

D. Site investigative work necessary for land use application submittals such as surveys, soil logs, percolation tests and other related activities;

E. The placement of signs consistent with Chapter 17.80 GHMC.

F. Existing and ongoing agricultural activities, as defined in this chapter;

G. Forestry practices regulated and conducted in accordance with the provisions of Chapter 76.09 RCW and forest practice regulations;

H. Activities affecting a hydrologically isolated Category IV wetland, if the functional wetland size is less than 1,000 square feet, except that such activities shall comply with the city flood hazard construction code and the city storm drainage management plan;

I. Maintenance, operation and reconstruction of existing roads, streets, utility lines and associated structures, provided that reconstruction of any such facilities does not extend outside the scope of any designated easement or right-of-way;

J. Activities on improved roads, rights-of-way, easements, or existing driveways;

K. Normal maintenance and reconstruction of structures, provided that reconstruction may not extend the existing ground coverage;

L. Activities having minimum adverse impacts on wetlands, such as passive recreational uses, sport fishing or hunting, scientific or educational activities;

Section 39. A new Section 18.08.204 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.204 Variances from the minimum requirements.

A. Variance applications shall be considered by the city according to variance procedures described in Chapter 17.66 GHMC and shall be processed as a Type III application under the permit processing procedures of GHMC Title 19. The required showings for a variance shall be according to this section. The burden is upon the applicant in meeting the required showings for the granting of a variance.

B. The examiner shall have the authority to grant a variance from the provisions of this chapter, when, in the opinion of the examiner, the conditions as set forth in this section have been found to exist. In such cases a variance may be granted which is in harmony with the general purpose and intent of this chapter.

1. Required Showings for a Variance. Before any variance may be granted, it shall be shown:

a. That there are special circumstances applicable to the subject property or the intended use such as shape, topography, location or surroundings that do not apply generally to other properties and which support the granting of a variance from the minimum requirements; and

b. That such variance is necessary for the preservation and enjoyment of a substantial property right or use possessed by other similarly situated property but which, because of the ordinance codified in this chapter, is denied to the property in question; and

c. That the granting of such variance will not be materially detrimental to the public welfare.

2. Granting a Variance. When granting a variance, the examiner shall determine that the circumstances do exist as required by this section, and attach specific conditions to the variance which will serve to accomplish the standards, criteria and policies established by this chapter.

C. To apply for a variance, the applicant shall submit to the city a complete variance application. Such application shall include a site plan, pertinent information, a cover letter addressing the required showings for a variance and required fees.

Section 40. A new Section 18.08.206 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.206 Reasonable use exceptions.

If the application of this chapter would preclude all reasonable use of a site, development may be permitted, consistent with the general purposes and intent of this chapter.

A. Information Required. An application for a reasonable use exception shall be in writing to the department director and shall include the following information:

1. A description of the area of the site which is within a critical resource area or within the setbacks or buffers as required under this title;

2. The area of the site which is regulated under the respective setbacks (minimum yards) and maximum impervious coverage of the zoning code (GHMC Title 17);

3. An analysis of the impact that the amount of development proposed would have on the critical area as defined under this title;

4. An analysis of whether any other reasonable use with less impact on the critical area and buffer area, as required, is possible;

5. A design of the project as proposed as a reasonable use so that the development will have the least practicable impact on the critical area;

6. A description and analysis of the modification requested of the minimum requirements of this title to accommodate the proposed development;

7. Such other information as may be required by the department which is reasonable and necessary to evaluate the reasonable use respective to the proposed development.

B. Findings for Approval of Reasonable Use Exception. If an applicant successfully demonstrates that the requirements of this title would deny all reasonable use of a site, development may be permitted. The department director shall make written findings as follows:

1. There is no feasible alternative to the proposed development which has less impact on the critical area;

2. The proposed development does not present a threat to the public health, safety or welfare;

3. Any modification of the requirements of this title shall be the minimum necessary to allow for the reasonable use of the property;

4. The inability of the applicant to derive a reasonable use of the property is not the result of actions by the applicant which resulted in the creation of the undevelopable condition after the effective date of this title;

5. The proposal mitigates the impacts to the critical area to the maximum extent practicable, while maintaining the reasonable use of the site;

6. That all other provisions of this chapter apply excepting that which is the minimum necessary to allow for the reasonable use of the site or property. The director may impose any reasonable conditions on the granting of the reasonable use exception, consistent with the minimum requirements of this chapter.

C. Notification of Decision. A decision by the director under this section shall be provided, in writing, to the applicant and all property owners adjacent to or abutting the site. The applicant shall be responsible for providing a current listing of all adjacent property owners along with application for a reasonable use exception.

D. Appeal of Director's Decision. The decision of the director may be appealed in accordance with the procedures established under GHMC Title 19.

E. Limits of Applying Reasonable Use Exception. A reasonable use exception shall only be considered in those situations where a reasonable use would be prohibited under this title. An applicant who seeks an exception from the minimum requirements of this title shall request a variance under the provisions of this title.

F. Time Limitation. A reasonable use exception shall be valid for a period of two years, unless an extension is granted by the department at least 30 days prior to the expiration date. Any extension granted shall be on a one-time basis and shall be valid for a period not to exceed one year. The time limit is void if the applicant fails to procure the necessary development permit within the time allotted. The department may grant a time extension if:

1. Unforeseen circumstances or conditions necessitate the extension of the development exception; and

2. Termination of the development exception would result in unreasonable hardship to the applicant, and the applicant is not responsible for the delay; and

3. The extension of the development exception will not cause adverse impacts to environmentally sensitive areas.

Section 41. A new Section 18.08.208 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.208 Performance Bonding.

A. As part of the any mitigation plan the City shall require the applicant to post a performance bond or other security in a form and amount deemed acceptable by the City to ensure mitigation is fully functional.

1. A performance bond shall be in the amount of one hundred and twenty-five percent (125%) of the estimated cost of the uncompleted actions or the estimated cost of restoring the functions and values of the critical area that are at risk, whichever is greater.

2. The bond shall be in the form of a surety bond, performance bond, assignment of savings account, or an irrevocable letter of credit guaranteed by an acceptable financial institution with terms and conditions acceptable to the City attorney.

3. Bonds or other security authorized by this Section shall remain in effect until the City determines, in writing, that the standards bonded for have been met. Bonds or other security shall be held by the City for a minimum of five (5) years to ensure that the required mitigation has been fully implemented and demonstrated to function, and may be held for longer periods when necessary.

4. Depletion, failure, or collection of bond funds shall not discharge the obligation of an applicant or violator to complete required mitigation, maintenance, monitoring, or restoration.

5. Public development proposals shall be relieved from having to comply with the bonding requirements of this Section.

6. Any failure to satisfy critical area requirements established by law or condition including, but not limited to, the failure to provide a monitoring report within thirty (30) days after it is due or comply with other provisions of an approved mitigation plan shall constitute a default, and the City may demand payment of any financial guarantees or require other action authorized by the City code or any other law.

7. Any funds recovered pursuant to this Section shall be used to complete the required mitigation.

Section 42. Section 18.08.220 of the Gig Harbor Municipal Code is hereby repealed.

Section 43. A new Section 18.08.220 is hereby added to the Gig Harbor Municipal Code, which shall read as follows:

18.08.220 Penalties and enforcement.

A. The Community Development director shall have authority to enforce this chapter, any rule or regulation adopted, and any permit, order or approval issued pursuant to this chapter, against any violation or threatened violation thereof. The Community Development Director is authorized to issue violation notices and administrative orders, levy fines and/or institute legal actions in court. Recourse to any single remedy shall not preclude recourse to any of the other remedies. Each violation of this chapter, or any rule or regulation adopted, or any permit, permit condition, approval or order issued pursuant to this chapter, shall be a separate offense, and, in the case of a continuing violation, each day's continuance shall be deemed to be a separate and distinct offense. All costs, fees and expenses in connection with enforcement actions may be recovered as damages against the violator.

B. The Community Development Director may serve upon a person a cease and desist order if any activity being undertaken in a designated critical area or its buffer is in violation of this chapter. Whenever any person violates this chapter or any approval issued to implement this chapter, the Community Development Director may issue an order reasonably appropriate to cease such violation and to mitigate any environmental damage resulting therefrom.

C. Any person who undertakes any activity within a designated critical area or within a required buffer without first obtaining an approval required by this chapter, except as specifically exempted, or any person who violates one or more conditions of any approval required by this chapter or of any cease and desist order issued pursuant to this chapter shall incur a civil penalty as provided for in Chapter 17.07 GHMC.

D. The city's enforcement of this chapter shall proceed according to Chapter 17.07 GHMC.

Section 44. Section 18.08.230 of the Gig Harbor Municipal Code is hereby repealed.

Section 45. Section 18.08.260 of the Gig Harbor Municipal Code is hereby repealed.

Section 46. Transmittal to State. The City Community Development Director is directed to forward a copy of this Ordinance, together with all of the exhibits, to the Washington State Office of Community Development within ten days of adoption, pursuant to RCW 36.70A.106.

Section 47. Severability. If any section, sentence, clause or phrase of this Ordinance is held to be invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, clause or phrase of this Ordinance.

Section 48. Effective Date. This Ordinance shall take effect and be in full force five (5) days after passage and publication of an approved summary consisting of the title.

PASSED by the City Council and approved by the Mayor of the City of Gig Harbor this 27th day of March, 2006.

CITY OF GIG HARBOR

[signature]

STEVEN K. EKBERG, MAYOR PRO TEM

ATTEST/AUTHENTICATED:

By: Molly M Towslee

MOLLY TOWSLEE, City Clerk

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY

By: ______________________
CAROL A. MORRIS

FILED WITH THE CITY CLERK: 3/8/06
PASSED BY CITY COUNCIL: 3/27/06
PUBLISHED: 4/5/06
EFFECTIVE DATE: 4/10/06
ORDINANCE NO: 1036

Exhibit A
CITY OF GIG HARBOR 2006 CRITICAL AREAS UPDATE
Findings of Fact

The Growth Management Act requires the adoption of development regulations that protect critical areas designated in accordance with RCW 36.70A.170.

RCW 36.70A.172 requires local governments to include the best available science in developing policies and development regulations to protect the functions and values of critical areas and to give special consideration to the conservation and protection measures necessary to preserve or enhance anadromous fisheries.

Critical areas include wetlands, areas with a critical recharging effect on aquifers used for potable water, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat conservation areas.

The City of Gig Harbor hired the environmental consultants Adolfson Associates, Inc., and Associated Earth Sciences, Inc., to evaluate a wide range of sources of best science available with respect to the City's critical areas and to make recommendations that meet the intent of the Growth Management Act and are also reflective of local needs and conditions.

The review of applicable best available science and local conditions by Adolfson Associates, Inc. are documented in the following technical memoranda: *Gig Harbor Comprehensive Plan Update - Geologic and Flood Hazard Areas; Aquifer Recharge Areas – Phase I*, July 23, 2004 prepared by Associated Earth Sciences, Inc., included as Attachment 1, and *Final Best Available Science Technical Memorandum*, June 8, 2004 prepared by Adolfson Associates, Inc., included as Attachment 2. Best available science sources are listed in each memorandum.

Adolfson Associates, Inc., and Associated Earth Sciences, Inc., reviewed existing policies and development regulations with respect to best available science documentation and recommended amendments to city code and policies consistent with the documentation and the GMA. These recommendations were tailored to the local setting to recognize the urban character of Gig Harbor.

Proposed amendments to the policies of the Comprehensive Plan and the Gig Harbor Municipal Code based on the best available science documentation were reviewed by the Planning Commission at four study sessions on October 7, 2004, October 21, 2004, November 4, 2004, and November 18, 2004. The study sessions were advertised and open to the public. The Planning Commission held a public hearing on November 4, 2004, which was advertised in accordance with City notification requirements.

The Planning Commission recommended amendments to the Comprehensive Plan and Gig Harbor Municipal Code (GHMC) included departures from the best available science recommendations by Adolfson Associates, Inc. These departures include:

1. Amending the recommended minimum buffer width for Category III wetlands from 60 feet to 50 feet (draft Section 18.08.100 GHMC);
2. Amending the recommended minimum buffer width for Category IV wetlands from 35 feet to 25 feet (draft Section 18.08.100 GHMC);
3. Amending the recommended minimum wetland buffer requirements when buffer reductions are allowed from 70 percent to 55 percent of the standard width (draft Section 18.08.110 GHMC); and
4. Amending the recommended criteria for wetland buffer reductions to exclude from eligibility buffers that are degraded due to a documented code violation.

Departures 1 and 2 are supported in the Planning Commission record as being necessary to meet planned residential densities and achieve the growth projections for the City, i.e., balancing the requirements of the Growth Management Act. Potential impacts of Departures 1 and 2 are mitigated by a code provision to increase the buffer from the standard if necessary, based on best available science, to maintain viable populations of existing species; if endangered, threatened, sensitive or as documented priority species or habitats, or essential or outstanding habitat sites are present; or if required due to geotechnical considerations.

Adolfson Associates proposed new buffer reduction approval criteria that must be addressed in a buffer enhancement plan to offset potential adverse impacts of the buffer reduction allowance (Departure 3) recommended by the Planning Commission. Proposed approval criteria for wetland buffer reductions limit reductions to degraded buffers and include determinations of no harm to wildlife and property and enhancement of habitat, drainage and water quality.

Proposed amendment 4 increases regulatory restrictions and is not a departure from best available science.

The Gig Harbor City Council held a public hearing on the Planning Commission's recommended amendments to critical area policies and regulations on November 22, 2004 and December 13, 2004.

The City of Gig Harbor received comments from State Washington Department of Ecology (Ecology) in a letter from Ms. Gretchen Lux dated November 22, 2004 and February 1, 2005. Ecology commented on the proposed wetland rating system, exemption for small wetlands, and wetland buffers proposed. Adolfson Associates and City staff considered recommendations from Ecology and revised regulations to include the wetland rating system and narrower provisions for the exemption language for small wetlands.

On November 28, 2005 the Council held public hearing on the proposed Critical Areas Ordinance, and chose to remand the ordinance to the Planning Commission for additional public meetings.

At their regular meeting on January 23, 2006 the City Council moved the Critical Areas Ordinance be reviewed by the Community Development Committee. The Gig Harbor Community Development Committee held public meetings on February 7, 2006, and February 21, 2006 to address the Department of Ecology's (DOE) letters dated November 22, 2004 and February 1, 2005. The Committee requested staff find Best Available Science (BAS) to support the proposed amendments to the Critical Areas Ordinance. Staff reviewed the Department of Ecology's BAS (Wetlands in Washington State Volume 1 included as Attachment 4), and found that the wetland buffer widths and alteration recommendations of DOE reflected BAS. The Community Development Committee directed staff to modify the proposed amendments to the Critical Areas Ordinance to reflect the buffer widths and alteration recommendations of DOE.

Modifications include increased wetland buffer widths and reduced wetland buffer alterations to reflect Alternative 3 (Sections 8C.2.3, 8C.2.4, 8C.2.5 and 8C.2.6) of Appendix 8-C of Wetlands in Washington State Volume 2 (included as Attachment 5).

In addition, the City of Gig Harbor has adopted policies and codes in its Comprehensive Plan to protect the functions and values of critical areas. These are shown in Findings of Fact Attachment 3. In addition, critical areas may be protected by other actions of the City of Gig Harbor, such as stormwater management standards, critical area restoration, and public education; and from external regulations, such as the Forest Practices Act.

Attachment 1

Associated Earth Sciences, Inc.

July 23, 2004
Project No. KE04196A

RECEIVED
JUL 27 2004
AHBL, INC.

AHBL
2215 North 30th Street, Suite 300
Tacoma, Washington 98403

Attention: Mr. Mike Katterman, ACIP

Subject: Gig Harbor Comprehensive Plan Update
Geologic and Flood Hazard Areas; Aquifer Recharge Areas
Phase I

Dear Mr. Katterman:

Associated Earth Sciences Inc. (AESI) is pleased to present this letter providing the results of our Phase I assessment of the Gig Harbor Critical Areas Ordinance, in particular our preliminary review of the Geologic Hazard Areas, Flood Hazard Areas, and Aquifer Recharge Areas. This work has been performed in general accordance with AHBL's proposal to the City of Gig Harbor dated April 2, 2004. The purpose of the Phase I scope of work with respect to critical areas was: 1) review the literature on best available science (BAS) and existing inventory information relevant to Gig Harbor, and 2) review the Critical Areas Ordinances for consistency with BAS cited above.

Literature Inventory

The following documents were reviewed or citations noted as part of the Phase I scope of work:

1. *Model Critical Areas Regulations and Review Procedures (Draft)*, dated February 20, 2003 prepared by the Washington State Office of Community Development.

2. *Citations of Recommended Sources of Best Available Science For Designating and Protecting Critical Areas*, dated February 2002 prepared by the Washington State Office of Community Development.

3. *Guidance Document for the Establishment of Critical Aquifer Recharge Area Ordinances*, dated December 1998 prepared by the Washington State Department of Ecology.

4. Smith, Mackey, *Relative Slope Stability of Gig Harbor Peninsula, Pierce County, Washington*, Washington Division of Geology and Earth Resources Geologic Map GM-18 dated 1976.

5. *The Coastal Zone Atlas of Pierce County*, dated December 1979 prepared by the Washington State Department of Ecology.

6. *Water Resources and Geology or the Kitsap Peninsula and Certain Adjacent Lands*, Washington State Department of Conservation, Division of Water Resources, Water Supply Bulletin No. 18, Plate One dated 1962.

7. Pierce County Critical Area Maps Entitled, *Slope Stability, Aquifer Recharge Areas, Flood Hazard Areas, Steep Slopes, Landslide Hazard Areas, Landslide and Erosion Hazard Areas* and *Gig Harbor Community Plan Update, Land Use Designations* from the Pierce County Web Site Map Gallery.

8. *Soil Survey of Pierce County*, dated February 1979 prepared by the United States Department of Agriculture, Soil Conservation Service.

9. Shipman, Hugh, *Coastal Landsliding on Puget Sound: A Review of the Landslides Occurring Between 1996 and 1999*, dated 2001 prepared by the Washington State Department of Ecology, Report #01-06-019.

10. Thorsen, G.W., *Landslide Provinces in Washington*, 1989 in Engineering Geology in Washington prepared by the Washington Division of Geology and Earth Resources, Washington Department of Natural Resources.

Best Available Science Inventory

The City of Gig Harbor has developed their own critical areas regulations in the Gig Harbor Municipal Code (GHMC Chapter 18.12) but relies on the Pierce County critical area maps to identify their known critical areas. These maps and the sources used to produce these Pierce County maps were reviewed and compared to the BAS inventory listed in the *Literature Inventory* section presented above.

- Landslide and Erosion Hazard Areas

The sources for the Pierce County *Slope Stability, Landslide and Erosion Hazard Areas, Landslide Hazard Areas and Steep Slopes* maps are listed as the following publications:

1. Washington State Department of Ecology Coastal Zone Atlas, 1979
2. Soil Survey of Pierce County, 1979
3. Pierce County Digital Orthophotography, 2001

The various Pierce County maps that deal with slope stability and landslide hazards do not always agree on where the critical areas in Gig Harbor are located. These maps rely largely upon the Coastal Zone Atlas that does a good job of mapping landslide or unstable areas on the coast but does not provide maps for inland areas. Another problem with the Pierce County maps is that they are at such a large scale that it is difficult to locate a particular site or address to determine if the site is in a critical area. Also Pierce County does not provide a map that shows the areas classified as hillsides, ravine sidewalls and bluffs (GHMC Chapter 18.12.050) which is peculiar to the GHMC.

We proposed four action items for updating the landslide and erosion hazard area maps and for creating a hillside, ravine sidewalls and bluffs map.

a) Compare all the various Pierce County maps dealing with landslide hazards and compose a composite map for Gig Harbor that clearly shows the known hazard areas.

b) Review document number 4 in the literature inventory list and add that information into the updated map.

c) Produce the updated map at a smaller scale that does not extend much beyond the city limits and that shows streets and other landmarks so that properties can be easily located by the public.

d) Use existing topography maps to prepare a hillside, ravine sidewall and bluff critical area map at a useable scale with streets and known landmarks.

- Flood Hazard Areas

Flood Hazard Areas are defined in Chapter 18.12.080 of the GHMC and are based on the Federal Emergency Management Administration (FEMA) flood insurance rate maps. The Pierce County Flood Hazard Area Map is also based on this same source, which is the predominant document for identifying flood hazard areas and represents the BAS in this area. Like the landslide hazard maps, the flood hazard map for Pierce County is at too large a scale to be useful to the public.

We proposed two action items for updating the flood hazard area maps for the City of Gig Harbor:

a) Review the recent FEMA database to confirm that the flood maps have not changed since the Pierce County maps were produced.

b) AESI should be provided a copy of the report entitled "The Flood Insurance Study for the City of Gig Harbor" dated March 22, 1981 and the accompanying flood insurance maps for our review.

c) Produce an updated map at a smaller scale that does not extend much beyond the city limits and that shows streets and other landmarks so that properties can be easily located by the public.

- Aquifer Recharge Areas

The aquifer recharge areas of Pierce County in the vicinity of Gig Harbor are based on the DRASTIC model and on the wellhead protection source area reference on file with the Tacoma-Pierce County Health Department. The DRASTIC model is a computer model produced by the United States Environmental Protection Agency (EPA) to identify areas of ground water recharge that are susceptible to contamination. From review of the Pierce County Aquifer Recharge Area Map, it appears that most of the aquifer recharge areas identified in the vicinity of Gig Harbor are based on wellhead protection zones. This conclusion is based on the circular shapes of the aquifer recharge areas that are typical for a wellhead protection area based on a standard fixed radius analysis.

We proposed two action items for updating the flood hazard area maps for the City of Gig Harbor:

a) Review published geologic maps that include Gig Harbor to determine if other areas within the city should be protected based on geologic and hyrogeologic factors other than protecting domestic water supply wells.

b) Produce an updated map at a smaller scale that does not extend much beyond the city limits and that shows streets and other landmarks so that properties can be easily located by the public.

Critical Areas Ordinance Review

AESI reviewed the GHMC Chapter 18.12, Sections 18.12.010 through 18.12.180 and Chapter 15.04, Sections 15.04.010 through 15.04.090. In general the ordinance appears to be fairly complete. Based on our review, we have the following comments:

1. Section 18.12.050A1(a): We recommend that the section on buffers be changed to read as follows: "Buffers. A 50-foot undisturbed buffer of natural vegetation shall be established and maintained from the top, toe and sides of all ravine sidewalls and bluffs <u>50 feet high or less</u>. <u>For ravine sidewalls and bluffs greater than 50 feet high, the width of the buffer shall be equal to the height of the ravine sidewalls or bluffs.</u> All buffers shall be measured on a horizontal plane."

2. Section 18.12.050A2(a): We recommend that a geologist or engineering geologist licensed in the State of Washington be added to the list of professionals able to prepare the site analysis reports.

3. Section 18.12.060A: We recommend that the section be changed to read as follows: "...shall be accompanied by a geotechnical report prepared by a geologist or engineering geologist licensed in the State of Washington or a geotechnical engineer licensed as a civil engineer in the State of Washington. If it . ."

4. Section 18.12.100A: This section may be revised depending upon the results of the BAS review recommended above.

5. Section 15.04.090: We recommend this section be revised to read: "... a further review must be made by persons licensed as a geologist, engineering geologist or geotechnical engineer in the State of Washington; and the proposed new ...".

We appreciate the opportunity to be of service to you on this project. Should you have any questions regarding this letter, please call us at your earliest convenience.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

704
Jon N. Sondergaard
3/22/04

Jon N. Sondergaard, P.G., P.E.G.
Senior Associate Geologist

JNS/sa
KE04196A1
Projects\20041196\KE\WP - W2K

Attachment 2

MEMORANDUM

DATE: June 8, 2004

TO: Mike Katterman, AHBL Inc.

FROM: Teresa Vanderburg, Ilon Logan

CC: Kent Hale

RE: Final Best Available Science Technical Memorandum

Environmental Solutions

1.0 INTRODUCTION

1.1 Project Authorization

On behalf of the City of Gig Harbor, Adolfson Associates, Inc. (Adolfson) has prepared this technical memo to provide a brief overview of the "best available science" pertaining to management of critical areas and its application to urban environments such as those found in the City of Gig Harbor (the City). This paper will provide guidance to the City in development and revision of the Gig Harbor Municipal Code (GHMC) Title 18 Environment regarding streams, wetlands, and critical fish and wildlife habitat areas (City of Gig Harbor, 2001a). Shorelines of the state are described separately in another document prepared for the City, the *City of Gig Harbor Draft Shoreline Characterization* (Adolfson, 2003).

Rules promulgated under the 1990 Washington State's Growth Management Act (GMA) (RCW 360.70A.060) required counties and cities to adopt development regulations that protect the functions and values of critical areas, including streams, wetlands, wildlife habitat, and critical aquifer recharge areas. In 1995, the Washington State legislature added a new section to the GMA to ensure that counties and cities consider reliable scientific information when adopting policies and development regulations to designate and protect critical areas. As a result of this legislation, in 2000 the Growth Management Division of Washington's Office of Community Development (OCD) adopted procedural criteria to guide cities and counties in identifying and including the "best available science" (BAS) in their critical area policies and regulations in accordance with RCW 36.70A.172(1).

This paper discusses the results of a limited BAS review for streams, wetlands, and critical fish and wildlife habitat areas and evaluates the applicability of the science to these critical areas in the City. The information is a summary of existing literature and is not intended to be an exclusive list of all BAS currently published, but is intended to provide a brief overview of published information useful for local planning and regulatory review. Adolfson has based our review of the City environment on existing literature, and preliminary information from the City. No field investigations were conducted as part of this review. At the City's direction, Adolfson has limited its effort in this phase of the critical areas ordinance update to conserve funds for the second phase involving the revisions to the regulations.

1.2 Overview of the City Environment

The City of Gig Harbor is an urbanizing city located on the Gig Harbor Peninsula at the southern end of Puget Sound in Pierce County, Washington. The City encompasses an area of approximately four square miles and has an estimated population of 6,575 (as of August 2000). An additional five square miles of unincorporated land lies within the City's urban growth area (UGA). The City is bordered by Henderson Bay to the northwest, unincorporated Pierce County to the west, south and north, and Puget Sound to the east.

2.0 STATE OF THE SCIENCE FOR STREAMS AND RIPARIAN BUFFERS

2.1 Functions and Values of Streams

The important functions provided by streams include: maintaining stream baseflows; maintaining water quality; providing in-stream structural diversity; and providing biotic input of insects and organic matter. Stream baseflows are maintained by surface water that flows into riparian areas during floods or as direct precipitation and infiltrates into groundwater in riparian areas to be stored for later discharge to the stream (Ecology, 2001a) particularly during the region's typically dry season (Booth, 2000; May et al., 1997a). Urbanization changes the volume, rate, and timing of surface water flowing through stream systems, which can impact the physical characteristics of the stream channel (Booth, 1991). In addition, several studies have found that stream degradation has been associated with the quantity of impervious surface in a basin (Booth, 2000; May et al., 1997a; May et al. 1997b; Horner and May, 2000).

Low stream temperature and high water quality are critical elements of essential habitat for all native salmonid fish. Riparian vegetation, particularly forested riparian areas, can affect water temperature by providing shade to reduce solar exposure and regulate high ambient air temperatures, ameliorating water temperature increases (Brazier and Brown, 1973; Corbett and Lynch, 1985). Dissolved oxygen is one of the most influential water quality parameters for stream biota, including salmonid fish (Lamb, 1985). The most significant factor affecting dissolved oxygen levels in most streams is temperature, with cooler waters maintaining higher levels of oxygen than warmer waters (Lamb, 1985). Common pollutants in urban areas that affect water quality include nutrients such as phosphorus and nitrogen, pesticides, bacteria, and miscellaneous contaminants such as PCBs and heavy metals. In general, concentrations of pollutants increase in direct proportion to total impervious area (May, et al., 1997a).

Substrate quality, pool quality and quantity, and floodplain connectivity and off-channel refugia are general habitat elements that support many species of salmonid fish. The National Marine Fisheries Service (NMFS, 1996) and U.S. Fish and Wildlife Service (USFWS, 1998) have developed guidelines to address physical habitat elements necessary to support healthy salmonid populations under variable conditions. Most of the research has been done in rural environments; however, these represent the BAS for urban environments at this time.

Riparian areas provide food for salmonids, both directly and indirectly through biotic input (Meehan et al., 1977). Many species of aquatic invertebrates have become adapted to feed on dead and decomposing organic material that has fallen or washed into the stream from adjacent uplands (Benfield and Webster, 1985). Most juvenile salmonids that rear in streams prey on terrestrial insects that fall into streams from overhanging vegetation or aquatic invertebrates (Horner and May, 1999; May et al., 1997a). Undisturbed riparian areas can retain sediments, nutrients, pesticides, pathogens, and other pollutants that may be present in stormwater runoff, protecting water quality in streams (Ecology, 2001a).

2.2 Function and Values of Riparian Buffers

Riparian buffers along stream banks help mitigate the impacts of urbanization and disturbance on adjacent lands (Finkenbine et al., 2000 in Bolton and Shellberg, 2001). Knutson and Naef (1997) summarize many of the functions of riparian buffers for Washington. The Washington Department of Fish and Wildlife's (WDFW) recommended standard buffer widths for the state's five-tier stream typing system are based on this latter research (OCD, 2002). Table 1 identifies the ranges for recommended buffer widths from two of the papers used in the development of the WDFW recommended buffers. Buffer widths reported to be effective for riparian functions vary considerably; the literature is not definitive in identifying one buffer width for each function studied (Williams and Lavey, 1986; Johnson and Ryba, 1992).

Table 1. Range of Effective Buffer Widths Based on Scientific Literature

Function	Riparian Buffer Functions and Appropriate Widths Identified by May (2000)	Riparian Buffer Functions and Appropriate Widths Identified by Knudson and Naef (1997)
Sediment Removal/Erosion Control	26 - 600 feet	N/A
Sediment Removal	N/A	26 - 300 feet
Erosion Control	N/A	100 - 125 feet
Pollutant Removal	13 - 860 feet	13 - 600 feet
Large Woody Debris	33 - 328 feet	100 - 200 feet
Water Temperature	36 - 141 feet	35 - 151 feet
Wildlife Habitat	33 - 656 feet	25 - 984 feet

A general relationship between buffer width and buffer effectiveness is apparent in the research findings. Studies indicate that buffers 100-to 150-feet (30 to 45 meters) wide provide most (on the order of 80 percent) of the potential functions (Horner and May, 2000; Knutson and Naef, 1997; and Leavitt, 1998).

2.3 Stream Management in Urban Environments

Two recent studies have focused on the general effects of urbanization on streams in the lowland Puget Sound region; Booth, 2000, and Horner and May, 1999. In these studies, a general trend has emerged that places a greater emphasis on evaluation of buffer effectiveness in the context of other watersheds and evaluation of landscape-level alterations to watersheds (Roni et al., 2002; Richards et al., 1996). For example, restoration of the natural woody debris recruitment function of riparian areas is difficult in areas that lack mature forested streamside vegetation (Larson, 2000). Booth, 2000 and Horner and May, 1999 recommend that new watershed-based strategies may need to be implemented that would address hydrology, water quality, and riparian functions to successfully address management of buffer width and quality, land use controls, and stormwater management. When applied in the context of a basin-wide change, these strategies may most effectively address protection, enhancement, and restoration of stream systems as opposed to prescriptive buffers. In terms of fish habitat restoration, barriers like lengthy and/or inappropriately installed culverts and stormwater control structures can inhibit fish migration and prohibit fish from accessing upstream habitats. Restoring fish passage is an effective way to increase the quality and accessibility of habitat and can result in relatively large increases in potential fish production at a nominal cost (Roni et al., 2002).

2.4 Fisheries Habitat and Salmonid Use in the City of Gig Harbor

2.4.1 Streams in the City of Gig Harbor

The City of Gig Harbor can be divided into six drainage basins: North/Donkey Creek, Gig Harbor, Bitter/Garr/Wollochet Creek, Gooch/McCormick Creek, Crescent Creek, and Puget Sound. The City's *Stormwater Comprehensive Plan* (2001b) describes the major streams found in these drainage basins and provides an assessment of their functions. The major streams include: Crescent Creek, North/Donkey Creek, Gooch Creek, McCormick Creek, Bitter Creek, and Garr Creek. All the creeks eventually discharge into Puget Sound. There is generally less than three miles to their headwaters with steep descents over short distances (City of Gig Harbor, 2001b).

None of the streams in the City of Gig Harbor are currently listed on the Washington State Department of Ecology's (Ecology) 1998 303(d) list, which lists streams that do not meet water quality standards for one or more parameters (Ecology website, 2004). Water quality sampling in the Key Peninsula/Gig Harbor/Island (KGI) watersheds has been undertaken by Stream Team volunteers and by URS Corporation technicians on behalf of Pierce County Water Programs (KGI Watershed Interim Council, 2001). Samples were taken on June 1, 2000 and July 31, 2001. Fecal coliform bacteria levels in Crescent Creek were found to be in excess of the state water quality standard of 100 cfu/100ml. Nitrate levels in Goodnough Creek were slightly elevated, with levels ranging between 1.7 and 1.86 mg/L, and likely indicate the presence of nutrients or fertilizers in the system (KGI Watershed Interim Council, 2001). Potential water quality hazards exist at marinas and boat moorage facilities due to fuel spills, increased nutrients from sewage pump-out activities, increased presence of pollutants due to hull scraping and use of anti-fouling paint on boat hulls, and high concentrations of creosote-treated wood pilings and structures.

The primary marine waters along the UGA boundary are Gig Harbor, Henderson Bay, Colvos Passage, and the Puget Sound Narrows. Burley Lagoon, a saltwater lagoon, is adjacent to Henderson Bay on Puget Sound.

2.4.2 Salmonid Fish Use in Gig Harbor

The *Salmonid habitat limiting factors: Water Resources Inventory Area (WRIA) 15 (East) Final Report* identifies the known presence of salmon in streams in the City of Gig Harbor (Haring, 2000). Chinook salmon (*Oncorhynchus tshawytscha*), listed as threatened under the ESA, are present in Crescent, Purdy, and McCormick Creeks. Chinook presence in these listed drainages are likely strays from other basins (Haring, 2000). Crescent Creek contained a historic wild run of Chinook, which ended in the 1940's (Williams et al., 1975). Chinook are still observed in Crescent Creek and are likely returns from annual plantings (Haring, 2000). Steelhead trout (*O. mykiss*) are present in Crescent, McCormick, Purdy, and Donkey Creeks. Coho (*O. kisutch*) may be found in Purdy, McCormick, Crescent, and Donkey Creeks. Chum salmon (*O.* keta) are present in Purdy, Crescent, Donkey, and McCormick Creeks. Cutthroat trout (*Salmo clarki*) are ubiquitous throughout the watershed and are believed to be present in most streams (Haring, 2000). Gig Harbor Bay and Henderson Bay provide habitat for rearing and outmigration (WDFW, 2003). Nearshore habitat is important environment for juvenile salmonids, where the shallow water depth obstructs the presence of larger, predator species (City of Gig Harbor, 2001b).

Potential forage fish spawning areas within the City are referenced in three sources: Marine Resource Species (MRS) data maintained by WDFW (2003), the *Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment* (Pentec Environmental, 2003), and the *Final Report: Northwest Straits Nearshore Habitat Evaluation* (Anchor Environmental and People for Puget Sound, 2002). The three forage fish species most likely to occur include surf smelt, sand lance, and Pacific herring. The different species utilize different parts of the intertidal and subtidal zones, with sand lance and surf smelt spawning primarily in the substrate of the upper intertidal zone, and Pacific herring spawning primarily on intertidal or subtidal vegetation (Anchor Environmental and People for Puget Sound, 2002). These three species account for over 50 percent of the diet of adult salmonids. Information on the three potential forage fish species within the City's jurisdiction is summarized in the *City of Gig Harbor Draft Shoreline Characterization* (Adolfson, 2003).

3.0 STATE OF THE SCIENCE FOR WETLANDS AND WETLAND BUFFERS

While estuarine and tidal habitats are considered wetlands, they fall under the jurisdiction of the Shoreline Management Act (SMA) and will be addressed under the SMA and not in this report. The *City of Gig Harbor Draft Shoreline Characterization* (Adolfson, 2003) provides information regarding estuarine and tidal wetlands in the City of Gig Harbor. This memorandum also

includes review of the Washington State Department of Ecology's draft review document summarizing best available science for freshwater wetlands (*Freshwater Wetlands in Washington State Volume 1: A Synthesis of the Science*) prepared by Sheldon et al., 2003.

3.1 Wetland Definition

Wetlands are formally defined by the Corps of Engineers (Corps) (Federal Register, 1982), the Environmental Protection Agency (EPA) (Federal Register, 1988), the Washington Shoreline Management Act (SMA) of 1971 (Ecology, 1991) and the Washington State Growth Management Act (GMA) (Ecology, 1992) as "... 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, marshes, bogs, and similar areas" (Federal Register, 1982, 1986). The City of Gig Harbor Muncipal Code also defines wetlands as described above (City of Gig Harbor, 2001a).

3.2 Wetland Functions and Values

Wetlands are integral parts of the natural landscape. Their "functions and values" to both the environment and to the general public depend on several elements including their size and location within a basin, as well as their diversity and quality. The functions provided by wetlands and their assigned human-based values have been identified and evaluated through several studies (Cowardin et al., 1979; Adamus et al., 1987; Mitsch and Gosselink, 2000; Reppert et al., 1979; Cooke, 2000). These functions include; flood water attenuation and flood peak desynchronization, stream base flow maintenance and groundwater support, shoreline protection, water quality improvement, biological support and wildlife habitat, and recreation, education, and open space.

Flood water attenuation and flood peak desynchronization can be aided by a wetlands ability to control flood water and stormwater flow and to slowly release it to adjacent water bodies and/or groundwater (Verry and Boelter, 1979 *in* Mitsch and Gosselink, 2000). A wetlands effectiveness in controlling flood waters is based on factors such as the storage capacity and outlet discharge capacity of the wetland relative to the magnitude of stormwater inflow (Reinelt and Horner, 1991). The loss of wetlands in urban areas affects the ability of the remaining wetland systems to function in attenuating stormwater runoff, resulting in increased flood frequency and higher peak flood flows in drainage basins (Azous and Horner, 2001; Mitsch and Gosselink, 2000; Booth, 2000). In addition, increasingly higher storm flows in urbanized basins, relative to undisturbed watersheds, can result in sediment loading of streams and destruction of habitat for fish and other aquatic organisms (Richter and Azous, 2001, Azous and Horner, 2001).

Maintaining stream flow is an important function of freshwater wetlands to stream-flow-sensitive salmonids in the Pacific Northwest. Wetlands provide baseflow during the region's typically dry season (Booth, 2000; May et al., 1997a; Mitsch and Gosselink, 2000). Many studies have found that wetland loss, reduction, and vegetation alteration reduce most wetlands' capacity to provide baseflow support to streams (Booth, 2000; Mitsch and Gosselink, 2000; Brinson, 1993).

Wetlands adjacent to waterbodies serve to provide protection for the shoreline of that stream, river, or lake. Wetlands in basins that have relatively undeveloped shorelines and stream banks that contain dense woody vegetation along the Ordinary High Water Mark (OHWM) of a lake or stream and extend more than 200 to 600 feet from the OHWM provide the highest level of shoreline protection and erosion control. Wetlands that extend less than 200 feet provide less protection (Hruby et al., 1999; Cooke, 2000).

Removal of sediment and pollutants from stormwater are important water quality functions of wetlands (Mitsch and Gosselink, 2000; Cooke, 2000). A wetland's ability to perform water quality improvements can depend on a wetland's size, location within the basin, vegetation community structure, and productivity (Ecology, 1996).

Wetlands provide opportunities for foraging wildlife and for organisms that depend on detritus and/or organic debris for a food source (Erwin, 1990). Wetland habitats generally provide greater structural and plant diversity, more edge habitat where two or more habitat types adjoin, more varied forage, and a predictable water source that increases wildlife species abundance and diversity than upland habitats (Kauffman, et al., 2001).

In urbanizing areas, aquatic resources and adjacent uplands provide opportunities for greenways and open space. In Gig Harbor, wetlands and adjacent uplands provide important resources for wildlife viewing, passive recreation, and education about natural wetland-upland ecosystems. The *City of Gig Harbor Park, Recreation, and Open Space Plan* (City of Gig Harbor, 2001c) provides a thorough inventory of existing parks and opportunities.

3.3 Wetland Functional Assessment Methods

As described above, the functions provided by wetlands and their assigned human-based values have been identified and evaluated through many scientific studies (Cowardin et al., 1979; Adamus et al., 1987; Mitsch and Gosselink, 2000; Reppert et al., 1979; Cooke, 2000). Several functional assessment methods have been developed to identify functions performed in a wetland and evaluate the effectiveness of the wetland in performing that function. Some methods are quantitative, while others are qualitative.

Quantitative assessment methods include the US Army Corps of Engineers Hydrogeomorphic Method (HGM). HGM is based on the concept that wetland functions are driven primarily by the wetland's geomorphology (i.e., position in the landscape) and hydrologic characteristics (Brinson, 1993). In 1996, Ecology began the Washington State Wetland Function Assessment Method (WFAM) project. This functional assessment method, which was published in 1999, is a modified version of the HGM approach and is designed to provide a more scientific approach to assessing wetland functions (Hruby et al, 1999). The Washington Department of Transportation (WDOT) developed another method for rapid wetland assessments for linear projects (Null et al., 2000). Both the WFAM and the WDOT methods are cited in the OCD citations for best available science (OCD, 2002). The WDOT method is considered a qualitative method.

3.4 Wetland Rating System

In the State of Washington, Ecology has developed a wetland rating system for ranking wetlands according relative importance. This rating system is outlined in the *Washington State Wetland*

Rating System for Western Washington (Ecology 1993). Wetlands in this system are rated into four distinct categories; from Category I wetlands of highest value to Category IV wetlands of lowest value. Category I and IV wetlands are defined specifically in the rating system and Category II and III wetlands are determined by the summarized results of a rating form. The rating form uses semi-quantitative criteria such as size, level of disturbance, habitat diversity, connectivity to streams or other habitats, and buffer quality to classify wetlands. Ecology has recently released a draft of an updated wetland rating system for western Washington, which is based upon hydro-geomorphic (HGM) features (Hruby, 2004). The new wetland rating system is currently in public review.

3.5 Functions and Values of Wetland Buffers

Wetland buffers are vegetated upland areas immediately adjacent to wetlands. A scientific literature review indicates that buffer widths to protect a given habitat function or group of functions depend on numerous site-specific factors (Castelle et al., 1992a; Castelle and Johnson, 2000; FEMAT, 1993). These factors include the plant community (species, density, and age), aspect, slope, and soil type, as well as adjacent land use. Several literature reviews have been published summarizing the effectiveness of various buffer widths, mainly for riparian areas, but also for wetlands (Castelle et al., 1992a; Castelle and Johnson, 2000). Generally, the riparian buffer literature also applies to wetlands because very similar functions are provided by riparian buffers and wetland buffers. McMillan (2000) provides a recent literature review specific to wetland buffers in western Washington and evaluates land use intensity as well as wetland value when determining buffer widths.

Several studies indicate that buffers ranging from 100 to 150 feet wide provide most (on the order of 80 percent) of potential functions in most situations. In these studies, the relationship between buffer width and effectiveness is logarithmic, so that after a certain width an incremental increase in buffer width provides diminishing functional effectiveness. One study indicates that 90 percent of sediment removal can be accomplished within the first 100 feet of a riparian buffer, but an additional 80 feet of buffer is needed to remove just five percent more sediment (Wong and McCuen, 1982). However, other studies show that wildlife responses to human disturbance are varied and a buffer of 50 to 150 feet may not provide enough separation or protection (Knutson and Naef, 1997). Rather, wildlife use of wetland and riparian buffers is highly dependent upon the species and site-specific characteristics (i.e., type of wetland, geographic setting, etc.). A buffer of 200 or 300 feet or more from the aquatic resource has been documented as more appropriate for some species.

3.5.1 Wetland Mitigation & Enhancement Strategies

The Clean Water Act Section 404(b)(1) Guidelines for wetland mitigation require "no net loss" of wetlands by first avoiding, minimizing, rectifying, and reducing impacts to wetlands and their functions. Where loss of wetland acreage and/or functions is necessary, replacement or compensatory mitigation should be required. In compliance with GMA, the majority of local jurisdictions in Washington implement these guidelines through local critical area regulations.

Off-site and out-of-kind wetland mitigation has also been allowed by agencies in certain cases. The U.S. Army Corps of Engineers (Corps) and other agencies have allowed off-site mitigation of wetlands, and there has been growing interest in mitigation banks in Washington. Mitigation banking may give developers additional options for mitigation and banking also allows creation or preservation of larger and higher quality wetlands than might have been established on any one development site. The *Critical Areas Assistance Handbook* also includes mitigation banking as an allowed type of mitigation (CTED, 2003).

3.5.2 Wetland and Buffer Mitigation Success

Most wetland mitigation projects in Washington have not been successful for various reasons and have resulted in lost acreage, wetland types, and wetland functions (Castelle et al., 1992b; Ecology, 2001b; Mockler et al., 1998). An initial study by Ecology (Castelle et al., 1992b) reported that 50 percent or more of the mitigation projects studied did not meet permit requirements.

Twenty four mitigation sites in Washington were analyzed by Ecology (2001b) and found that although mitigation success has improved in the last 10 years, there is still much room for improvement. The Ecology study had the following major findings:

- 29 percent of the projects were achieving all of their specified measures;
- 54 percent of the projects were found to be minimally successful or not successful;
- Wetland enhancement as a type of mitigation performed poorly, compared to creation (50 percent of enhancement sites provided minimal or no contribution to overall wetland functions; 75 percent of sites provided minimal or no contribution to general habitat function); and
- 60 percent of created wetlands were moderately or fully successful and provided significant contribution to water quality and quantity functions.

3.5.3 Mitigation Ratios

Generally, wetland mitigation is implemented over a larger area than the wetland area adversely affected by a proposed project. Several authors and agencies have recommended various replacement ratios (Castelle et al., 1992b; CTED, 2003). Studies of the success of wetland mitigation projects suggest that replacement ratios based on mitigation success could be between 1:1.25 and 3:1 to replace lost wetland function and value. Mitigation ratios for wetlands in most local jurisdictions in western Washington currently range between 1:1 and 4:1. However, more information is needed to understand whether lost wetland functions and acreage can be entirely compensated.

The State of Washington Department of Community, Trade and Economic Development (CTED) *Critical Areas Assistance Handbook* (2003) recommends the following wetland mitigation ratios by classification of wetland:

- Category I wetlands - 6:1
- Category II wetlands - 3:1

- Category III wetlands - 2:1
- Category IV wetlands - 1.5:1

Larger replacement ratios are used to offset temporal losses of habitat and to ensure no net loss of wetlands. However, wetland mitigation ratios greater than 3:1 are based in part upon policy decisions to provide a disincentive to developers for impact of wetlands.

3.6 Wetlands and Wetland Buffers in the City of Gig Harbor

The *City of Gig Harbor Comprehensive Plan* (City of Gig Harbor, 1994) includes a map showing wetland areas in the City and UGA, based on a *City of Gig Harbor Wetlands Inventory and Report* completed in May 1992 (IES Associates, 1992). The May 1992 report included wetlands data provided by Pierce County GIS mapping and information gathered during field visits. The May 1992 Inventory was not available to Adolfson during preparation of this paper.

Wetlands in the City include tidal and non-tidal wetlands. Based upon the GIS information and other existing resources, it appears that scattered non-tidal wetlands within the City boundaries are mostly associated with Donkey and Crescent Creeks and their tributaries. Within the UGA, several wetlands occur on the plateau west of the City between Gig Harbor itself and Wollochet Bay. Non-tidal wetlands found in the City are characterized in the *City of Gig Harbor Park, Recreation, and Open Space Plan* (City of Gig Harbor, 2001c) and tidal wetlands, including salt and freshwater habitats, are described in the *City of Gig Harbor Draft Shoreline Characterization* (Adolfson, 2003).

4.0 STATE OF THE SCIENCE FOR CRITICAL FISH AND WILDLIFE HABITAT AREAS

4.1 Wildlife habitat types

Johnson and O'Neil (2001) provides the most up-to-date description of wildlife habitats in western Washington. The WDFW and the Northwest Habitat Institute developed this habitat typing methodology with input from a panel of regional wildlife experts and with information collected from more than 12,000 pertinent publications. Using this methodology, habitats can be assessed at three levels of detail: wildlife habitat types, structural conditions, and habitat elements. The term "wildlife habitat type" as referred to in Johnson and O'Neil (2001) generally describes vegetation cover types or land use/land cover types. Geographic distribution and physical setting (including climate, elevation, soils, hydrology, geology, and topography) and human activities (such as agriculture and urban development) influence vegetation cover and land use patterns. Wildlife species abundance and distribution are directly related to wildlife habitat types.

The WDFW has published management recommendations for Washington's priority habitats and species (Rodrick and Milner, eds., 1991). Specific documents addressing birds, reptiles and amphibians, invertebrates, riparian areas, and Oregon white oak woodlands have also been published by WDFW since 1991. These documents summarize the most up-to-date life history information for certain priority species and current research on priority habitats.

4.2 Wildlife habitat types and species commonly present in the City Gig Harbor

The City of Gig Harbor contains several habitat types due to the presence of marine, estuarine, freshwater, and terrestrial zones. These habitats are described in detail in the City's *Park, Recreation, and Open Space Plan* (City of Gig Harbor, 2001c).

The City provides habitat for many common wildlife species found in the Pacific Northwest. The *City of Gig Harbor Draft Shoreline Characterization* (Adolfson, 2003) and the City's *Park, Recreation, and Open Space Plan* (City of Gig Harbor, 2001c) contain discussions of species documented in the City.

Urban areas within Gig Harbor tend to support more "generalist" species and are more prone to invasion by non-native, invasive plant and animal species due to the high level of disturbance to soil and vegetation in agricultural and urban habitats (Ferguson et al., 2001). Generalist species can use a variety of vegetation cover types for breeding and foraging and include both native and non-native species tolerant of human disturbance. In contrast, many "specialist" species require specific habitat characteristics that are either limited or no longer present in developed landscapes. While Gig Harbor's urban character limits habitat for a number of specialist species, the City does provide habitat for several "special status" species. The potential effects of urban development on these "special status" species in Gig Harbor and management considerations for these species are discussed below.

4.3 Special Status Species

Special status species include species designated by federal government agencies (USFWS and NMFS) as endangered, threatened, proposed, and candidate, and species designated by WDFW as endangered or threatened. Like all wildlife species, each of the special status wildlife species identified in the City of Gig Harbor requires adequate forage, water, structure, and space for breeding/nesting, roosting, and cover. Their ability to survive in the remaining fragmented habitat areas in Gig Harbor depends on the presence of and their specific requirements for forage, water, and structure.

Correspondence received from the USFWS noted the presence of five bald eagle nesting territories in the vicinity of the City of Gig Harbor and that wintering bald eagles may also occur along the City's shoreline (USFWS, 2003). Other listed species that may occur in the vicinity include bull trout and marbled murrelet. No proposed or candidate species were identified by the USFWS and no species of concern have been documented within a one-mile radius of the City.

The regular nesting and roosting sites of special status species are considered priority habitat by the WDFW, and the agency has published recommendations for managing breeding and foraging habitats for these species (Rodrick and Milner, 1991). A bald eagle protection ordinance is outlined in WAC 232-12-292 and Watson and Rodrick (2002) provides management recommendations. Bald eagle nesting sites have been identified on priority habitats and species (PHS) maps (WDFW, 2003). Great blue heron and osprey, both state monitor species, are indicated as nesting and feeding in the City. Purple martin (state candidate) also have documented nesting occurrence in the City (WDFW, 2003).

4.4 Habitat Linkages, Isolation, and Fragmentation

Wildlife habitat linkages are typically linear strips of habitat that connect larger habitats, such as lowland forest or riparian areas. These bands of habitat provide enough food, structure, and water for some wildlife species to live in the linkage area, while others use these areas to move from one habitat area to another. Linkages that connect larger tracts of more diverse habitat are especially important in urban areas where habitats are fragmented and isolated by development and roads (Adams, 1994). Habitat linkages in urbanizing areas generally consist of riparian areas and forested steep slopes that provide habitat for species moving between foraging areas, breeding areas, and seasonal ranges, and which can provide habitat for the dispersal of young animals (Knutson and Naef, 1997). The potential and existing habitat linkages also encompass public lands, such as parks, open space, and trail corridors. Major roads and urban development, however, interrupt even the most substantial (widest) habitat linkages in Gig Harbor. Roads can be partial or complete barriers to terrestrial wildlife movement, especially to slow moving species such as turtles and salamanders (Ferguson et al., 2001).

Primary habitat linkages in Gig Harbor include riparian corridors along Donkey Creek and its tributaries and along Crescent Creek. The steep forested slopes along the Narrows and Colvos Passage provide habitat and in some places connect with inland forest patches. Additional linkage areas connecting smaller habitat tracts include the scattered forested areas and wetlands throughout the UGA.

4.5 Wildlife Habitat Protection and Restoration Strategies

Protecting the highest quality habitats in Gig Harbor may be an effective strategy for protecting wildlife habitat. In addition, protection of the remaining patches of lowland conifer forest in the City would preserve some of the remaining upland habitat and existing habitat linkages. Protection efforts can be focused on protecting intact, native forest habitats because these habitats are not easily replaced.

Changes to forest structure drive the composition of wildlife communities that live in western Washington habitats (Brown, ed. 1985). In upland and riparian habitats, the goal of enhancement could be to improve forest structure. To achieve long-term habitat improvement or enhancement this means planting native trees, providing regular monitoring and maintenance, followed by planting shade tolerant ground cover to complete the forest vegetation community. Measures that provide almost immediate habitat improvement include installation of upright snags, downed logs, brush piles, and other structural habitat elements.

5.0 DATA GAPS

The lack of a recent field inventory of streams, wetlands, and critical fish and wildlife conservation areas is a critical data gap in the preparation of this study. GIS data containing wetlands and streams was provided by the City for this study, but updated information including ground-truthing of mapped wetlands, wetland functions and values, and buffer quality is needed. An inventory of remaining open space and wildlife habitat in the City is needed and could be used to protect the larger patches and linkages of remaining forest, riparian corridors, wetlands, and open water habitats.

6.0 REFERENCES

Adams, L.W. 1994. *Urban Wildlife Habitats: A Landscape Perspective.* University of Minnesota Press. Minneapolis, MN.

Adamus, P.R., Clairan, E.J., Smith, R.D., and Young R.E. 1987. *Wetland Evaluation Technique (WET).*

Adolfson Associates, Inc. 2003. *City of Gig Harbor Draft Shoreline Characterization.* Prepared for the City of Gig Harbor. Seattle, WA.

Anchor Environmental, L.L.C. and People for Puget Sound. 2002. *Final Report Northwest Straits Nearshore Habitat Evaluation.* Prepared for Northwest Straits Commission (NWSC). Mount Vernon, WA.

Azous, A.L. and R.R. Horner. 2001. *Wetlands and Urbanization: Implications for the Future.* Seattle, WA.

Benfield, E. F. and J. R. Webster. 1985. *Shredder abundance and leaf breakdown in an Appalachian Mountain stream.* Freshwater Biology. Volume 15.

Bolton, S. and Shellberg, J. 2001. *Ecological Issues in Floodplains and Riparian Corridors. Center for Streamside Studies,* University of Washington, Seattle, WA.

Booth, D. B. 2000. *Forest cover, impervious-surface area, and the mitigation of urbanization impacts in King County, Washington.* Prepared for King County Water and Land Resources Division. Seattle, Washington.

Booth, D.B. 1991. Urbanization and the Natural Drainage System—Impacts, Solutions, and Progress. *Northwest Environmental Journal* 7(1): 93-118.

Brazier, J.R. and G.W. Brown. 1973. *Buffer Strips for Stream Temperature Control.* Research Paper No.15, Forest Research Lab, Oregon State Univ., Corvallis, OR.

Brinson. 1993. *Changes in the Functioning of Wetlands Along Environmental Gradients.* WETLANDS, Vol. 13, No.2, June 1993, pp. 65-74.

Brown, ed. 1985. *Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington.* U.S. Department of Agriculture. U.S. Forest Service Pacific Northwest Region, Portland, OR.

Castelle, A.J., and A.W. Johnson. 2000. *Riparian Vegetation Effectiveness.* National Council for Air and Stream Improvement Tech. Bull. No. 799.

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. 92-10. Adolfson Assoc., for Shorelands and Coastal Zone Manage. Program, Washington Dept. of Ecology, Olympia, WA.

City of Gig Harbor. 1994. *City of Gig Harbor Comprehensive Plan.* Gig Harbor, WA.

City of Gig Harbor. 2001a. *Gig Harbor Municipal Code.* Gig Harbor, WA.

City of Gig Harbor. 2001b. *Stormwater Comprehensive Plan.* Prepared by Gray and Osborne, Inc. Seattle, WA.

City of Gig Harbor. 2001c. *Park, Recreation, & Open Space Plan, Gig Harbor, Washington.* Gig Harbor, WA.

Cooke Scientific Services, Inc. 2000. *Wetland and Buffer Functions Semi-Quantitative Assessment Methodology (SAM) Final Working Draft User's Manual.*

Corbett, E.S. and J.A. Lynch. 1985. Management of Streamside Zones on Municipal Watersheds. pp. 187-190. *In* R. R. Johnson, C.D. Ziebell, D.R. Patton, P.F. Folliott, and R.H. Hamre (eds.), Riparian Ecosystems and their Management: Reconciling Conflicting Uses. First North American Riparian Conference, April 16-18, 1985, Tucson, Arizona.

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.

Erwin, K.L. 1990. *Wetland evaluation for restoration and creation.* In Kusler, J.A., and M.E. Kentula, eds. Wetland Creation and Restoration: The Status of the Science. Island Press, Washington, DC.

Federal Register. 1988. 40 CFR Part 230. Guidelines for Specification of Disposal Sites for Dredged or Fill Material. Vol. 45, No. 249, Pages 85336-85357. U.S. Government Printing Office, Washington, DC.

Federal Register. 1986. 40 CFR Parts 320 through 330: Regulatory Programs of the Corps of Engineers; Final Rule. Vol. 51. No. 219. pp. 41206-41260, U.S. Govt. Printing Office, Washington, D.C.

Federal Register. 1982. Title 33: Navigation and Navigable Waters; Chapter II, Regulatory Programs of the corps of Engineers. Vol 47, No. 138, p. 31810, U.S. Govt. Printing Office, Washington, D.C.

FEMAT. 1993. Forest Ecosystem Management: An Ecological, Economic and Social Assessment. Report of the Forest Ecosystem Management Assessment Team, USDA Forest Service et al., Washington, D.C.

Ferguson, H.L., K. Robinette, and K. Stenburg. *Chapter 12 Wildlife of Urban Habitats.* In Johnson, D.H. and T.A. O'Neil. 2001. *Wildlife-Habitat Relationships in Oregon and Washington.* Oregon State University Press. Corvallis, OR.

Haring, D. 2000. *Salmon Habitat Limiting Factors Water Resource Inventory Area 15 – East Kitsap Watershed.* Washington State Conservation Commission. November 2000.

Horner, R.R., and C.W. May. 1999. Regional Study Supports Natural Land Cover Protection as Leading Best Management Practice for Maintaining Stream Ecological Integrity. Comprehensive Stormwater & Aquatic Ecosystem 1999 – Conference Papers Vol. 1:233-247, Feb. 22 – 26, 1999, Auckland, New Zealand.

Horner, R.R., and C.W. May. May. 2000. *Watershed Urbanization and the Decline of Salmon in Puget Sound streams.* Center for Urban Water Res. Management, University of Washington, Seattle.

Hruby, T. 2004. *DRAFT Washington State Rating System for Western Washington – Revised.* Washington State Department of Ecology Publication # 04-06-014.

Hruby, T., T. Granger, K. Brunner, S. Cooke, K. Dublanica, R. Gersib, L. Reinelt, K. Richter, D. Sheldon, E. Teachout, A. Wald, and F. Weinmann. 1999. *Methods for Assessing Wetland Functions. Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington.* WA State Department of Ecology Publication #99-115, July 1999.

IES Associates. 1992. *City of Gig Harbor Wetland Inventory Report.* Gig Harbor, WA. [City could not locate for Adolfson review].

Johnson, A.W., and D. Ryba. 1992. *A Literature Review of Recommended Buffer Widths to Maintain Various Functions of Stream Riparian Areas.* King County Surface Water Management Division, Seattle, WA.

Johnson, D.H. and T.A. O'Neil. 2001. *Wildlife-Habitat Relationships in Oregon and Washington.* Oregon State University Press. Corvallis, OR.

Kauffman, J.B., M. Mahrt, L.A. Mahrt, and W.D. Edge. *Wildlife of Riparian Habitats.* Chapter 14 in Johnson, D.H. and T.A. O'Neil. 2001. *Wildlife-Habitat Relationships in Oregon and Washington.* Oregon State University Press. Corvallis, OR.

KGI Watershed Interim Council. 2001. *State of the Watershed Report 2001, A Summary of the Health of Our Water.* Prepared by the KGI Watershed Interim Council (formerly the Watershed Committee).

Knutson, K.C. and V.L. Naef. 1997. *Management Recommendations for Washington's Priority Habitats: Riparian.* Washington Department of Fish and Wildlife, Olympia WA.

Lamb, J. C. 1985. *Water Quality and Its Control.* John Wiley and Sons. New York, New York.

Leavitt, J. 1998. *The functions of riparian buffers in urban watersheds.* Masters Thesis. University of Washington. Seattle, Washington.

McMillan, A. 2000. *The Science of Wetland Buffers and Its Implications for the Management of Wetlands.* Masters Thesis, The Evergreen State College and Washington Department of Ecology, Olympia, WA.

Meehan, W.R., F.J. Swanson, and J.R. Sedell. 1977. *Influences of Riparian Vegetation on Aquatic Ecosystems with Particular Reference to Salmonid Fishes and Their Food Supply.* USDA Forest Service General Technical Report MR-43. Contributed paper, Symposium on the Importance, Preservation and Management of the Riparian Habitat, July 9, 1977, Tucson Arizona.

Mitsch, W.J. and Gosselink, J.G. 1993. *Wetlands.* Van Nostrand Reinhold, New York, NY.

Mockler, A., L. Casey, M. Bowles, N. Gillen, and J. Hansen. 1998. *Results of Monitoring King County Wetland and Stream Mitigations.* King County Department of Environmental Services, King County, WA.

National Marine Fisheries Service (NMFS). 1996. *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale.* NMFS Environmental and Technical Services Division.

Null, W., G. Skinner, W. Leonard. 2000. *Wetland Functions Characterization Tool for Linear Projects.* Washington State Department of Transportation, Environmental Affairs Office. Olympia, WA.

Pentec Environmental. 2003. *Key Peninsula, Gig Harbor, and Islands Watershed Nearshore Salmon Habitat Assessment.* Prepared for Pierce County Public Works and Utilities, Environmental Services, Water Programs. Tacoma, WA.

Reinbelt, L.E. and R. R. Horner. 1991. *Urban Stormwater Impacts on Hydrology and Water Quality of Palustrine Wetlands in the Puget Sound Region.* pp. 33-42 *in* Proceedings Puget Sound Water Quality Authority Research Meeting, Seattle, WA, January, 1991.

Reppert, R.T., W. Sigles, E. Stakhiv, L. Messman, and C. Meyers. 1979. *Wetlands Values: Concepts and Methods for Wetlands Evaluation.* Inst. for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA. Res. rpt. 79-R1.

Richards, C., L.B. Johnson, and G.E. Host. 1996. Landscape-Scale Influences on Stream Habitats and Biota. *Can. J. Fish Aquat. Sci.* 53:295-311.

Richter, K. and A.L. Azous. 2001. *Amphibian Distribution, Abundance, and Habitat Use In* Wetlands and Urbanization: Implications for the Future. Lewis Publishers, Boca Raton, Florida

Rodrick, E. and R. Milner, eds. 1991. *Management Recommendations for Washington's Priority Habitats and Species.* Washington Department of Wildlife, Olympia, WA.

Roni, P., T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock, and G.R. Pess. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds. *North American Journal of Fisheries Management.* 22:1-20.

United States Department of the Interior Fish and Wildlife Service (USFWS). 1998. *A Framework to Assist in the Making of Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulations Watershed Scale (Draft).* USFWS, Washington, DC.

United States Fish and Wildlife Service (USFWS). 2003. Listed Federal Species Letter dated July 14, 2003.

Washington State Department of Ecology (Ecology) Website. Oblique Aerial Photos, 2000 Series. Washington State Department of Ecology, Shorelands and Environmental Assistance Program. Olympia, WA. Available online at http://apps.ecy.wa.gov/shorephotos/index.html (accessed August 2003).

Sheldon, D., T. Hruby, P. Johnson, K. Harper, A. McMillan, S. Stanley, E. Stockdale. August 2003 Draft. *Freshwater Wetlands in Washington State Volume 1: A Synthesis of the Science.* Washington State Department of Ecology Publication # 03-06-016.

Washington State Department of Ecology (Ecology). 2001a. Focus: Riparian Areas. Washington Department of Ecology. Available online at: http://www.ecy.wa.gov/pubs/0010023.pdf

Washington State Department of Ecology (Ecology). 2001b. *Washington state wetland mitigation evaluation study phase 2: Success.* Publication 01-06-021.

Washington State Department of Ecology (Ecology). 1996. *Water Quality Guidelines for Wetlands: Using the Surface Water Quality Standards for Activities Involving Wetlands.* Washington Department of Ecology, Olympia, Publ. #96-06.

Washington State Department of Ecology (Ecology). 1993. *Washington State Wetlands Rating System – Western Washington.* Washington Department of Ecology, Olympia, Publ. #93-74.

Washington State Department of Ecology (Ecology). 1992. *The Growth Management Act and the State Environmental Policy Act: A Guide to Interrelationships.* Publication No. 92-07. Olympia, Washington.

Washington State Department of Ecology (Ecology). 1991. Shoreline Management Handbook: First Edition. Publication No. 90-45. Olympia, Washington.

Washington State Department of Fish and Wildlife (WDFW). 2003. *Priority Habitats and Species, "StreamNet", and Marine Resources Species databases.* Olympia, WA.

Washington State Office of Community Development (OCD). 2002. *Citations of Recommended Sources of Best Available Science for Designating and Protecting Critical Areas.* Olympia, WA.

Washington State Department of Community, Trade and Economic Development (CTED). 2003. *Critical Areas Assistance Handbook: Protecting Critical Areas Within the Framework of the Washington Growth Management Act.* Prepared by Berryman & Henigar Inc., Paul Inghram, Nancy Eklund, GeoEngineers, Inc., and Adolfson Associates Inc.

Watson, J. W. and E. A. Rodrick. 2002. Bald Eagle (*Haliaeetus leucocephalus*). In E. M. Larsen and N. Nordstrom, editors. *Management Recommendations for Washington's Priority Species, Volume IV: Birds [Online].* Available http://www.wa.gov/wdfw/hab/phs/vol4/baldeagle.pdf

Williams, R.D., and E.D. Lavey. 1986. *Selected Buffer References.* Water Quality and Watershed Research Laboratory, Durant, OK.

Williams, R.W., R.M. Laramie, and J.J. James. 1975. *A Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region.* Washington Department of Fisheries. Olympia, WA.

Wong, S.L., and R.H. McCuen. 1982. *The Design of Vegetative Buffer Strips for Runoff and Sediment Control.* A Technical Paper Developed as part of a Study of Stormwater Management in Coastal Areas Funded by Maryland Coastal Zone Management Program. 23 p.

Attachment 3

CRITICAL AREA PROTECTION IN THE COMPREHENSIVE PLAN AND GIG HARBOR MUNICIPAL CODE

COMPREHENSIVE PLAN POLICIES

Land Use Element

2.2.3. Generalized Land Use Categories

Generalized land use categories are identified to serve as a basis for establishing or accommodating the more detailed zoning code designation. The Comprehensive Plan defines eight generalized land use categories:

Preservation Areas

Preservation areas are defined as natural features or systems which possess physical limitations or environmental constraints to development or construction and which require review under the City's wetland ordinance or Critical Areas Ordinance. Preservation areas are suitable for retention or designation as open space or park facilities either as part of a development approval, easement or outright purchase by the City. Preservation areas are considered as overlays to the other generalized land use categories.

GOAL 2.4: PROTECT AND MAINTAIN GROUNDWATER QUALITY AND QUANTITY USED FOR PUBLIC WATER SUPPLIES

Provide an adequate supply of potable water to the city residents and allocate sufficient resources to assure continued supply of groundwater in the future. Require new developments within the urban area to connect to city water as it becomes available for the area. Minimize the impact of on-site septic systems by requiring new development within the urban area to be served by city sewer.

2.4.1. Aquifer Recharge Area and Site Suitability

- Avoid siting industry or uses which pose a great potential for groundwater contamination in those areas which are considered as critical aquifer recharge areas.

- Employ innovative urban design through flexible performance standards to permit increased structure height with decreased impervious coverage to maintain and enhance groundwater recharge.

2.4.2. Adequate Wastewater Treatment and Potable Water Supplies

- Provide for the expansion of the City's wastewater treatment plant to accommodate anticipated twenty-year growth within the urban growth area to minimize or avoid the potential impact to groundwater supplies from on-site septic systems.

- Discourage the continued use of sub-surface sewage disposal (on-site septic systems) within the urban growth area and encourage new developments to connect to the City sewer system.

- Coordinate with other agencies and water purveyors in developing a plan for the consolidation of small water systems within the urban growth area into the municipal water system.

GOAL 2.5: PROTECT AND ENHANCE SURFACE WATER QUALITY AND MANAGE FLOWS TO PRESERVE ENVIRONMENTAL RESOURCES

2.5.1. Adequate Provisions for Storm and Surface Water Management

- Maintain and implement the City's Stormwater Comprehensive Plan to ensure consistency with State and federal clean water guidelines, to preserve and enhance existing surface water resources, to eliminate localized flooding, and to protect the health of Puget Sound.

2.5.2. Support Low Impact Development methods to manage stormwater runoff on-site.

- Establish a review process and toolkit of Low Impact Development (LID) techniques for use in public and private development to reduce or eliminate conveyance of stormwater runoff from development sites. Allow and encourage alternative site and public facility design and surface water management approaches that implement the intent of Low Impact Development.

GOAL 2.6: OPEN SPACE/PRESERVATION AREAS

Define and designate natural features which have inherent development constraints or unique environmental characteristics as areas suitable for open space or preservation areas and provide special incentives or programs to preserve these areas in their natural state.

2.6.1. Critical Areas

- Designate the following critical areas as open space or preservation areas:

Slopes in excess of twenty-five (25) percent.
Sidewalls, ravines and bluffs.
Wetlands and wetland buffers.

- Restrict or limit development or construction within open space/preservation areas but provide a wide variety of special incentives and performance standards to allow increased usage or density on suitable property which may contain these limitations.

- Encourage landowners who have land containing critical areas to consider utilizing the resources of available land preservation trusts as a means of preserving these areas as open space.

- Consider the adoption of "existing use zoning" districts as an overlay for the protection and maintenance of environmentally unique or special areas within the urban growth area. Areas for consideration of this special type of district are as follows:

  The Crescent Valley drainage from Vernhardson Street (96th Street NW) north to the UGA boundary.

2.6.2. Incentives and Performance

- Provide bonus densities to property owners that them to include the preservation area as part of the density-bonus calculation.

- Provide a variety of site development options which preserve open space but which allow the property owner maximum flexibility in site design and construction.

2.6.3. Acquisition of Quality Natural Areas

- Consider the purchase of natural areas which are of high quality and which the public has expressed a clear interest in the protection and preservation of these areas.

Environmental Element

4.1.1. Tributary drainage

Protect perennial streams, ponds, springs, marshes, swamps, wet spots, bogs and other surface tributary collection areas from land use developments or alterations which would tend to alter natural drainage capabilities, contaminate surface water run-off or spoil the natural setting.

4.1.2. Stream and drainage corridors

Enforce buffer zones along the banks of perennial streams, creeks and other tributary drainage systems to allow for the free flow of storm run-off and to protect run-off water quality.

4.1.3. Floodplains

Protect alluvial soils, tidal pools, retention ponds and other floodplains or flooded areas from land use developments which would alter the pattern or capacity of the floodway, or which would interfere with the natural drainage process.

4.1.4. Dams and beaches

Enforce control zones and exacting performance standards governing land use developments around retention pond dams, and along the tidal beaches to protect against possible damage due to dam breaches, severe storms and other natural hazards or failures.

4.1.5. Impermeable soils

Protect soils with extremely poor permeability from land use developments which could contaminate surface water run-off, contaminate ground water supplies, erode or silt natural drainage channels, overflow natural drainage systems and otherwise increase natural hazards.

4.1.6. Septic System use

Enforce exacting performance governing land use developments on soils which have fair to poor permeability, particularly the possible use of septic sewage drainage fields or similar leaching systems. In areas which are prone to septic field failure, work with the Tacoma-Pierce Country Health district to encourage the use of City sewer, as available and where appropriate.

4.1.7. High water table

Protect soils with high water tables from land use developments which create high surface water run-off with possible oil, grease, fertilizer or other contaminants which could be absorbed into the ground water system.

4.1.8. Noncompressive soils

Protect soils with very poor compressive strengths, like muck, peat bogs and some clay and silt deposits, from land use developments or improvements which will not be adequately supported by the soil's materials.

4.1.9. Bedrock escarpments

Enforce exacting performance standards governing land use developments on lands containing shallow depths to bedrock or bedrock escarpments, particularly where combined with slopes which are susceptible to landslide hazards.

4.1.10. Landslide

Protect soils in steep slopes which are composed of poor compressive materials, or have shallow depths to bedrock, or have impermeable subsurface deposits or which contain other characteristic combinations which are susceptible to landslide or land slumps.

4.1.11. Erosion

Enforce exacting performance standards governing possible land use development on soils which have moderate to steep slopes which are composed of soils, ground covers, surface drainage features or other characteristics which are susceptible to high erosion risks.

4.2.5. Open space wildlife habitat

Enforce exacting standards governing possible land use development of existing, natural open space areas which contain prime wildlife habitat characteristics. Promote use of clustered development patterns, common area conservancies and other innovative concepts which conserve or allow, the possible coexistence of natural, open space areas within or adjacent to the developing urban area. Incorporate or implement the standards adopted in the Washington State Administrative Guidelines for the identification and protection of critical wildlife habitat, as appropriate.

4.2.6. Wetland wildlife habitat

Protect lands, soils or other wetland areas which have prime wildlife habitat characteristics. Promote use of site retention ponds, natural drainage methods and other site improvements which conserve or increase wetland habitats. Incorporate or implement the standards adopted in the Washington State Administrative Guidelines for the identification and protection of critical wildlife habitat, as appropriate.

4.2.7. Woodland wildlife habitat

Protect lands, soils or other wooded areas which have prime woodland habitat characteristics. Promote use of buffer zones, common areas, trails and paths, and other innovative concepts which conserve or increase woodland habitats. Incorporate or implement the standards adopted in the Washington State Administrative Guidelines for the identification and protection of critical wildlife habitat, as appropriate.

4.3.1. Best to least allocation policies

As much as possible, allocate high density urban development onto lands which are optimally suitable and capable of supporting urban uses, and/or which pose fewest environmental risks. To the extent necessary, allocate urban uses away from lands or soils which have severe environmental hazards.

4.3.2. Performance criteria

As much as practical, incorporate environmental concerns into performance standards rather than outright restrictions. Use review processes which establish minimum performance criteria which land-owners and developers must satisfy in order to obtain project approvals. As much as possible, allow for innovation and more detailed investigations, provided the end result will not risk environmental hazards or otherwise create public problems or nuisances.

4.3.3. Best Available Science

Ensure that land use and development decisions are consistent with Best Available Science practices to avoid contamination or degradation of wetland, stream, shoreline, and other aquatic habitats. Special attention should be placed on anadromous fisheries.

4.4.3. Groundwater

Prevent groundwater contamination risks due to failed septic systems. To the extent practical, cooperate with County agencies to create and implement plans which will provide suitable solutions for subdivisions with failed septic systems, and which will prevent future developments in high risk areas. Adopt specific performance standards for the development of land in areas identified as critical aquifer recharge areas.

4.4.4. Stormwater - development standards

Prevent surface water contamination and erosion of natural surface drainage channels due to ill-conceived or poorly designed urban development. Promote the use of storm water retention ponds and holding areas, natural drainage and percolation systems, permeable surface improvements, clustered developments and other concepts which will reduce stormwater volumes and velocities.

4.4.5. Stormwater - operating standards

Coordinate with the appropriate local and state agencies in promoting public education and awareness on the proper use of household fertilizers and pesticides. Develop and implement performance standards regarding the dumping of wastes, trapping of greases and other byproducts which can be carried into the natural drainage system.

Shoreline Management Element

9.1.1. Waterway

Define and regulate the design and operation of water-oriented activities including aquaculture and fish farming, and over-water-structures or water-borne improvements including piers, floats, barges and the like to protect the navigational capabilities of the harbor. Define and regulate activities which may occur within or affect the natural tides, currents, flows and even floodways to protect the functional integrity of the harbor.

9.1.2. Habitats
Preserve natural habitat areas, including beaches, streams and estuaries, from disruption. Protect fragile ecosystems which provide the waterfront unique value, especially fish spawning beds in the natural tributaries of Crescent Valley and Donkey Creeks.

9.1.3. Water and shoreline quality
Define and regulate activities which can possibly contaminate or pollute the harbor and shorelines including the use or storage of chemicals, pesticides, fertilizers, fuels and lubricants, animal and human wastes, erosion and other potentially polluting practices or conditions.

Coordinate with the Puget Sound Water Quality Authority, Pierce County and the Tacoma-Pierce County Health Department to secure adequate funding from available sources to develop and implement a water quality baseline study as a prelude to an area-wide water-quality basin plan.

9.1.4. Natural setting
Preserve the natural shoreline and harbor setting to the maximum extent feasible and practical. Control dredging, excavations, land fill, construction of bulkheads, piers, docks, marinas or other improvements which will restrict the natural functions or visual character of the harbor or shoreline. Utilize natural materials and designs where improvements are considered to blend new constructions with the natural setting and with older structures.

GIG HARBOR MUNICIPAL CODE

Chapter 14.20 - STORMWATER MANAGEMENT

Chapter 15.04 - FLOOD HAZARD CONSTRUCTION STANDARDS

Chapter 17.94 - LAND CLEARING

Chapter 18.04 - ENVIRONMENTAL REVIEW (SEPA)

Chapter 18.08 – WETLAND MANAGEMENT REGULATIONS

Chapter 18.12 - CRITICAL AREAS

Chapter 5

The Science and Effectiveness of Wetland Management Tools

5.1 Reader's Guide to this Chapter

This chapter builds on the previous discussion of how wetlands function (Chapter 2), how human activities and changes in land use cause disturbances (across the landscape and at specific sites) that influence the factors that control wetland functions (Chapter 3), and how wetland functions are impacted by these disturbances (Chapter 4).

Chapter 5 presents a synthesis of what the current literature reports on four tools currently used to identify wetlands and to address impacts to wetlands and their functions: wetland definitions, wetland delineation methods, wetland ratings, and buffers. This chapter does not provide language or recommendations for regulatory or policy language—those will be provided in a separate volume on management options and recommendations (Volume 2).

5.1.1 Chapter Contents

Major sections of this chapter and the topics they cover include:

Section 5.2, Introduction and Background on Regulatory Tools introduces the key wetland management tools that are discussed in this chapter.

Section 5.3, How Wetlands Are Defined and Delineated describes similarities and differences in the way various agencies define *wetland*. It explains the critical difference between "biological wetlands" and "regulated wetlands." It also discusses certain types of wetlands that are frequently exempted from regulation, such as isolated wetlands, small wetlands, or those designated as Prior Converted Croplands. The various manuals that have been developed to guide the delineation of wetland boundaries are also briefly discussed.

Section 5.4, Wetland Rating Systems discusses how rating systems have been developed to rapidly assess wetland characteristics in the field. These characterizations allow wetlands to be rated for regulatory or management purposes. This section introduces the reader to the Washington State wetland rating systems, which were briefly mentioned previously in a number of places in the document. It also includes discussion of certain wetland types that require particular attention under the Washington State wetland rating systems.

Section 5.5, Buffers comprises the bulk of this chapter. This section provides a synthesis of the literature on how buffers protect and maintain wetland functions. The section concludes by summarizing recommendations from the literature for establishing effective buffer widths.

Section 5.6, Chapter Summary and Conclusions ties together the major concepts presented in the chapter.

5.1.2 Where to Find Summary Information and Conclusions

Each major section of this chapter concludes with a brief summary of the major points resulting from the literature review on that topic in a bulleted list. The reader is encouraged to remember that a review of the entire section preceding the summary is necessary for an in-depth understanding of the topic.

For summaries of the information presented in this chapter, see the following sections:

- Section 5.3.6
- Section 5.4.2
- Section 5.5.3.5
- Section 5.5.4.4
- Section 5.5.5.4
- Section 5.5.6.1

In addition, Section 5.6 provides a summary and conclusions about the overarching themes gleaned from the literature and presented in this chapter.

5.1.3 Data Sources and Data Gaps

No literature review was conducted for the section on wetland definitions or delineations. Both of these management tools are currently established by state and federal statutes. It was determined that review of the previous discourse on these topics was not relevant to the current state of the science for Washington State.

Considerable research was published prior to 2000 on the role of small wetlands relative to wildlife in a landscape context. Since then, several synthesis documents on small and isolated wetlands have been published.

Papers on the adequacy or effectiveness of wetland rating systems were not found; instead, the literature concentrates on function assessment methods. This chapter does not attempt to assess the science on wetland function assessment because the Washington State Department of Ecology (Ecology) has evaluated and described different function assessment methods previously (see Volume 2, Appendix 5-B for more information). Additionally, Ecology completed function assessment methods for several different wetland hydrogeomorphic types on both sides of the state within the last five years (see Chapter 2 for further information).

The subject of buffers is well documented in the scientific literature. Numerous studies from across the U.S. have been conducted for wetland and stream buffers. The results of buffer studies, completed here in the Pacific Northwest as well as other areas of the country, provide remarkably consistent findings related to the factors that are important in determining appropriate buffer widths. This consistency is particularly striking in the numerous buffer synthesis documents. Additionally, the results of many studies conducted in other parts of the U.S. have been replicated in studies in the Pacific Northwest.

Determining relevance to Washington, however, can be challenging, since the physical settings of the studies vary widely. Some, however, obviously do relate to Washington; for example, literature related to agricultural practices and vegetated filter strips from the north-central United States and south-central Canada is relevant to some agricultural practices in Washington, especially in areas east of the Cascades.

The majority of research on buffers tends to focus on how buffers influence water quality. Far fewer studies examine the influence of a buffer's physical characteristics on attenuating rates of surface water flow.

Most studies on buffers related to wildlife document the needs of a particular species or guild related to how far they travel from aquatic habitats to fulfill their life-needs. While there is substantial literature on the implications of habitat fragmentation, this literature does not specifically address the role of buffers in reducing fragmentation between wetlands and other parts of the landscape.

Numerous compilations and syntheses of the literature concerning buffers have been completed since 1990. These synthesis documents are used in this document as direct sources when no more recent research was found. This chapter also cites literature related to stream buffers and riparian areas when the findings are relevant to the functions or processes these areas provide to the adjacent aquatic resource.

A more detailed description of the types of literature used and any recognized gaps in the scientific literature are provided within each section on buffers as appropriate.

5.2 Introduction and Background on Regulatory Tools

The regulatory tools discussed in this chapter are components of "typical" wetland protection programs. The intent is not to analyze all elements of protection programs and their regulations but to focus on the key science-based elements relating directly to wetland protection and management. Therefore, this chapter focuses on the following four elements:

- Wetland definitions
- Wetland delineation methods
- Wetland ratings
- Buffers

The topic of compensatory mitigation, another key regulatory tool, is discussed separately in Chapter 6 because of the volume of information and literature available on this subject.

5.3 How Wetlands are Defined and Delineated

5.3.1 How Agencies Define Wetlands

Several definitions of wetlands have been developed and used by various federal, state, and local agencies and jurisdictions. The effectiveness of current federal or state wetland definitions was not evaluated as part of this synthesis. However, definitions are included here because how a wetland is defined is critical to determining what areas are subject to the provisions of a law or regulation.

For the purposes of most laws and regulations, wetlands are usually defined using one of the following two definitions:

> *Those areas that are saturated or inundated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.* (U.S. Army Corps of Engineers 1987);
>
> or
>
> *"Wetlands" or "wetland areas" means areas that are inundated or saturated by surface or ground water 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, marshes, bogs and similar areas. Wetlands do not include those 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 nonwetland areas to mitigate the conversion of wetlands.* (Washington Administrative Code 173-22-030.)

The Washington State definition is derived from the U.S. Army Corps of Engineers (Corps) definition, but it also includes clarifying language that identifies which common human-made or -induced features are not meant to be defined as wetland. The state definition is required by the Growth Management Act (RCW 36.70A.030 (20)) to be used in all local critical area regulations.

In addition, for the National Wetland Inventory, the U.S. Fish and Wildlife Service (USFWS) defined wetlands as follows:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purpose of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.* (Cowardin et al. 1979)

Note that the definition used by the USFWS allows the use of a single parameter to determine if an area is a wetland. The definition also includes areas that may not be vegetated, such as gravel bars and mudflats. In most cases, the Corps and Ecology definitions require the presence of all three parameters (vegetation, soil, and hydrology) for an area to be considered a wetland, and they both assume that wetlands generally are vegetated.

5.3.2 Biological vs. Regulated Wetlands

In some jurisdictions, all lands that meet the definition of *wetland* are regulated. However, it is not unusual for a jurisdiction to differentiate within its regulations between "wetlands" (i.e., biological wetlands) and "regulated wetlands" (i.e., wetlands that they intend to regulate). The definition of what constitutes a regulated wetland may vary from jurisdiction to jurisdiction.

In reviewing regulatory language from local wetland regulations, the three primary criteria used to differentiate between "wetland" and "regulated wetland" were:

- The category or rating of the wetland
- The size of the wetland
- The type of wetland (such as isolated wetlands and those designated as Prior Converted Croplands)

In general, a category or rating system has been used historically in regulatory language to differentiate between wetlands that need different degrees of protection. Rating systems are used by local jurisdictions to group wetlands based on physical characteristics and/or functions that the wetlands may provide and how those characteristics or functions are valued. Section 5.4 of this document describes the current state of the science on wetland ratings and the wetland rating systems developed for eastern and western Washington.

The criterion of wetland size is usually a minimum below which the jurisdiction will not regulate a wetland. For example, the jurisdiction may allow no fill in wetlands larger than 10,000 square feet, or they may include language such as "Category 2 wetlands larger than 0.25 acre cannot be altered." The historical rationale for the use of size as a regulatory criterion was the perception that "bigger is better," and the belief that small wetlands were less important and did not provide significant functions. The scientific literature of the last 10 years has made it clear that size does matter but not in the way previously believed. In multiple studies, small wetlands have been shown to contain a significant diversity of plant and animal species (See Section 5.3.3 for more information).

Additionally, two other wetland types may be exempted from regulation: isolated wetlands and wetlands designated as Prior Converted Croplands.

In 2001, the U.S. Supreme Court determined that isolated wetlands are not subject to regulation under Section 404 of the federal Clean Water Act if the only basis for their regulation is their use by migratory birds. However, the Court did not define "isolated," and the federal government has not issued any new guidance or regulations to clarify the situation. In general practice, the U.S. Army Corps of Engineers (Corps), the federal agency that administers the Clean Water Act, considers isolated wetlands to be those of any size that are not adjacent to or have no direct surface water connection to any navigable waters. However, recent lower court decisions have interpreted Corps jurisdiction over isolated waters differently, and the situation is in flux.

Washington State has determined that isolated wetlands are regulated by the Department of Ecology under the state Water Pollution Control Act (RCW 90.48). Since some local jurisdictions in Washington fashion their wetland regulations on the federal or state standards, it is important to consider the implications of not regulating isolated wetlands. Thus, scientific information on isolated wetlands is discussed in Section 5.3.4.

Wetlands that are designated as Prior Converted Croplands (PCC) are another type of wetland that are exempt from regulation by the federal government. PCC are those wetlands that were drained or otherwise manipulated prior to December 23, 1985, for the production of commodity crops. They are wetlands in which inundation (ponding) does not occur for more than 14 consecutive days during the growing season. These sites must produce an agricultural commodity that requires planting a crop that needs annual tilling. These areas are considered waters of the U.S. if they are abandoned (i.e., tilling and planting has not occurred for five consecutive years), and hydrophytic vegetation and wetland hydrology returns. However, even if they are not abandoned, many of the PCCs in Washington still meet the three criteria required for biological wetlands. As with isolated wetlands, the Department of Ecology regulates PCCs that are wetlands under state law.

No information on wetland areas meeting the definition of PCC was found in the scientific literature. However, many wetlands meeting the criteria for PCC would still be expected to provide important functions, given that the criteria for being designated "Prior Converted" require only that the wetland has been manipulated for production of commodity crops since 1985 and does not pond for more than 14 consecutive days during the growing season. The authors of Volume I have observed widespread flooding in PCC areas during the winter and have observed use of these areas by several species of overwintering waterfowl. One published study of waterfowl in Puget Sound documented significant use of farmlands by several duck species for feeding during the winter (Lovvorn and Baldwin 1996). This study found greater use by waterfowl of farm fields that were flooded in winter, but made no distinction between upland farm fields, farmed wetlands, and Prior Converted Croplands. In addition, the authors of Volume I have documented significant water quality and quantity functions provided by PCCs in projects reviewed and permitted by the Department of Ecology (This data has not been published).

If the agricultural activities were abandoned, PCCs could revert to a plant community characteristic of wetland; and, without maintenance of the hydrologic modifications, the wetland's water regime may revert to a condition more like that which existed prior to the alteration. Further analysis of the functions of wetland areas designated as PCC is needed.

No literature was found that discussed the ecological consequences of the legal bifurcation between biological wetlands and regulated wetlands. However, literature was found that discusses the functions and values provided by small wetlands and isolated wetlands, as discussed below.

5.3.3 Small Wetlands

The elimination of small wetlands is an issue that has gained attention over the past 10 years. Many regulations have preferentially allowed filling of small wetlands. Many regulations completely exempt wetlands under a certain threshold. Also, size is one of the most common characteristics used in determining wetland ratings at the local level, and smaller wetlands typically receive lower levels of protection. Yet, the loss of small wetlands is one of the most common cumulative impacts on wetlands and wildlife (Weller 1988, Tiner et al. 2002).

No definition of *small* is provided here because what constitutes "small" varies between jurisdictions and scientific studies (see also Section 5.3.2). In some contexts, small is determined exclusively by size. Small may mean less than 0.10 acre; in others, it may mean less than 10 acres.

Some jurisdictions, however, also differentiate small wetlands using criteria that reflect function and values. Small wetlands can have outlets, be in a floodplain, or be otherwise associated with a larger aquatic system. These characteristics are often used in rating systems and, combined with size, determine what is considered a small wetland. For example, a jurisdiction may include language in their regulations such as "Category 2 wetlands larger than 0.25 acre cannot be altered." For each of the studies below, we have included the authors' definition of small.

In addition to the obvious loss of habitat for wildlife, fragmentation of habitat increases as small wetlands are eliminated, resulting in greater distances between wetland patches in the landscape. Semlitsch and Bodie (1998) found that creating greater distances between wetlands of 0.5 to 10 acres in size can have a significant effect on the ability of a landscape to support viable populations of amphibians, as juveniles dispersing from a source wetland may not be able to travel far enough to recolonize other surrounding (now distant) wetlands. Management priorities have focused on larger, semi-permanent wetlands, with the least emphasis on protecting the smaller, seasonal wetlands (< 1.2 acres) that are critical components of wetland complexes (Naugle et al. 2001).

The following sections describe studies of the use of small wetlands by wildlife, and the role that small wetlands play in maintaining connections between habitats. For each of these studies, the authors' definition of small is described.

Studies of the relationship between wetland size and wildlife distribution have mostly focused on amphibians and birds. Few studies have examined how use of wetlands by mammals relates to wetland size, and no studies of this relationship were found for macroinvertebrates or reptiles. No studies were found that documented the role that small wetlands play in providing water quality or hydrologic functions. However, the degree to which small wetlands perform water quality or hydrologic functions is likely to be determined by site-specific characteristics (see Chapter 2) and can be estimated on a per-acre basis using some of the available function assessment methods.

5.3.3.1 Amphibians and Small Wetlands

Snodgrass et al. (2000) undertook a study of amphibian use of wetlands to address three commonly held beliefs about small wetlands (0.7 acres - 3 acres):

- They have short hydroperiods
- They support few species
- They support species that are also found in larger wetlands

Snodgrass et al. (2000) determined that amphibian species richness increases with length of hydroperiod. They also concluded that short-hydroperiod wetlands (smaller temporarily ponded wetlands) are also important in maintaining biological diversity in that they support species not found in larger wetlands with longer hydroperiods. The species they found in small wetlands were not a subset of those in larger wetlands but rather a unique group of species.

Similarly, amphibian richness in Puget Sound wetlands was found to have no correlation with wetland size (1 - 30 acres). High richness occurred in some of the smallest wetlands (Richter and Azous 1995). The study indicates that small wetlands that are vegetatively simple can serve adequately as breeding habitats as long as favorable nonbreeding habitat is present nearby. Species richness also was not related to persistence of ponding.

Gibbs (1993) conducted a simulation model in Maine from which he theorized that small wetlands may be most important for wetland organisms with low population growth rates and low densities. The model demonstrated that the loss of small freshwater wetlands (less than approximately 5 acres [2 ha]) would result in a decline of total wetland area by 19% and total wetland number by 62%, while the average distance between wetlands would increase by 67% (Gibbs 1993). The model showed that the loss of small wetlands would result in a change (from 90% to 54%) of the area that would lie within the maximum migration distance of terrestrial-dwelling and aquatic-breeding amphibians. The risk of extinction would significantly increase for local populations of turtles, small birds, and small mammals that are currently stable even though the model showed no change in the risk of metapopulation extinction for salamanders or frogs. Amphibian populations in the study were buffered from the risk of extinction due to high rates of population increase. The model demonstrated that dispersal ability for amphibians is a predictor of population growth rate and density, not sensitivity of a population to loss of small wetlands.

5.3.3.2 Birds and Small Wetlands

Bird use of wetlands appears to have a stronger relationship to wetland size than that of amphibians. Bird richness was positively correlated with larger wetland size in a Puget Sound study of palustrine wetlands (Richter and Azous 2001b). This is attributed to the fact that larger wetlands in the study generally had greater structural complexity and a greater number of habitat types.

Martin-Yanny (1992) also found that bird species richness and abundance in wetlands of the Pacific Northwest are positively correlated with wetland size. However, Martin-Yanny noted that habitat heterogeneity was a more important determining factor than wetland area in influencing bird species richness. Wetlands in highly urbanized watersheds had fewer neotropical migrant species, fewer ground-nesting birds, and more edge-tolerant (habitat generalist) species. This is because urbanizing watersheds tend to have smaller wetlands (less than 10 acres [4 ha]) with more edge habitat, making birds more susceptible to competition, predation, and nest parasitism. The author recommends preserving large wetlands or complexes of smaller wetlands that are connected by extensive upland buffers.

In northern prairie marshes, bird species richness was also seen to increase with marsh size and to decrease as the wetland became more isolated (Brown and Dinsmore 1986). Marshes that were part of wetland complexes showed higher species richness than isolated wetlands. Certain bird species used smaller marshes only when the marshes were part of a wetland complex. Large isolated marshes in the study often had lower species richness than smaller marshes that were part of wetland complexes. While bird species richness increased, the rate of increase slowed as the marshes became larger. In other words, they concluded that prairie marshes in the size range of 49 to 74 acres (20 to 30 ha) were more efficient in preserving bird species than larger marshes.

A study of agriculturally disturbed wetlands in western Oregon reached similar conclusions in finding that larger wetlands support more bird species (Budeau and Snow 1992). These authors also showed that wetlands of all sizes were important to water-birds.

However, in eastern Washington, Foster et al. (1984) found that waterfowl breeding use of wetlands in the Columbia Basin was greatest in smaller wetlands (less than 1 acre [0.4 ha]).

5.3.3.3 Mammals and Small Wetlands

The study that modeled the effects of the loss of small wetlands in Maine showed that local populations of small mammals faced a significant risk of extinction following the loss of small wetlands (<5 acres) (Gibbs 1993). However, in a study of Puget Sound wetlands, Richter and Azous (2001c) concluded that wetland size alone was not a significant factor in determining mammal richness or abundance. They noted that small-mammal richness was most closely affected by the combined factors of:

- Wetland size
- Extent of retention of forest adjacent to the wetland
- Quantity of large woody debris within wetland buffers

In conclusion, the literature suggests that size is not a significant factor in contributing to most wetland habitat functions. Rather, habitat structure, connectivity, and wetland hydroperiod are much more significant factors in determining habitat functions than size alone. The literature emphasizes that small wetlands are critically important to amphibians, particularly when connectivity between wetlands and with adjacent uplands is maintained. However, none of the studies evaluated the role of wetlands less than 0.5 acre, so the implications of exempting wetlands less than 0.25 acre, as is commonly done in local wetland regulations, are unknown.

The next section deals specifically with isolated wetlands. The following excerpt from Moler and Franz (1987) describes small, isolated wetlands and sheds some light on the attributes of both size and isolation.

> *To a great extent, the unique values and functions of small, isolated wetlands have been overlooked. This oversight derives from several factors, perhaps foremost being the general tendency to think of small wetlands as being little more than subsets of larger wetlands. So long as the uniqueness of small wetlands is unrecognized, then it is intuitive to think of wetlands as declining in value directly as function of size. Similarly, so long as the unique values of isolated wetlands are unrecognized, it is understandable that connected wetlands might be considered of greater value. In reality, small isolated wetlands are biologically unique systems. Because of their isolation and small size, they support a very different assemblage of species than that found in*

larger, more permanently wet situations. The ephemeral nature of many small wetlands makes them unsuitable for species which require permanent water.

5.3.4 Isolated Wetlands

Isolated wetlands are being addressed in this document because of the recent Supreme Court decision to exclude many isolated wetlands from federal regulation. The Supreme Court decision regarding isolated wetlands was made based on a legal interpretation of jurisdiction under the federal Clean Water Act (Solid Waste of Northern Cook County v. United States Army Corps of Engineers). The key factor was the language in the Act that relates to navigable waters. The Court did not rule that isolated wetlands are less important than non-isolated wetlands, only that the intent of Congress in passing the Clean Water Act was to relate the protection of waters of the United States to navigability. The Court also did not provide any definition of what constitutes "isolation" for purposes of jurisdiction.

The Seattle District of the U.S. Army Corps of Engineers (Corps) does not have any national or regional guidance for making isolated wetland determinations. As of November 2004, if a wetland meets the test of "adjacency" (neighboring, bordering or contiguous) with any navigable water, or if the wetland has a surface outlet that drains to a navigable water, then the Corps does not consider it isolated (T.J. Stetz, U.S. Army Corps of Engineers, Seattle, personal communication 2004). Future court or administrative decisions may change how isolated wetlands are determined.

Much confusion has resulted from this decision, and some in the public have assumed that isolated wetlands are less important or less worthy of protection. Therefore, it is important to summarize some of the basic science on isolated wetlands, which is presented in the paragraphs that follow.

Much of the information comes from the work of Tiner et al. (2002) and a recent issue of *Wetlands* (Volume 23, #3, 2003) that includes numerous articles on isolated wetlands. Readers are directed to this work for more detailed information. Additionally, the work of Hruby et al. (1999, 2000) in developing assessment methods for wetland functions in Washington provides important scientific information on depressional wetlands in Washington, a wetland type that contains the majority of isolated wetlands in Washington.

Wetlands can be defined as isolated based on their geographic isolation, ecological isolation, or hydrologic isolation (Tiner et al. 2002). For this discussion, isolated wetlands are defined by a very specific type of hydrologic isolation—they do not have a surface outlet by which water leaves the wetland, even seasonally, to another water body. Although frequently described as closed depressions (Tiner et al. 2002, Winter and LaBaugh 2003), isolated wetlands can also be sloped wetlands where surface water, if present, re-enters the shallow groundwater zone at the base of the wetland and is not linked via surface flows to a downstream water body. Isolated wetlands are not necessarily small. They can be large systems with substantial heterogeneity and diverse habitat types (Tiner et al. 2002, Leibowitz 2003).

Generally, isolated wetlands provide most of the same functions as non-isolated wetlands and do so for the same reasons: position in the landscape, hydrologic regime, and type of soils and vegetation present (Leibowitz 2003, Whigam and Jordan 2003, Liebowitz and Nadeau 2003). Basic functions of isolated wetlands as described by Hruby et al. (1999), Tiner et al. (2002), Leibowitz (2003), and Whigam and Jordan (2003) are presented below.

- **Water quantity (hydrologic functions).** Isolated wetlands have no surface outlet. Precipitation and local runoff entering the wetland must either return to the atmosphere by evapotranspiration or infiltrate into groundwater (Leibowitz 2003). As a result, their ability to retain surface water may be significant, depending upon the surrounding topography. This provides potential flood storage because no surface water leaves the wetland to cause potential flooding or erosion downgradient.

- **Water quality.** Because they lack an outlet, isolated wetlands function as sediment traps for contaminants that move into them. Isolated wetlands function as sinks for most dissolved and all sediment-associated nutrients and toxics because they have no outlets that allow materials to be transported downgradient (Hruby et al. 1999). A review of the literature by Whigam and Jordan (2003) concludes that isolated, depressional wetlands have been shown to improve water quality and to efficiently retain nutrients.

- **Wildlife habitat.** Isolated wetlands provide wildlife habitat functions similar to those of non-isolated wetlands (Liebowitz 2003), except in regard to habitat for migrating fish in Washington (Hruby et al. 1999). The habitat value of isolated wetlands is governed by the same factors as non-isolated wetlands (hydrologic regime, vegetation, habitat structure, connectivity to other habitats, etc.) (Liebowitz 2003, Gibbons 2003). Tiner et al. (2002) found that isolated wetlands provide essential habitat for a wide range of guilds and may be vital to maintaining viable, genetically diverse metapopulations. They state:

  > *From an ecological standpoint, isolated wetlands are among the country's most significant biological resources. In some areas, isolation has led to the evolution of endemic species vital for the conservation of biodiversity. In other cases, their isolation and sheer numbers in a given locality have made these wetlands crucial habitats for amphibian breeding and survival (e.g., woodland vernal pools and cypress domes) or for waterfowl and waterbird breeding (e.g., potholes). In arid and semi-arid regions, many isolated wetlands are veritable oases – watering places and habitats vital to many wildlife that use them for breeding, feeding, and resting, or for their primary residence.*

5.3.5 Delineation Methods

In addition to the definition of what constitutes a wetland, the U.S. Army Corps of Engineers (Corps) and Washington State Department of Ecology (Ecology) have provided guidance on how to determine the edge of a wetland (i.e., how to delineate the wetland boundary). Delineating a wetland's boundary is a necessary step in the regulatory process because it factors into calculations of potential wetland impacts and determines the starting point for buffers and setbacks.

The Corps published a federal manual to delineate wetlands in 1987 and another manual in 1989, jointly with the U.S. Environmental Protection Agency (EPA), Soil Conservation Service, and U.S. Fish and Wildlife Service. In subsequent years (1991, 1992, and with EPA in 1994) the Corps released updates to clarify questions and provide regional guidance.

In the early 1990s, there was substantial controversy over proposals to change the 1987 and 1989 federal delineation manuals. A substantial amount of literature was produced analyzing the effectiveness of the various delineation manuals for determining a wetland edge. In subsequent years, the use of the 1987 Federal Manual for Delineation of Wetland Areas became the required legal standard for the Corps.

As required by state legislation, Ecology issued the *Washington State Wetlands Identification and Delineation Manual* in 1996 (WAC 173-22-080, Ecology publication #96-94). Ecology's manual uses the original 1987 Corps of Engineers manual and incorporates changes in the manual made by the federal government since 1987. The state manual includes national guidance issued by the Corps in 1991 and 1992 (which is not present in the 1987 Corps manual), as well as regional guidance issued by the Corps and EPA in 1994. In addition, the state manual eliminated references and examples that were not relevant to Washington State and added examples and situations relevant to Washington. The 1996 state manual is required by statute (RCW 36.70A.175) to be used by local jurisdictions in implementing the Growth Management Act. Since the two manuals rely upon the same criteria and indicators for hydrology, soils, and vegetation, proper use of either manual should result in the same boundary.

5.3.6 Summary of Key Points

- Regulatory agencies define the term *wetland* in slightly different ways.
- Local jurisdictions often differentiate between "biological wetlands" and "regulated wetlands". The distinction is often based on the wetland rating and/or wetland size.
- The studies of the correlation of wetland size to wildlife use conflict somewhat in their findings, but most generally conclude that small wetlands are important habitats (particularly where adjacent buffer habitats are available) and that elimination of small wetlands can negatively impact local populations.

- Small wetlands provide habitat for a range of species that are not a subset of the species found in larger, more permanently inundated wetlands. Small wetlands do not just provide a smaller area for the same array of amphibian species found in larger wetlands.

- Small wetlands are very important in reducing isolation among wetland habitat patches. Smaller wetlands provide significant habitat for wildlife and affect the habitat suitability of larger wetlands by reducing isolation on the landscape.

- The presence of small wetlands reduces the distance between wetlands and thus increases the probability of successful dispersal of organisms. This, in turn, likely increases the number of individuals dispersing among patches in a wetland mosaic, thereby reducing the chance of population extinction.

- Isolated wetlands provide the same range of wetland functions as non-isolated wetlands. Isolated wetlands provide important water quantity, water quality, and habitat functions.

- The U.S. Army Corps of Engineers 1987 wetland delineation manual and the 1996 *Washington State Wetlands Identification and Delineation Manual* are the current standards to be used in determining the boundary of a wetland. Correct use of these two manuals should result in the same wetland boundary.

5.4 Wetland Rating Systems

Wetland rating systems (or categorizations) are one of the numerous procedures that have been developed to analyze wetlands, providing ways to identify, characterize, or rate wetland characteristics, functions, and social benefits (values). Categorizations, as well as other procedures such as function assessment, are used by natural resource managers and regulators in a variety of contexts for regulating, planning, and managing the wetland resource (Bartoldus 1999). In the context of local regulations, rating systems are used to categorize wetlands based on different needs for protection. However, rating systems can often be used as one means to analyze wetlands.

Many different procedures to analyze wetlands have been developed in the last three decades. These range from detailed scientific evaluations that may require many years to complete, to the judgments of individual experts during one visit to a wetland. For example, Bartoldus (1999) summarized 40 different tools that were developed up to 1998, and that are used to meet the needs of regulating and managing wetlands.

Although many different rating-type tools have been developed, the literature search for this document did not uncover any analyses of the effectiveness of rating systems at protecting the wetland resource. It is assumed that better protection for wetlands is provided with improved understanding of wetland functions and values (e.g., Roth et al. 1993, National Research Council 1995).

Scientific rigor is often time consuming and costly. For regulatory use, tools are needed that provide some information on the functions and values of wetlands in a time- and cost-effective way. One way to accomplish this is with an analytical tool that categorizes wetlands by their important attributes or characteristics based on the collective judgment of regional experts. Categorization methods, such as rating systems, are relatively rapid but can still provide some scientific rigor (Hruby 1999).

The rapid method most commonly used for analyzing wetlands in eastern and western Washington has been Ecology's wetland rating systems (Ecology 1991, 1993, Hruby 2004a,b). This rating system or some modification of it has been incorporated in the wetland regulations of at least 20 counties in the state and many cities and towns as well (Chris Parsons, Washington State Department of Community, Trade and Economic Development (CTED), personal communications and survey 1999, data are available on request from CTED).

In the first editions of the Washington State wetland rating systems, the term *rating* was not used in a manner that is consistent with its definition in the dictionary, and this has caused some confusion. The method does not rate the wetland and generate a relative estimate of value (e.g., high, medium, low). Rather, it is a categorization of wetlands based on specific criteria, such as sensitivity to disturbance and rarity in the landscape.

The rating systems were 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. However, the rating systems were not intended to replace a full assessment that may be necessary to determine the levels of performance for numerous functions or to plan and monitor a compensatory mitigation project. As noted in the wetland rating system for eastern Washington:

> *The rating categories are intended to be used as the basis for developing standards for protecting and managing the wetlands to minimize further loss of their resource value. The management decisions that can be made based on the rating include the width of buffers necessary to protect the wetland from adjacent development, the ratios needed to compensate for impacts to the wetland, and permitted uses in the wetland.* (Hruby 2004a)

The rating systems for both eastern and western Washington have been revised by Ecology in conjunction with teams of wetland experts and local planners in each region who provided technical input and field testing. The goal of the revisions is to reflect the best and most current science on wetlands and how they function (using three broad groups of functions—hydrologic, water quality, and habitat) while maintaining rapidity and ease of use. You can access the rating systems for eastern and western Washington at the following web site: http://www.ecy.wa.gov/programs/sea/wetlan.html.

Wetland rating systems used in other parts of the nation

Categorization systems have also been used in other parts of the United States to manage wetlands. Other states have wetland categorizations as part of their wetland laws and rules, and other jurisdictions have used them to help manage wetlands for specific projects. For example:

Vermont adopted a law (10 VSA Chapter 37, Section (a) (7-9)) mandating that rules be adopted to identify Vermont's significant wetlands. The rules categorize wetlands into three classes of which the first two are considered "significant" (Vermont Department of Environmental Conservation 1999).

New Jersey has a wetland categorization included directly in its law (NJAC 7:7A). Criteria are provided for categorizing wetlands into (1) freshwater wetlands of exceptional resource value, (2) wetlands of ordinary resource value, and (3) wetlands of intermediate resource value.

New York has adopted rules that categorize wetlands into four categories based on ecological associations, hydrologic features, pollution control features, cover types, and distribution and location (6 NYCRR Part 664.5).

West Eugene, Oregon developed a method for a plan based on "needs for protection" (City of Eugene 2002).

North Carolina created a GIS-based system that characterizes the "significance" of wetlands based on several landscape and function-based criteria (Gainey and Roise 1998).

5.4.1 Other Characteristics Used for Rating

Some wetlands in Washington are categorized in the Washington State wetland rating systems based on important characteristics that are not specifically related to functions. These characteristics include rarity on the landscape, sensitivity to disturbance, and difficulty in restoring or creating such wetlands through mitigation efforts (Ecology 1991, Hruby 2004a,b). The wetland types that have been defined for eastern and western Washington are listed below. Some of the types are unique to either eastern or western Washington (e.g., Wetlands in coastal lagoons are unique to western Washington):

- Bogs
- Alkali wetlands
- Mature and old-growth forested wetlands
- Vernal pools
- Wetlands identified by the Washington State Department of Natural Resources as "Natural Heritage" wetlands"

- Wetlands in coastal lagoons
- Interdunal wetlands
- Estuarine wetlands

Each of these types is described in more detail below.

5.4.1.1 Bogs

Many of the scientific studies of bogs have been published in Europe and the northern parts of the United States, such as Minnesota and Maine. There has not been extensive research on bogs in Washington State. This summary of the literature is not intended to be a thorough synthesis but provides basic background information regarding characteristics of bogs requiring special consideration for management.

Predominance of Organic Soils

Bogs are peatlands (wetlands with organic soils) that have been classified according to their shape, chemistry, plant species, and vegetation structure (Gore 1983). The common factor in bogs is the presence of organic soils or peat, which result from the accumulation of poorly decomposed plant material. The optimum conditions for peat formation occur in cool, humid climates in a location with poorly drained soil.

The rate of peat accumulation is generally quite low, although it can vary with site-specific factors. Heathewaite and Gottlich (1993) report rates of accumulation ranging from 2 to 4 inches (5 to 10 cm) every 100 years. Durno (1961) lists a range of 0.5 to 4.3 inches (1.2 to 11 cm) accumulation every 100 years. In Washington, Rigg (1958) reports peat accumulation of 1 inch (2.5 cm) in 40 years for the west side of the Cascades and 1 inch in 50 years on the east side. Peat can be as little as 8 inches (20 cm) deep to over 45 feet (15 m) deep (Heathewaite and Gottlich 1993).

The three ways that peat is formed, described below, illustrate the lengthy process of peat and bog formation and help explain why bogs are almost impossible to recreate through compensatory mitigation (see below and in Chapter 6).

- In a **filled-lake sequence**, open water progresses to a sedge or moss community that gradually builds a mat over the water, evolving into a bog, bog forest, and then climax community (Conway 1949).
- **Paludification** occurs when bogs invade the surrounding forest. Sphagnum species cause a rise in the water table as peat layers compress and impede drainage (Heathewaite and Gottlich 1993).
- A **flow-through succession** occurs when surface flows are modified. Organic matter builds up to the point where surface flows are diverted around the peat mound. As it builds, the mound becomes isolated from groundwater, relying solely on precipitation as its water source (Klinger 1996).

Studies have shown, on the other hand, that many bogs remain very stable for thousands of years as a sphagnum moss/shrub community, even though succession to a forested community can occur (Klinger 1996).

Acidity and Poor Nutrients

Bogs have unusual hydrodynamics and chemistry for wetlands. They typically only receive precipitation and very localized surface runoff as their sources of water. As a result, many essential nutrients, such as nitrogen, occur in low concentrations. The upper layers of peat, formed by slowly decomposing sphagnum, are often strongly acidic, usually with a pH of 4 or less.

Bogs typically support plant species that are specially adapted to these harsh growing conditions. Sphagnum moss, as well as other mosses, usually dominate the vegetation near the ground. Ericaceous shrubs, such as Labrador tea (*Ledum gladulosum*), are also common in bogs.

Trees can grow in bogs but at a very slow rate due to the poor growing conditions. In studies in the Pacific Northwest, Rigg (1918) found tree growth in sphagnum peat soils was slow. Rigg determined that hemlock (*Tsuga heterophylla*) grew in sphagnum soils at a rate that was only 27% of its growth rate in productive upland soils, and that Douglas-fir (*Pseudotsuga menziesii*) grew in sphagnum at only 16% of its growth rate in upland soils. He measured the annual growth of western red cedar (*Thuja plicata*) as only 0.02 inches (0.6 mm).

Although persistent wet conditions, low soil oxygen, and high acidity are important factors, it is actually the lack of available nutrients, or the inability of plants to absorb nutrients because of acidity (Moore and Bellamy 1974), that most influences the flora of bogs. Most bog species have developed special adaptations to these conditions and out-compete more common wetland plants (Mitsch and Gosselink 2000). Therefore, this makes bog species susceptible to nutrient loading and changes in acidity (as well as alterations in water source that can precipitate these changes) that would enable other species to establish and dominate.

Bogs in Western and Eastern Washington

In western Washington, Kunze (1994) characterized numerous types of peatlands, including bogs and fens. She identified 10 types of sphagnum bog communities in the Puget Trough region and 14 in the Olympic Peninsula/southwest Washington. They occur in the lowlands of the Puget Trough in depressions, oxbows, and old lake beds. These typically have a raised center with a moat around the edge. Bogs and fens also occur on the Olympic Peninsula and in southwest Washington where they can occupy basins, slopes, and flat to rolling ground, as well as forming along low-gradient streams. Bogs in the foothills of the Cascades include sloping bogs, which are influenced by both mineral soil water and precipitation.

Peatlands in eastern Washington have not been classified to the extent of those in western Washington. However, 50 peatlands were identified by Rigg (1958). Forty-four of those identified were located in the northeastern corner of the state. They included fens associated with flowing water, and bogs formed in depressions or along lake margins. Six peat systems were found in scabland channels and depressions on the Columbia Plateau.

Difficulty in Restoring Bogs

Researchers in Northern Europe and Canada have found that restoring bogs is difficult, specifically in regard to plant communities (Bolscher 1995, Grosvermier et al. 1995, Schouwenaars 1995, Schrautzer et al. 1996), water regime (Grootjans and van Diggelen 1995, Schouwenaars 1995), and/or water chemistry (Wind-Mulder and Vitt 2000). In fact, restoration may be impossible because of changes to the biotic and abiotic properties (Shouwenaars 1995, Schrautzer et al. 1996).

It is apparent that true restoration of a raised bog ecosystem is a long-term process. In *Restoration of Temperate Wetlands*, Joosten (1995) states:

> *Long term studies in bog regeneration indicate that restoration of bogs as self-regulating landscapes after severe anthropogenic damage is impossible within human time perspective, because the necessary massive re-establishment of bog key species and renewed accumulation of peat require centuries.*

Refer to Chapter 6 for more information on the challenges in restoring bogs.

5.4.1.2 Alkali Wetlands

Alkali wetlands are characterized by the occurrence of non-tidal, shallow saline water. In eastern Washington, these wetlands contain surface water with specific conductance (a measure of salinity) that exceeds 3,000 micromhos per centimeter. These wetlands provide the primary habitat for several species of migratory shorebirds and are also heavily used by migrating waterfowl. They also have unique plants and animals that are not found anywhere else in eastern Washington. For example, the small alkali bee that is used to pollinate alfalfa and onion for seed production lives in alkali systems. This bee is a valuable natural resource for agriculture in the western United States and especially in eastern Washington (Delaplane and Mayer 2000). The "regular" bees which pollinate fruits and vegetables are generally too large to pollinate the small flowers of these commercially important plants.

The salt concentrations in alkali wetlands have resulted from a relatively long-term process of groundwater surfacing and evaporating. These conditions cannot be easily reproduced through compensatory mitigation because the balance of salts, evaporation, and water inflows is hard to reproduce, and no references were found suggesting this has ever been attempted. Alkali wetlands are also rare in the landscape of eastern Washington. Of several hundred wetlands that were surveyed and visited by wetland scientists during field work for the state's function assessment methods and the rating system for eastern Washington (Hruby et al. 2000, Hruby 2004a), only nine could be classified as alkali.

5.4.1.3 Mature and Old-Growth Forested Wetlands

No mature or old-growth forested wetlands have ever been successfully created or restored through compensatory mitigation. A mature forested wetland may require 80 years or more to develop, and the full range of functions performed by these wetlands may take even longer (Stanturf et al. 2001). The actual time required to reconstruct old-growth forests and their soil properties (in contrast to mature forests) is unknown (Zedler and Callaway 1999). These forested wetlands provide important functions associated with wetlands as well as habitat functions associated with mature and old-growth forests. (Washington State Department of Fish and Wildlife 1999a).

5.4.1.4 Vernal Pools

Vernal pool wetlands occur in eastern Washington and are formed when small depressions in bedrock or in shallow soils fill with snowmelt or spring rains. They retain water until the late spring when reduced precipitation and increased evapotranspiration lead to a complete drying out. The wetlands hold water long enough throughout the year to allow some strictly aquatic organisms to flourish but not long enough for the development of a typical wetland environment (Zedler 1987). Vernal pools often contain upland species during the summer after they dry out and may be difficult to identify as jurisdictional wetlands during part of the year.

Vernal pools in the scablands are the first to melt in the early spring. This open water provides areas where migrating waterfowl can find food while other, larger bodies of water are still frozen. Furthermore, the open water provides areas for pair bonding of waterfowl (R. Friesz, Washington State Department of Fish and Wildlife, personal communications 2000-2004). Thus, vernal pools in a landscape with other wetlands provide a critical habitat function for waterfowl (Hruby 2004a).

5.4.1.5 "Natural Heritage" Wetlands

"Natural Heritage" wetlands are those that have been identified by scientists of the Washington State Natural Heritage Program as high-quality, relatively undisturbed wetlands, and wetlands that support state threatened, endangered, or sensitive plant species.

The Natural Heritage Program has identified important natural plant communities and species that are very sensitive to disturbance or threatened by human activities and maintains a database of these sites. The program's web site states:

> *Some natural systems and species will survive in Washington only if we give them special attention. By focusing on species at risk and maintaining the diversity of natural ecosystems and native species, we can help assure our state's continued environmental and economic health.* (Washington State Department of Natural Resources No Date, http://www.dnr.wa.gov/nhp/about.html)

5.4.1.6 Estuarine Wetlands

Estuaries, the areas where freshwater and salt water mix, are among the most highly productive and complex ecosystems. Here, tremendous quantities of sediments, nutrients, and organic matter are exchanged between terrestrial, freshwater, and marine communities. A large number of plants and animals benefit from estuarine wetlands. Fish, shellfish, birds, and plants are the most visible organisms that live in estuarine wetlands. However, a huge variety of other life forms also live in an estuarine wetland, including many kinds of diatoms, algae and invertebrates.

Estuaries, of which estuarine wetlands are a part, are a "priority habitat" as defined by the state Department of Fish and Wildlife. Estuaries have a high fish and wildlife density and species richness, important breeding habitat, important fish and wildlife seasonal ranges and movement corridors, limited availability, and high vulnerability to alteration of their habitat (Washington State Department of Fish and Wildlife, http://www.wa.gov/wdfw/hab/phslist.htm , accessed October 15, 2003).

Estuarine wetlands are not freshwater wetlands, and therefore, information about them was not reviewed in Volume 1. They are included in this compilation of wetlands with special characteristics because they are included in the wetland rating System for western Washington (Hruby 2004b). They are often found adjacent to freshwater wetlands and should be managed in conjunction with freshwater wetlands. The methods for identifying estuarine wetlands and the rationale for protecting them are described in more detail in the rating system (Hruby 2004b).

5.4.1.7 Wetlands in Coastal Lagoons

Coastal lagoons are shallow bodies of water, like a pond, partly or completely separated from the sea by a barrier beach. They may, or may not, be connected to the sea by an inlet, but they all receive periodic influxes of salt water. This can be either through storm surges overtopping the barrier beach or by flow through the porous sediments of the beach. Coastal lagoons often contain vegetated areas that are jurisdictional wetlands. The wetlands associated with coastal lagoons are, therefore, included in the rating system as wetlands with special characteristics.

Wetlands in coastal lagoons probably cannot be reproduced through compensatory mitigation, and they are relatively rare in the landscape. No information was found on any attempts to create or restore wetlands in coastal lagoons in Washington that would suggest this type of compensatory mitigation is possible. Any impacts to lagoons will, therefore, probably result in a net loss of their functions and values.

In addition, coastal lagoons and their associated wetlands are proving to be very important habitat for salmonids. Unpublished reports of ongoing research in the Puget Sound (Hirschi et al. 2003, Beamer et al. 2003) suggest coastal lagoons are heavily used by juvenile salmonids.

5.4.1.8 Interdunal Wetlands

As defined in the western Washington rating system (Hruby 2004b), any wetlands that are located to the west of the Boundary Line of Upland Ownership as determined in 1889 are considered interdunal. The boundary line is a legally defined line along the Pacific Coast. Interdunal wetlands form in the "deflation plains" and "swales" that are geomorphic features in areas of coastal dunes. These dunes are the result of the interaction between sand, wind, water, and plants. The dune system immediately behind the ocean beach (the primary dune system) and its associated wetlands is very dynamic and can change from storm to storm (Wiedemann 1984). This means that the location of the wetlands is not fixed and may change from year to year.

Interdunal wetlands provide critical habitat for many species in this ecosystem (Wiedemann 1984). Although important, these wetlands constitute only a small part of the total dune system (Wiedemann 1984). No methods have been developed to characterize how well interdunal wetlands function so these wetlands cannot be rated by a score for their functions. In the absence of direct methods for characterizing their functions, the rating of interdunal wetlands is based on their documented importance as habitat in the coastal dune ecosystem.

5.4.2 Summary of Key Points

- Wetland rating systems provide a rapid method to identify, characterize, categorize, or estimate relative wetland functions and values. This information is used in regulating and managing wetlands.
- The rapid method most commonly used for analyzing wetlands in eastern and western Washington has been the Washington State wetland rating systems. The rating system was designed to differentiate between wetlands based on a broad grouping of functions that they provide (hydrologic, water quality, and habitat), as well as other characteristics (listed in the next bullet). However, this rating system does not replace the more robust function assessment methods developed for Washington State. The latter may be necessary to determine the level of performance for specific functions (such as the potential to remove sediment) or to plan and monitor a compensatory mitigation project.
- In the rating system, some wetlands are categorized because of their rarity on the landscape, sensitivity to disturbance, or difficulty in restoration or creation through mitigation efforts, and not because of the functions these wetlands perform. The wetland types in Washington that are included in the rating system because they have these other characteristics include bogs, alkali wetlands, mature and old-growth forested wetlands, vernal pools, estuarine wetlands, wetlands in coastal lagoons, interdunal wetlands, and "Natural Heritage" wetlands.

5.5 Buffers

Buffers are another common element of wetland regulations. Buffers are vegetated areas adjacent to an aquatic resource that can, through various physical, chemical, and/or biological processes, reduce impacts from adjacent land uses. Buffers also provide the terrestrial habitats necessary for wildlife that use wetlands to meet their life-history needs. In this document, we collectively call these processes that buffers provide the *functions* of buffers. Buffers and other adjacent upland areas provide habitat for other wildlife species that do not commonly use wetlands. This document does not address those functions of upland habitats.

The primary purpose of buffers is to protect and maintain the wide variety of functions and values provided by wetlands (or other aquatic areas). The physical characteristics of buffers—slope, soils, vegetation, and width—determine how well buffers reduce the adverse impacts of human development and provide the habitat needed by wildlife species that use wetlands. These characteristics are discussed in detail in this section.

The subject of buffers is well documented in the scientific literature. The research on buffers has occurred worldwide, and this section includes literature from a variety of regions when it was found to be relevant. In particular, a variety of literature related to agricultural practices and vegetated filter strips from the north-central United States and south-central Canada is directly relevant to some agricultural practices in Washington State, especially east of the Cascades. In addition, studies on buffers in urban and suburban settings conducted in the Pacific Northwest region are clearly relevant. However, many of the buffer studies conducted elsewhere in the U.S. and the world, as well as the many buffer synthesis documents, provide information relevant to the state of Washington.

The majority of research on buffers tends to focus on the processes that buffers provide to filter sediment or take up nutrients (i.e., their influence on water quality). Far fewer studies look at the influence of a buffer's physical characteristics on attenuating surface water flow rates, except as it relates to water quality. The long-term effectiveness of buffers in providing such mechanical and biological processes is not well documented in the literature and may represent a critical need for future research.

The literature on buffers related to wildlife is, in general, less focused. Most studies document the needs of a particular species or guild relative to distances for breeding or other life-history needs within a radius from aquatic habitats. There is substantial literature on the implications of habitat fragmentation and connectivity, some of it related specifically to agricultural practices, forestry practices, or the impacts of urbanization. This literature does not specifically address the role of buffers in providing connectivity between wetlands and other parts of the landscape. It does, however, unequivocally support maintaining connectivity between wetlands in order to maintain viable populations of species that are closely associated with wetlands. The reader is referred to Section 4.11 in Chapter 4, which discussed the effects of habitat loss and fragmentation as well as Section 5.5.4.3.

Older research studied the tolerance limits of wetland wildlife for disturbance—how closely a disturbance can approach animals before they are flushed from wetlands—with particular emphasis on waterfowl. These studies tend to be older than 1990 and focus on the prairie pothole region of North America. Where the findings are germane and where they have not been superceded by more recent work, they are included.

In addition to papers on specific research studies, multiple compilations and syntheses of literature on buffers have been completed since 1990. Synthesis papers were compiled by Castelle and other authors (1992b, 1994, and 2000) and another was compiled by McMillan (2000) as a master's thesis. These compilations include literature that was published prior to 1990, but much of the work they rely on is considered seminal to the effectiveness of buffers in protecting wetlands and contributing to habitat. Therefore these synthesis documents are used in this document as direct sources when no more recent research was found to supercede the earlier findings.

This section also cites literature related to stream buffers and riparian areas when the findings are relevant to the influence these areas have on the adjacent aquatic resource. The literature on stream buffers related to microclimate, water quality influences, and some habitat characteristics is particularly relevant because the ways buffers protect and maintain these functions is similar whether they are adjacent to streams or wetlands.

5.5.1 Terms Used to Describe Buffers

The scientific literature varies widely on the terms used to denote the area that serves to reduce impacts to wetlands from adjacent land uses and provide habitat for parts of the life-cycle of many species. Common terms include:

- Buffer
- Wetland setback
- Vegetated filter strip
- Buffer strip
- Riparian area
- Riparian zone
- Riparian corridor

These terms can be differentiated as those that are a product of regulations or policy language and those that define or describe an ecological condition or location (Castelle et al. 1994). Terms such as *buffer*, *wetland setback*, or *vegetated filter strip* are most commonly applied in an administrative context to denote the landscape immediately adjacent to an aquatic resource, the dimensions of which are legally determined. The terms *buffer strip* or *vegetated filter strip* may imply a relatively undisturbed, vegetated area that helps attenuate the adverse effects of land uses adjacent to a wetland. For example, Norman (1996) provides this definition:

> *Buffer strips are strips of vegetated land composed in many cases of natural ecotonal and upland plant communities which separate development from environmentally sensitive areas and lessen these adverse impacts of human disturbance.*

The terms *riparian areas* or *riparian zones* are defined by many to denote ecologically discernable ecotones (transition zones) along aquatic resources where the presence or action of surface waters, or the presence and duration of shallow groundwater, influences the structure and composition of the vegetation community (Lowrance et al. 1995, Harper and MacDonald 2001). The term *riparian corridor* is defined by Naiman et al. (1993) as "encompass(ing) the stream channel and that portion of the terrestrial landscape from the high water mark towards the uplands where vegetation may be influenced by elevated water tables or flooding, and by the ability of the soils to hold water."

5.5.2 Functions Provided by Buffers

The literature is broadly consistent on the ways in which buffers can provide for the protection and maintenance of wetland functions. These include:

- Removing sediment
- Removing excess nutrients (phosphorous and nitrogen)
- Removing toxics (bacteria, metals, pesticides)
- Influencing the microclimate
- Maintaining adjacent habitat critical for the life needs of many species that use wetlands
- Screening adjacent disturbances (noise, light, etc.)
- Maintaining habitat connectivity

As noted by Castelle and Johnson (2000), buffers can be both ecological sources and sinks. They can control or limit the effects of land uses upslope of the aquatic resource (act as a sink), and they can contribute biological benefits to the aquatic resource (act as a source). Naimen et al. (1992) summarize the range of functions provided by buffers along streams as follows:

> *It is well known that riparian vegetation regulates light and temperature regimes, provides nourishment to aquatic as well as terrestrial biota, acts as a source of large woody debris,...regulates the flow of water and nutrients from uplands to the stream, and maintains biodiversity by providing an unusually diverse array of habitat and ecological services.*

These same functions can be attributed to wetland buffers (Castelle et al. 1992b, Desbonnet et al. 1994, McMillan 2000).

The literature also describes the physical, chemical, and/or biological characteristics of a buffer that determine the functions it provides. The most frequently cited physical characteristics that influence the effectiveness of a buffer are:

- Vegetation characteristics (composition, density, and roughness—for example, downed material)
- Percent slope
- Soils
- Buffer width and length (adjacent to the source of impacts)

Only two of the physical characteristics noted above can be easily managed (vegetation characteristics and buffer width/length), while the others are characteristics that do not lend themselves to manipulation.

By far the issue of greatest interest with respect to buffers is the question of how wide a buffer needs to be in order to be effective in protecting a wetland (or other aquatic resource). While the literature is unanimous that buffers provide important functions that protect wetlands and provide essential habitat for many species, there is wide-ranging discussion about how much buffer is necessary to be effective in providing a particular level of function (Young et al. 1980, Booth 1991, Castelle et al. 1994, Norman 1996, Dosskey 2000, McMillan 2000, Rickerl et al. 2000).

For ease of discussion as to the effective widths of buffers, the functions of buffers listed above are grouped into two major categories:

- Water quality (discussed in Section 5.5.3)
- Wildlife habitat (discussed in Section 5.5.4)

Buffers and their influence on wetland hydroperiod, as described in the few studies found on this subject, are summarized in the shaded box on the next page.

The following literature sources are generally consistent in describing what functions buffers provide to aquatic resources as well as the physical parameters that influence a buffer's ability to provide these functions: Budd et al. (1987), Phillips (1989), Castelle et al. (1992, 1994), Naiman et al. (1992), Belt and O'Laughlin (1994), Desbonnet et al. (1994), Norman (1996), Dillaha and Inamdar (1997), Dosskey (2000), Van der Kamp and Hayashi (1998), Liquori (2000), McMillan (2000), Todd (2000), Townsend and Robinson (2001), Dosskey (2001).

Buffers alone have limited influence on wetland hydroperiod

As described in detail in Chapter 3, human land uses, such as agricultural practices, clearing, and land development, alter the movement and storage of surface water and groundwater within a wetland's contributing basin. These changes can significantly affect the hydroperiod of wetlands and other aquatic resources, causing an adverse effect on many wetland functions (Azous and Horner 2001). There is little published literature on the effectiveness of buffers in ameliorating the effect of changes in land use within the contributing basin on wetland hydroperiod. Some of the literature indicates that wetland buffers are far less effective at maintaining wetland hydroperiod than other mechanisms, such as controlling impervious surfaces and utilizing effective stormwater management practices (Herson-Jones et al. 1995).

Research in the Puget Sound Basin has agreed that changes in the land cover type in the contributing basin have a stronger influence on the resulting hydroperiod of the wetland than the buffer does (Booth 1991, Azous and Horner 2001). An exception may be for wetlands that have a very small contributing basin. However, the rate and manner in which stormwater enters the wetland following land-use changes in the contributing basin will most often shift from sheet flow and interflow to one or more point sources, resulting in a potential change in hydroperiod. Based on hydroperiod models using the U.S. Environmental Protection Agency's Hydrologic Simulation Program Fortran (HSPF model) for areas west of the Cascades, the wetland will tend to receive more water more quickly in the fall and will receive less water for a shorter period in the spring, resulting in a shift in the seasonal hydroperiod.

Buffer width is usually not sufficient to counteract the influence of land-use changes and stormwater management facilities within the wetland's contributing basin.

5.5.3 Buffers and Protection of Water Quality

Buffers protect the water quality of wetlands through four basic mechanisms:

- They remove sediment (and attached pollutants) from surface water flowing across the buffer
- They biologically "treat" surface and shallow groundwater through plant uptake or by biological conversion of nutrients and bacteria into less harmful forms
- They bind dissolved pollutants by adsorption onto clay and humus particles in the soil
- They help maintain the water temperatures in the wetland through shading and blocking wind

Literature describing the different ways that buffers maintain and improve water quality in wetlands and other aquatic areas is abundant. There is also considerable research on the effective widths that provide a relative percentage of removal of sediments, nutrients, and some toxics emanating from various sources. Four categories of water quality improvement are discussed below:

- Removing sediment
- Removing nutrients
- Removing toxics and pathogens
- Maintaining microclimate

For each of these categories, a summary is provided on what the literature says about the relationship between buffer width (or other characteristics) and the buffer's effectiveness in providing that type of water quality improvement. A summary table is included that lists the range of buffer widths for each category and the literature references that substantiate those findings. However, the literature does not address the issue of "how much pollutant removal is acceptable." For each pollutant, there may be a maximum amount that a buffer can process before its ability to do so is overwhelmed. The literature does not provide any specific thresholds (See section 5.5.5.3 for more on this issue).

5.5.3.1 Removing Sediment

Characteristics that Influence a Buffer's Ability to Remove Sediment

A buffer's ability to remove sediment from surface water flows depends upon several physical characteristics of the buffer. Sediment removal occurs when (Castelle et al. 1992b, Dillaha and Inamdar 1997, Phillips 1989):

- Flows are slowed sufficiently to allow particles to settle out
- Physical filtering by vegetation and roots mechanically removes sediments from the water column
- The slope of the buffer is of a low enough gradient to preclude formation of rills and scouring
- There is large woody debris on the ground to create roughness
- The infiltration rate of the soils allows water to move through the soils rather than on the surface

The way sediment-laden water enters a buffer influences the ability of the buffer to slow the flows sufficiently to allow sediment deposition. Several studies noted that vegetated buffers are only effective at removing sediments if sediment-laden waters enter the buffer as sheet flow, rather than in channels or rivulets (Phillips 1989, Booth 1991, Castelle et al. 1992b, Desbonnet et al. 1994, Belt and O'Laughlin 1994, Sheridan et al. 1999). Norman (1996) cites work conducted by Schueler in 1987 that found buffers in urban settings were most effective at removing sediments where slopes were less than 5%, and waters entered the buffer in shallow, dispersed sheet flow. Norman surmised that, "The rate of removal of pollutants appears to be a function of the width, slope, and soil permeability of the (buffer) strip, the size of the contributing runoff area, and the runoff velocity."

In other research, Sheridan et al. (1999) found that the greatest reduction in sediment loading occurs in the initial "treatment" stages using a vegetated filter strip that is managed and mowed. Their research found the greatest removal of sediments (56 to 72%) and reduction in flow rates occurs in the outer portion of a vegetated filter strip (the strip closest to the source of sediment). Grass filter strips provided removal ranging from 78 to 83% of suspended sediments.

The ability of a buffer to provide physical filtering of sediments also depends on the condition of the vegetation and the surface roughness. Belt and O'Laughlin (1994) noted that when vegetation, rocks, or other obstructions were eliminated from the buffer surface, sediment-laden waters flowed further into (or through) a buffer. Buffers were found to be effective in removing sediments only if flows were shallow and broad, not narrow and incised. The presence of woody debris and vegetative obstructions on the ground surface (roughness) was found to slow flows, inhibit the formation of rills, and facilitate sediment deposition.

In contrast, hydrologic models created by Phillips (1989) estimated that surface roughness would be of minor concern, and buffer width was not critical, as long as a minimum 49-foot (15 m) buffer was maintained. This study was based on estimated models, whereas Belt and O'Laughlin's work was based on field measurements.

Phillips (1989) also emphasized the importance of slope. He states, "Results show that where solid-phase pollutants transported as suspended or bed-load in overland flow are the major concern, slope gradient is the most critical factor, followed by soil hydraulic conductivity." Slope gradient is critical because, on slopes greater than 5%, sheet flow can start to become channelized. Channelized flows have faster rates, more erosive powers, and less contact with vegetation (Norman 1996). Faster moving water has the capacity to carry fine sediment particles farther than slower flows, even moving through dense vegetation.

In his research in urbanizing settings, Booth (1991) notes that buffers adjacent to aquatic resources may have limited ability to filter and slow flows caused by stormwater. He found that (1) in some instances the buffers no longer existed in a natural vegetated condition, (2) once development occurred, and the buffer was subdivided into multiple private ownerships, maintaining an intact buffer was not possible, or (3) the increased volumes and rates of flows were too significant to be controlled by conditions within a vegetated buffer.

Buffers were found to facilitate reduction of sediment from active agricultural fields in several studies:

- Welsch (1991) found that a three-tiered buffer system on a shallow slope, with the first tier (closest to the source of sediment) composed of dense herbaceous vegetation, maximized sediment removal (See Section 5.5.6 for a discussion of the three-tiered system).
- Dosskey (2001) noted in agricultural settings that vegetated buffers retain pollutants by reducing the flow rates and filtering surface runoff from fields.
- Assessing management options to control non-point-source pollution (sediment, nitrogen, and phosphorus) in agricultural settings, Yocom et al. (1989) recommended the use of vegetated filter strips between actively cropped land and adjacent wetlands.

Buffer Width and Effectiveness in Removing Sediment

As noted above, the ability of a buffer to remove sediment is based on the condition of the buffer and its slope, as well as the characteristics of the incoming sediment. The following variables all contribute to the sediment removal effectiveness of a buffer:

- The velocity of sediment transport (in surface water)
- The size of sediment particles from the source materials
- The density of the vegetation present
- The presence and extent of large woody debris
- Surface roughness within the buffer

However, the relationship between the width of the buffer and its effectiveness is non-linear. The largest particles and the greatest percentage of particles are dropped in the outer portions of the buffer (closest to the source of sediment). In these outer areas, the rate of surface flow begins to diminish as the water is slowed by vegetation and woody debris. Slower water movement allows particles to drop out of the water column.

This is graphically illustrated in the graph below (Figure 5-1). This table is included here for illustrative purposes only, to depict the non-linear nature of buffers in removing sediments. This graph is based on data from the buffer synthesis by Desbonnet et al. (1994).

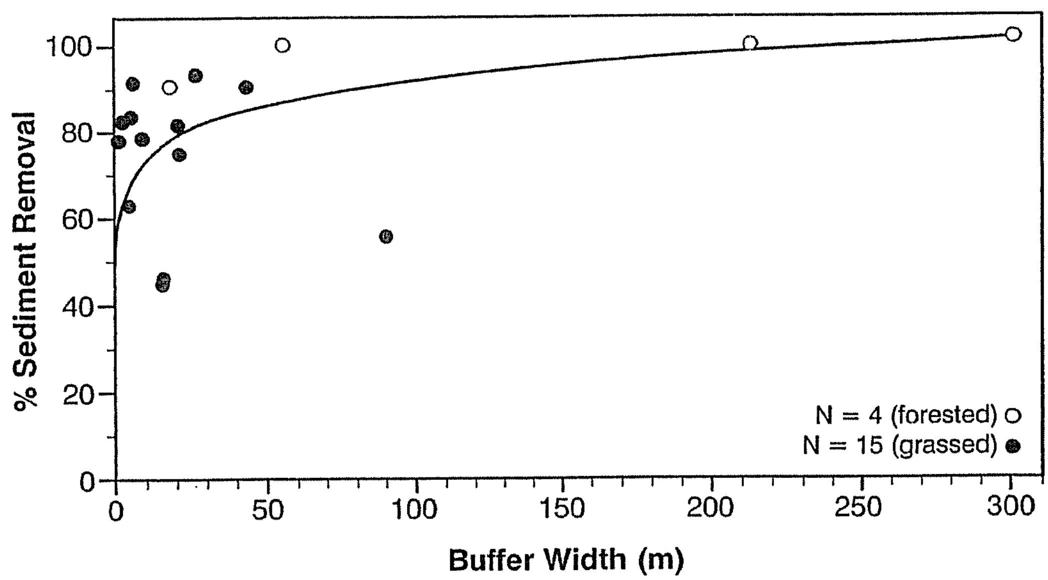


Figure 5-1. Relationship of percent removal to buffer width for the treatment of sediments contained in surface water runoff (Desbonnet et al. 1994).

In 1982, Wong and McCuen derived a formula to model a buffer's ability to remove sediments based on sediment particle size, the slope within the buffer, the rate of surface runoff, and the amount of vegetation and woody debris (roughness) in the buffer (Castelle et al. 1994). The model predicted that there would be a point of relative diminishing returns for function vs. width. For example, "If the sediment removal design criteria were increased from 90 to 95% on a 2% slope, then the buffer widths would have to be doubled from 30.5 to 61 m (100 to 200 ft)." In other words, the model predicted that the width of the buffer would have to double to achieve an additional 5% removal of sediment after 90% of it had already been removed from the water column. Desbonnet et al. (1994) determined that a small buffer (7 feet [2 m]) could effectively remove up to 60% of suspended sediment, while a buffer of up to 82 feet (25 m) would be needed to remove 80%.

These findings are consistent with others who have found that progressively larger buffer dimensions are required to filter out finer particles (Norman 1996). These and other studies are summarized in Table 5-1.

See Section 5.5.5 for discussion of the ability of buffers to continue providing sediment removal over the long term.

Table 5-1. Summary of studies on sediment control provided by buffers of various widths.

Author(s)	Date	Buffer Width	Comments
Broderson	1973	200 feet (61 m)	Effective sediment control "even on steep slopes"
Desbonnet et al.	1994	6.6 – 82 feet (2 – 25 m)	60% removal in 6.6 feet (2 m); 80% removal required 80 feet (25 m)
Desbonnet et al.	1994	16 – 49 feet (5 – 15 m)	On grassy buffers on slopes with less than 5% slope, removed all but the finest particles
Ghaffarzadeh et al.	1992	16 – 49 feet (5 – 15 m)	Found 85% removal in 30-foot (9.1 m) buffers
Horner and Mar	1982	200 feet (61 m)	80% of sediments. As cited by Castelle and Johnson (2000)
Lynch et al.	1985	98 feet (30 m)	75 to 80% removal of sediment from logging activities into wetlands
Norman	1996	9.8 feet (3 m): sands 49.9 feet (15.2 m): silts 400 feet (122 m): clays	Distances required for effective removal of progressively smaller particle sizes
Wong and McCuen	1982	100 – 200 feet (30.5 – 61 m)	90% at 100 feet (30 m), need 200 feet (61 m) to obtain 95% removal effectiveness
Young et al.	1980	80 feet (24.4 m)	92% sediment removal rate from feedlot through vegetated buffer strip

5.5.3.2 Removing Nutrients

Characteristics that Influence a Buffer's Ability to Remove Nutrients

Nutrients are transported into wetlands via sediment-laden water or dissolved in surface or shallow subsurface flows. The primary nutrients of concern are nitrogen and phosphorous. Buffers remove nitrogen and phosphorous through a variety of mechanisms that are similar to the mechanisms present within the wetland itself, as described in Chapter 2.

As much as 85% of phosphorous in surface waters is bound to sediments (Karr and Schlosser 1977) and thus can be removed via sediment removal in buffers. Phosphorus and other nutrients may be effectively reduced in surface waters by filtering and uptake; however, dissolved forms of nitrogen are not affected by surface processes and can be more effectively removed in the buffer through subsurface contact with fine roots (Muscutt et al. 1993, Townsend and Robinson 2001). Lowrance et al. (1995) confirm that the areas where improvements in water quality are the most effective are where precipitation moves across, through, or near the rooting zone of a forested buffer. These findings are similar to those of Phillips (1989), who found that longer contact of dissolved pollutants through wider vegetated buffers was the most important factor for effective removal.

Buffer Width and Effectiveness in Removing Nutrients

It is difficult to compare studies of buffer width and effectiveness at removing nutrients because the basic parameters of the studies differ greatly. Some studies were conducted in field settings while others occurred in experimentally designed plots. There were differences in the loading rate of nutrients, the types of soils, and the vegetation in the buffers. Some studies examined only nitrogen or phosphorous removal, whereas others combined different nutrients. The result is that reported effectiveness of buffer widths for removing nutrients ranges from a few meters to hundreds of meters. Studies are listed in Table 5-2.

In a synthesis of research on nitrogen removal, McMillan (2000) found nitrogen can be effectively removed in buffer strips ranging from 20 to 98 feet (6 to 30 m) wide. He cites work by two research groups (Patty et al. 1997, Daniels and Gilliam 1996) that 47 to 99% removal of nitrogen can be achieved in buffers ranging from 20 to 66 feet (6 to 20 m) wide. This is not totally consistent with synthesis results presented by Desbonnet et al. (1994) that "well configured" buffers (with ideal slope, soils, and vegetation) as small as 30 feet (9 m) could reduce as much as 60% of nitrogen, while 197-foot (60 m) buffers would be necessary for 80% nitrogen removal.

A recent study from Oregon documented the role of red alder forests in exporting nitrogen to streams (Compton et al. 2003). They found that the percent of alder forest in a watershed was positively correlated with nitrate concentrations in surface water. This has implications for assuming that buffers with alder forests will help reduce the input of nitrogen from adjacent land uses into wetlands and other surface water.

The literature also describes a range of buffer widths necessary for phosphorus removal. Studies of buffer widths as small as 13 feet (4 m) and as large as 279 feet (85 m) found phosphorus removal rates of 50% to over 90% (see Table 5-2).

Overall, a consistent pattern emerges from the literature. The largest relative percent removal of phosphorus occurs within the outer portions of the buffer (closest to the source), while larger buffers are required to remove increasingly more of the nutrients. This consistency substantiates the conclusions of many that initial contact causes sediment-associated nutrients to be deposited, while dissolved nutrients require longer residence time and prolonged contact with vegetation for effective uptake (removal from the water column) to occur.

Castelle and Johnson (2000) surmised in their literature review that nutrient removal may have a similar non-linear relationship to buffer width as sediment removal. However, Phillips (1989) found that buffer width was a more critical element for dissolved nutrients (especially nitrogen), because wider buffers provided more prolonged contact with the rooting zone and time for uptake and conversion. Phillips did not report widths of buffers related to a certain percent of removal or effectiveness.

Limited research has been done on the long-term effectiveness of buffers for nutrient removal when there is an ongoing nutrient source present on the outside edge of the buffer. See Section 5.5.5.3 for a discussion.

Table 5-2. Summary of studies on nutrient removal provided by buffers of various widths.

Author(s)	Date	Width	Comments
Daniels and Gilliam	1996	20 – 66 feet (6 – 20 m)	47-99% removal of nitrogen
Desbonnet et al.	1994	30 feet (9 m): 60% removal 197 feet (60 m): 80% removal	Small buffers could have effective removal rates for nitrogen; much larger buffers are necessary for a significant increase in effectiveness
Desbonnet et al.	1994	Averages: 39 feet (12 m): 60% 279 feet (85 m): 80%	When all the findings from the literature synthesis were averaged, the average removal efficiencies were non-linear: larger buffers were needed for increases in effectiveness
Dillaha	1993	15 feet (4.6 m): 70% 30 feet (9.1 m): 84 %	Percent removal of suspended solids and their associated nutrients with vegetated filter strips. As cited in Todd (2000)
Dillaha	1993	15 feet (4.6 m): 61 % 30 feet (9.1 m): 79 %	Removal of phosphorus with vegetated filter strips. As cited by Todd (2000)
Dillaha	1993	15 feet (4.6 m): 54% 30 feet (9.1 m): 73%	Removal of nitrogen with vegetated filter strips. As cited by Todd (2000)
Doyle et al.	1977	12.5 feet (3.8 m) forested 13.1 feet (4 m) grass	Reduced nitrogen, phosphorus, and potassium levels
Edwards et al.	1983	98 feet (30 m)	50% removal rate of phosphorus
Lowrance	1992	23 feet (7 m)	Forested buffer zones were effective at removing nitrate through plant uptake and microbial denitrification
Lynch et al.	1985	98 feet (30 m)	Forested buffers reduced soluble nutrient levels from logging activities to "appropriate" levels
Patty et al.	1997	20 – 66 feet (6 – 20 m)	47 - 99% removal of nitrogen
Shisler et al.	1987	62 feet (19 m)	Forested riparian buffers effectively removed up to 80% and 89% of phosphorus and nitrogen, respectively
Thompson et al.	1978	39 – 118 feet (12 – 36 m)	Found a range of removal effectiveness of 44 to 70%

Author(s)	Date	Width	Comments
Vanderholm and Dickey	1978	> 853 feet (260 m)	Removal of 80% of nutrients, solids, and BOD from feedlot runoff with shallow (<0.5%) buffer slopes. Cited in Castelle et al. (1992b)
Young et al.	1980	69 feet (21 m): 67% removal 89 feet (27 m): 88% removal	Removal of phosphorus
Xu et al.	1992	33 feet (10 m)	Significant reductions in nitrate through a mixed herbaceous and forested buffer strip (as cited by Castelle and Johnson 2000)

5.5.3.3 Removing Toxics and Pathogens

Characteristics that Influence a Buffer's Ability to Remove Toxics and Pathogens

A buffer's ability to remove toxicants and pathogens is one of the least thoroughly studied. At this time, it represents a significant data gap. Castelle and Johnson (2000) note the lack of research on pathogens, toxicants and fecal coliform bacteria (an indicator of the possible presence of pathogens). Many of the studies they examined are quite old, but little recent research was found to supplement these older studies. Therefore, the conclusions presented from the synthesis of the previous work are provided here.

Gilliam (1994) also confirms in his work that little to no research is available on the effective removal of fecal coliforms or various pesticides. Much of the work assessed the effectiveness of removal of nutrients and toxics, without identifying a dimension of width necessary to provide that removal.

Toxics (pesticides and metals) can be removed by buffers through sedimentation, biological uptake by vegetation, adsorption onto clay or humus particles in the soil of the buffer, or degradation of the toxics through biochemical processes (McMillan 2000, Patty et al. 1997).

As mentioned in the discussion of sediment removal, Welsch (1991) described the use of a three-tier buffering system for the most effective removal of sediments and their associated toxics. The outermost tier (closest to the source of impacts) was a densely vegetated filter strip, managed to ensure no erosion or rill formation. He found the most effective removal of sediments and the toxics adhered to sediment particles was through surface sheet flows through the vegetated filter strip. The middle tier was subject to some management activities (limited agriculture or limited tree harvest), while the innermost tier was undisturbed natural vegetation. Dissolved nutrients and some toxics were not affected by physical filtering unless there was prolonged contact with the rooting zone through the shallow groundwater table. See Section 5.5.6 for further discussion.

Castelle and Johnson (2000) note that the apparent effectiveness of small buffers in removing toxics is due to the adsorption of many toxics to sediment particles. When vegetated buffers are effective at filtering sediments, they will also be effective at filtering those toxics and nutrients adhered to the sediments.

One study in Saskatchewan (Donald et al. 1999) found that the concentrations of agricultural pesticides and herbicides in wetlands were influenced by the timing of precipitation relative to the applications of the chemicals. They noted that buffer width may influence exposure of the wetland to these chemicals, but they did not quantify what buffer widths related to the effectiveness of removing chemicals.

Neary et al. (1993) reviewed studies in the Southeastern U.S. on the use of buffers in reducing contamination of water by pesticides. They found that cases of high concentrations of pesticides in water only occurred when no buffer was present or when pesticides were applied within the buffer. Regular use of buffer strips kept concentrations of pesticide residue within water-quality standards. Neary concluded that, generally speaking, buffer strips of 15 m (49 ft) or larger are effective in minimizing contamination of streams by pesticide residue.

Table 5-3 summarizes studies on the effectiveness of toxicant and pathogen removal provided by buffers of various widths.

Table 5-3. Summary of studies on pathogen control provided by buffers of various widths.

Author(s)	Date	Width	Comments
Doyle et al.	1977	12.5-foot (3.8 m) forested buffers 13.1-foot (4 m) grass buffers	Reduction in fecal coliform bacteria levels.
Grismer	1981	98-foot (30 m) grass filter strip	Removal of 60% of fecal coliform bacteria.
Young et al.	1980	115-foot (35 m) grass buffer	Reduced microorganisms to acceptable levels.

5.5.3.4 Maintaining Microclimate

The influence of buffers on microclimate is most often thought of in the context of shading for maintaining water temperature. This is well documented in the literature in relation to the effects on streams (Lynch et al. 1985, Johnson and Stypula 1993, Belt and O'Laughlin 1994, Castelle and Johnson 2000,). In those documents, literature focused on streams and their buffers is almost exclusively relied upon to discuss the influences of buffers on water temperature. No literature was found that specifically examined the influence of buffers on the water temperatures and microclimates within wetlands.

It may be tempting to deduce that the benefit of forested shade in moderating water temperatures is the same in wetlands as in streams. However, it is not reasonable to apply to wetlands the findings on the widths used for stream buffers for the purpose of shading. As with streams, there are many variables that can influence how shading affects the water temperature in a wetland. These variables relate to differences in water budgets (e.g., the relative influence of groundwater on a seasonal basis, whether the wetland has an inlet/outlet, etc.). In addition, the physical configurations of a large open-water wetland, a small fully vegetated wetland, and a linear stream corridor may not provide reasonable parallels. With these limitations in mind, some relevant findings are provided below.

Forests can create shade and also block the wind, which can help moderate temperatures in adjacent aquatic systems (Oke 1987). Stable water temperature helps maintain water quality because cooler water can carry higher loads of dissolved oxygen, which is important for many aquatic biota. Warmer water can also result in a looser bond between sediment particles and nutrients, which could result in an increase in nutrient loading in warmer aquatic systems (Karr and Schlosser 1977).

Microclimate influences can also extend from large wetlands into the adjacent forests. Harper and MacDonald (2001) conducted research on boreal forests near lakes and found a "distinct lake edge community" of about 131 feet (40 m) width. The lake edge community tended to have greater structural diversity, less canopy cover, fewer snags, greater amounts of coarse woody debris, and greater number of saplings and mid-canopy trees than the interior forest. Changes in the distribution of vegetation species were along a shade tolerance gradient, but the authors postulated that moisture gradient or water table depth also had an influence. Their research was conducted within forests adjacent to open water lakes, but it would be valid to extrapolate their findings to forested communities adjacent to permanent, large open wetlands that would create the same "light and shade" effect. The findings imply that large open aquatic systems influence the adjoining upland community for approximately 131 feet (40 m) distance into the interior of the forested buffer. Thus, buffers not only influence temperatures and wind effects in a wetland, but research identifies that large aquatic systems may have a reverse positive influence on the vegetation structure and species diversity of the buffer. This can thereby affect some of the habitat discussed later in this chapter.

Table 5-4. Summary of a study on the influence of microclimate provided by buffers of various widths.

Author(s)	Date	Width	Comments
Harper and MacDonald	2001	Approx. 131 feet (40 m)	Influence of large aquatic systems on adjacent upland forest composition and structural complexity

5.5.3.5 Summary of Key Points

- The use of buffers to protect and maintain water quality in wetlands (removing sediments, nutrients, and toxicants) is best accomplished by ensuring sheet flow across a well vegetated buffer with a flat slope (less than 5%).
- Significant reductions in some pollutants, especially coarse sediments and the pollutants adhered to them, can be accomplished in a relatively narrow buffer of 16 to 66 feet (5 to 20 m), but removal of fine sediments requires substantially wider buffers of 66 to 328 feet (20 to 100 m).
- Removal of dissolved nutrients requires long retention times (dense vegetation and/or very low slope) and, more importantly, contact with fine roots in the upper soil profile (i.e., soils that are permeable and not compacted). Distances for dissolved nutrient removal are quite variable, ranging in the literature from approximately 16 to 131 feet (5 to 40 m).
- The literature is consistent in finding that it takes a proportionally larger buffer to remove significantly more pollutants because coarse sediments and the pollutants associated with them drop out in the initial (outer) portions of a buffer. It takes a longer time for settling, filtering, and contact with biologically active root zones to remove fine particles and dissolved nutrients.
- The role of buffers in protecting the microclimate of streams is well documented and may be applicable to wetlands, but no specific data on buffers and wetland microclimate maintenance were found.

5.5.4 Buffers and Wildlife Habitat

Wetland buffers are essential to maintaining viable wildlife habitat because they perform three overlapping functions:

- Buffers can provide an ecologically rich and diverse transition zone between aquatic and terrestrial habitats. This includes necessary terrestrial habitats for many wildlife species that use and/or need wetlands but also need terrestrial habitats to meet critical life requirements.
- Buffers can screen wetland habitat from the disturbances of adjacent human development
- Buffers may provide connectivity between otherwise isolated habitat areas

In regard to wildlife, most of the scientific research is not directly focused on the effectiveness of buffers for maintaining individuals or populations of species that use wetlands. Some of the research simply documents use of upland habitats adjacent to wetlands by wildlife to meet their life-history needs. For example, a substantial body of research identifies the distances that amphibians may be found away from a wetland edge. However, the implications to amphibian populations of providing buffers that are smaller than those identified ranges are not well documented.

The following discussion summarizes the literature on buffers related to wildlife that use wetlands for the three essential functions listed above. Several documents are cited that represent a synthesis of scientific literature on the effectiveness of buffers for protecting wildlife-related functions of wetlands. Even though these documents include some research conducted prior to 1990, they have been included where relevant.

There is substantial literature on the implications to wildlife populations from fragmenting habitats as a result of human activities. However, this research was not necessarily conducted to address the effectiveness of various buffer widths. The literature on this topic is mentioned because of the management implications for the long-term viability of species that are closely associated with wetlands. The reader is referred to Section 4.11 in Chapter 4 and Section 5.5.4.3 for a detailed discussion of habitat fragmentation.

5.5.4.1 Maintaining Terrestrial Habitat Adjacent to Wetlands

Buffers provide a transition between aquatic and terrestrial environments and are a critical component of the habitat of wildlife that use wetlands. The specific habitat functions provided by wetland buffers include:

- Sites for wildlife for foraging, breeding, and nesting
- Cover for escape from predators or adverse weather
- Source of woody debris and organic matter that provides habitat structure and food, as well as moderation of water temperatures within adjacent wetlands to support species that are sensitive to temperature (e.g., fish, amphibians).
- Areas for dispersal and migration related to both individuals and populations; buffers may connect or be part of corridors

As defined previously, buffers are predominantly upland habitat communities that lie adjacent to aquatic habitats. They are a different habitat type than the wetland and their presence increases habitat heterogeneity by providing niches for more species. First described by Leopold (1933) as the "edge effect," and later by Odum (1959) as an "ecotone," this phenomenon features higher use of transition zones by wildlife, particularly between aquatic and terrestrial habitats. It has been demonstrated in studies of birds (Beecher 1942, McElveen 1977), mammals (Bider 1968), and amphibians (Bury 1988). The same pattern has been demonstrated in the Pacific Northwest in studies by Oakley et al. (1985), Knight (1988), and Cross (1988). Recent research conducted in the Puget Sound lowlands found that the greatest species richness of birds and small mammals in 50 foot wetland buffers was found when an additional 1,640 feet (500 m) of relatively undisturbed habitat was adjacent to the wetland buffer (Richter and Azous 2001b, 2001c).

Protection of upland areas adjacent to wetlands is critical to helping ensure that wildlife populations that are closely associated with wetlands have access to the habitat features necessary to meet their survival requirements. Species that are closely associated with wetlands, such as many amphibians, aquatic invertebrates, waterfowl, and some mammals, require access to wetlands for critical stages of their life-history. Many more species use wetlands, as well as other aquatic systems such as streams, lakes, or rivers, to meet various life-history needs. Research shows that species that were assumed to be dependent upon wetlands also depend upon adequate and appropriate upland habitats to maintain viable populations (Foster et al. 1984, Bury 1988, Washington Department of Wildlife in Castelle et al. 1992b, Semlitsch 1998, Semlitsch 2000).

In addition, vegetated buffers protect habitat in wetlands by maintaining the microclimate (through temperature moderation), as discussed previously, and by providing a source of organic matter to aquatic systems. This includes both large organic debris (e.g., logs, root wads, limbs), which provides habitat structure in aquatic environments, and particulate and dissolved organic matter, which provides a source of food for invertebrates (Brown 1985, Groffman et al. 1991a).

In coastal wetlands in South Carolina, Braccia and Batzer (2001) found that large woody debris within wetlands was critical for both aquatic and terrestrial invertebrate populations. They identified that the source of the large woody debris within the wetlands was from the adjacent uplands. The forest conditions in adjacent uplands, therefore, can have a significant influence on wetland biota because the aquatic invertebrates form the foundation of many food chains in aquatic settings (Castelle et al. 1994).

Buffer Width and Effectiveness in Protecting Wetland Habitat and Providing Habitat in Adjacent Uplands

This section summarizes the literature that identified ranges of widths of uplands that protect wetland habitat and/or that provide adjacent upland habitat for wildlife species that use wetlands. The literature presents findings in a variety of ways. Some studies identify the distance that target species range from a wetland source, while other researchers identified the distances that species travel between wetlands. Synthesis documents outlined recommendations for buffer widths based on a review of research findings. Some of the literature identified use of habitats by broad categories of wildlife guilds, while other studies focused on limited guilds or even individual species.

It is important to understand that the range of buffer widths identified and discussed in the literature is a reflection of many variables including the objectives of the research, the species/guilds studied and their varied life-history needs, and the methods of the research. Thus, it is not appropriate to choose a single study or buffer dimension to justify a buffer dimension, whether large or small. It is critical to incorporate the life-history requirements of the range of targeted species when considering buffer dimensions. Synthesis documents clarify that a range of upland habitat buffer dimensions may be appropriate depending upon site considerations, landscape context, and targeted species.

For example, in summarizing the literature he reviewed on buffer effectiveness, McMillan (2000) concluded, "An appropriate buffer to maintain wildlife habitat functions for all but the most highly degraded wetlands would be comprised of native tree and/or shrub vegetation and range from 30 to 100 meters [98 to 328 feet]." Other authors have reached similar conclusions, with their buffer recommendations varying depending on the type of wildlife, life-history stage, intensity of adjacent land use, and surrounding landscape (Groffman et al. 1991a, Castelle et al. 1992b, Desbonnet et al. 1994, Semlitsch 1998). Because there is often substantial information on the needs for some specific wildlife groups, the research findings that are relevant for birds, amphibians, reptiles, and mammals are provided below. Following this discussion, Table 5-5 provides a summary of literature on general habitat needs in relation to buffer sizes.

One consideration not found for this synthesis was the implication of the condition of the upland buffer relative to its provision of wildlife habitat. In several studies on the use of upland buffers by native species, the study identified that the buffer was upland forest. However, no studies were reviewed for this synthesis that compared wildlife use of mature forested buffers with buffers composed of meadow, shrubland, harvest forest, or younger forests. Some research has identified the importance of intact forest habitat to wetland-related species (Azous and Horner 2001, Richter 1997), but a comparison study was not found for this synthesis.

Generally, wildlife-species have varying needs for different types of adjacent habitat for different life needs, such as breeding, foraging, and resting (Brown 1985). This makes it difficult to prescribe one particular type of habitat as best for wildlife. Habitat is very species specific. However, as a general rule, most researchers have recommended that buffers be maintained or restored to a forested condition if only for the screening function they provide. (Obviously, this has little relevance to the shrub-steppe ecoregion in Eastern Washington, where trees are rarely found.)

Birds

The research on birds ranges from studies in individual species to summaries on bird species richness. A tremendous amount of research on waterfowl exists, with the majority being conducted in the prairie pothole region of the United States. This section focuses on studies or syntheses that are relevant to the Pacific Northwest.

The Puget Sound Stormwater Management Research Program found that a distance of 1,640 feet (500 m) from a wetland edge was necessary to account for total species richness of birds (Richter and Azous 2001b). In a study of bird use of freshwater wetlands in urban King County, Washington, Milligan (1985) determined that bird species diversity was strongly correlated with the percentage of the wetland boundary that was buffered by at least 49 feet (15 m) of trees and shrubs.

In eastern Washington, Foster et al. (1984) determined that 68% of waterfowl nests were in upland areas within 98 feet (30 m) of the wetland edge, whereas it would take a 312-foot (95 m) buffer to encompass 95% of the nesting sites.

Temple and Cary (1988) created a computer model whose results may relate to the breeding success of forest birds using wetland buffers. Estimating the effects of habitat fragmentation on birds breeding in the interior of forests in Wisconsin, their model predicted that nesting success was strongly correlated to distance to the edge of a forest. The computer model predicted a success rate of 70% for nests greater than 656 feet (200 m) from the forest edge, 58% for a distance of 328 to 656 feet (100 to 200 m), and only 18% for nests less than 328 feet (100 m) from the forest edge. Applying these findings to wetland buffers, those less than 100 feet (30 m) in width might not be expected to support bird species that nest in forest interiors. The authors concluded that, without "recruits" (birds moving into appropriate habitat niches from farther afield), the continued fragmentation of forest habitats could lead to local extinction of populations of birds that use the interior of forests.

Amphibians

The research on amphibians and buffers in relation to their habitat needs comes both from studies in the Pacific Northwest and literature summaries from around the United States. Findings are rather consistent in that amphibians range substantial distances from breeding locations in a wetland to fulfill their life-history needs. On the west side of the Cascades, there appears to be a preference for forested habitats adjacent to breeding sites. Urban land uses near breeding sites seem to have a negative influence on amphibian abundance.

Detailed findings include:

- A study in the Puget Sound lowlands documented a decline in amphibian richness in wetlands where forest in the contributing watershed was diminishing. Results were not linked to buffer dimensions (Richter and Azous 2001a).
- In a study in King County by Ostergaard (2000), the greatest use of stormwater ponds by native breeding amphibians was found when 3,280 feet (1,000 m) of forested habitat was available adjacent to the pond.
- A study of pond-breeding salamanders in the eastern U.S. found that a buffer of 534 feet (164 m) would be needed to encompass 95% of adult and juvenile salamanders. This buffer range may apply to other similarly mobile species (Semlitsch 1998). Buffers of 98 to 328 feet (30 to 100 m) were recommended along riparian zones, depending upon slope, stream width, and adjacent use (Semlitsch 1998).
- Salamanders use upland habitats over 1,969 feet (600 m) from the edge of wetlands for non-breeding life-history stages. Sustaining viable amphibian species closely associated with wetlands requires maintaining the connection between wetlands and terrestrial habitats (Semlitsch 1998).

See Table 5-5 for further information on these studies.

In addition, in the Midwestern U.S., Knutson et al. (1999) found a positive correlation between the presence of forest around the perimeter of the wetland and amphibian abundance, and a negative correlation to urban land uses on the perimeter.

Reptiles

Western pond turtles are associated with a variety of aquatic habitats, including wetlands, streams, and rivers. In a California study, western pond turtles were found to overwinter as far as 1,650 feet (500m) from water (Reese and Welsh 1997). An unpublished study done in Washington for the Washington Department of Wildlife found nest sites as far as 615 feet (187m) from water, usually in open areas with good sun exposure (Holland 1991).

Research on freshwater turtles in North Carolina found that turtles used a wide area for nesting and terrestrial hibernation in uplands surrounding the ponds where breeding occurred (Burke and Gibbons 1995). They found that a 902-foot (275 m) buffer was required to protect 100% of the nest and hibernation sites. Protecting 90% of the sites required a 240-foot (73 m) buffer. The authors concluded that most buffer requirements are inadequate to protect turtle habitat for all stages of their life-history.

Mammals

Use of wetlands by mammals depends upon adjacent uplands. The literature indicates that even a mammal that is closely associated with wetlands, such as a beaver, uses upland habitats an average of 100 feet (30 m) from the wetland edge in eastern Washington and over 300 feet (100 m) distant in western Washington (Castelle et al. 1992b). Research on small mammals found the greatest concentration of species near riparian corridors, with some species found within that riparian corridor that were not found farther away in upland habitats (Cross 1985).

Dimensions of effective buffers for mammals are more difficult to discern from the literature because they depend upon the species' life-history. Also, as discussed in Section 4.11 of Chapter 4, habitat linkages and fragmentation may be more critical for the sustainability of some populations.

As part of the Puget Sound Stormwater Management Research Program, Richter and Azous (2001c) found that the highest richness of small mammals was in wetlands with at least 60% of the first 1,640 feet (500 m) of buffer in forest cover. Other findings of this program include:

- The preservation of large woody debris within the wetland and adjacent upland forest is important for maintaining small-mammal habitat.
- Small-mammal richness was best associated with the combined factors of wetland size, adjacent forest, and the quantity of large, coarse woody debris within the wetland and its buffer.

- In southwestern Oregon, Cross (1985) conducted research on small mammals in "leave-strips" adjacent to streams within zones of forest that had been harvested. He found that the richness of small-mammal species was highest in the riparian zone closest to the stream, intermediate in the transition zone, and lowest in the upland zone. (The zones were defined by vegetation composition, not by dimension.) Because riparian habitats provide more niches for species, it is expected that such habitats would maintain greater species richness (Cross 1985).

Cross also found no species in the upland zone that were not found in the riparian zone, but he found five species present in the riparian zone that were not present in the upland or transition zones. A strip averaging 220 feet (67 m) wide supports mammal communities at similar numbers and richness to the nearby undisturbed riparian corridor. This study focused on small mammals which, relative to large mammals, have small home ranges. Therefore, the study is not broadly applicable to appropriate leave-strip dimensions for larger species.

Table 5-5 presents a summary of literature on wildlife and buffer/upland habitat use that was relevant to this synthesis. As noted previously, some of the research is specific to individual species, some is focused on a particular guild or group of similar species, some looks at life-history patterns (nesting distances), and some sources represent synthesis documents of buffer effectiveness. These distances do not necessarily reflect the literature relative to human disturbance and/or habitat fragmentation, which are discussed in the next sections.

It is difficult to synthesize the findings of the research on wildlife and the width of buffers into simple generalizations that can be readily applied. When looking at life-history needs (e.g., nesting sites, foraging ranges, etc.), the distances presented in the literature range from 98 feet (30 m) (Foster et al. 1984, Castelle et al. 1992b) to 3,280 feet (1,000 m) (Richter 1997). These distances, measured in the field, represent the distance that species ranged, nested, or foraged from a wetland edge.

Other authors have presented their own synthesis or recommendations of effective buffer ranges based on review of the literature. These range from 49 feet (15 m) (Desbonnet et al. 1994) to 328 feet (100 m) (Groffman et al. 1991a, Castelle et al. 1992b, Desbonnet et al. 1994, McMillan 2000). Note that Desbonnet et al. (1994) recommends a range of buffer dimensions based on site conditions, species of interest, and proposed adjacent land uses; hence, their studies are cited at both ends of the distance spectrum.

Table 5-5. Summary of studies on wildlife habitat provided by buffers.

Author(s)	Date	Width	Comments
Allen	1982	328 – 590 feet (100 – 180 m)	Mink use: generally concentrated within 330 feet (100 m) of water but will use upland habitats up to 590 feet (180 m) distant
Burke and Gibbons	1995	240 feet (73 m): 90% 902 feet (275 m): 100%	Buffer to encompass % nesting and hibernation of turtles in North Carolina

Author(s)	Date	Width	Comments
Castelle et al.	1992b	197 – 295 feet (60 – 90 m): Western Washington 98 – 197 feet (30 – 60 m): Eastern Washington	Range for all species they noted Range for all species they noted
Castelle et al.	1992b	263 feet (80 m) avg. - 590 feet (180 m)	Wood duck nesting locations from wetland edge (non-Washington data)
Castelle et al.	1992b	98 feet (30 m): Eastern Washington 328 feet (100 m): Western Washington	Distance of beaver use of upland habitats from water edge
Chase et al.	1995	98 feet (30 m) or more	100 feet (30 m) would be "adequate"; buffers larger than 100 feet needed to meet habitat needs, including breeding for birds and some mammals
Cross	1985	220 feet (67 m)	Forested "leave-strips" for small mammal richness adjacent to streams in SW Oregon
Desbonnet et al.	1994	49 – 98 feet (15 – 30 m): low intensity 98 – 328 feet (30 – 100 m): high intensity	Variable buffer widths using adjacent land uses as decision-making criteria
Fischer et al.	2000	98 feet (30 m) minimum	Literature review; majority of literature cited recommends buffer widths of 330 feet (100 m) for reptiles, amphibians, birds, and mammals
Foster et al.	1984	98 feet (30 m): 68% of nests) 312 feet (95 m): 95% of nests	Waterfowl breeding use of wetlands in the Columbia Basin greatest in smaller (<1 acre [0.4 ha]) wetlands; 68% of waterfowl nests within 100 feet (30 m) of wetland edge; to encompass 95% of waterfowl nests would require 310 feet (95 m) of buffer
Groffman et al.	1991a	197 - 328 feet (60 - 100 m)	For most wildlife needs
Groffman et al.	1991a	328 feet (100 m)	Neotropical migratory bird species
Howard and Allen	1989	197 feet (60 m)	For most wildlife needs
McMillan	2000	98 – 328 feet (30 – 100 m)	Based on a synthesis of literature
Milligan	1985	49 feet (15 m)	Bird species diversity strongly correlated with the percentage of the wetland boundary buffered by at least 50 feet (15 m) of tree and shrub vegetation
Norman	1996	164 feet (50 m)	To protect wetland functions; more buffer may be required for "sensitive wildlife species"

Author(s)	Date	Width	Comments
Ostergaard	2001	3,280 feet (1,000 m)	Forested habitat surrounding stormwater ponds, related to native amphibian richness
Richter	1996	3,280 feet (1,000 m)	Literature review and synthesis
Richter	1996	3,280 feet (1,000 m)	Native amphibian use
Richter and Azous	2001b	1,680 feet (512 m)	Distance from wetland edge necessary to include all bird richness in Puget Sound lowland wetlands
Richter and Azous	2001c	1,640 feet (500 m): 60%	Highest small-mammal richness when 60% of first 1,640 feet (500 m) of buffer was forest habitat
Semlitsch	1998	1,969 feet (600 m)	Salamanders
Semlitsch	1998	228 – 411 feet (69.6 - 125.3 m) 539 feet (164.3 m) for 95% of all species	Six species of adult salamanders and two species of juveniles; mean distance from wetland edge was 228 feet (juveniles) – 411 feet (adults). To incorporate 95% of all species, buffer mean would have to be 539 feet
Short and Cooper	1985	164 – 328 feet (50 – 100 m)	164 feet (50 m) for foraging
Temple and Cary	1988	> 656 feet (200 m): 70% success 328 – 656 feet (100 – 200 m): 58% success < 328 feet (100 m): 18% success	Nesting success rates for interior-dwelling forest birds related to distance into the interior of a forest from the forest edge

5.5.4.2 Screening Adjacent Disturbances

Wetland buffers screen wildlife from human activities. Disturbance from humans can come in the form of noise and light (indirect effects) or from human presence/movement (direct effects). Noise and light can disrupt feeding, breeding, and sleeping habits of wildlife. Many wildlife species in wetlands are disturbed by unscreened human activity within 200 feet (61 m) (Washington Department of Wildlife in Castelle et al. 1992b). Dense shrubs and trees in a wetland buffer can limit intrusion and screen out noise, light, and movement from adjacent human development (Castelle et al. 1992b).

In addition, domestic pets such as dogs and cats can adversely affect wetland wildlife by preying on some wildlife species and are particularly damaging to ground-nesting species (Churcher 1989). See Section 4.12.5 in Chapter 4 for further discussion.

The effect of noise on wildlife is a topic of growing concern. Little research exists on the effective buffer widths required to filter sounds for wildlife. See Section 4.12.3 in Chapter 4 for a discussion of current literature on the effects of noise on wildlife.

Groffman et al. (1991a) determined that 105 feet (32 m) of dense, forested buffer was necessary to reduce noise from commercial areas to background noise levels. Shisler et al. (1987) differentiated between the impacts of low-intensity land uses (agricultural, recreational, low-density housing) and high-intensity land uses (high-density residential, commercial/industrial). They found that low-intensity land uses could be effectively screened with vegetated buffers of 49 to 98 feet (15 to 30 m), while high-intensity land uses required buffers of 98 to 164 feet (30 to 50 m).

Direct sighting of humans approaching was found to disrupt birds (i.e., change their behavior or cause flushing) between 46 and 164 feet (14 to 50 m) (Shisler et al. 1987, Josselyn et al. 1989, Rodgers and Smith 1997). Looking specifically at great blue herons, Short and Cooper (1985) documented that they would flush from their nests if humans approached within 328 feet (100 m). Buffers between 46 and 164 feet (14 to 50 m) may be required to screen wildlife from direct observation of humans, while larger buffers (328 feet or 100 m) were documented as necessary to screen nesting herons.

Other researchers differentiated between the types of activities humans are engaged in and their effects on wildlife. Humans walking toward birds were studied to see how closely they could approach before birds flushed from perches or stopped foraging. In Florida, Rodgers and Smith (1997) found that humans could approach 46 to 112 feet (14 to 34 m) before flushing, but automobiles flushed birds at 61 to 78 feet (18.5 to 24 m). Interestingly, they found that bird-watching (as opposed to humans who were simply walking) had the greatest adverse impacts on birds. They surmised this was due to the human behavior of stopping and standing with binoculars at one point for a prolonged time.

Cooke (in Castelle et al. 1992b) analyzed 21 wetland sites in western Washington and concluded that buffers smaller than 50 feet (15 m) were generally ineffective in screening human disturbance from alterations such as noise, debris, and altered use of the buffer.

Table 5-6 summarizes the findings of the literature related to the disturbance limits or screening effects of a buffer for various wildlife species.

Table 5-6. Summary of studies on screening provided by buffers.

Author(s)	Date	Width	Comments
Castelle et al.	1992b	200 feet (61 m)	General wildlife considerations
Cooke	1992	50 feet (15 m)	Analyzed 21 sites in King County. Buffers less than 50 feet were often disturbed by human activities and were not effective at screening "human effects." Found in Castelle et al. (1992b)
Groffman et al.	1991a	105 feet (32 m)	Dense forest to filter sound from commercial land uses to natural background levels
Josselyn et al.	1989	49 – 164 feet (15 – 50 m)	Unscreened human activity within 50 – 164 feet was disruptive to waterbirds in San Francisco Bay area

Author(s)	Date	Width	Comments
Rodgers and Smith	1997	46 to 112 feet (14 –34 m) 61 to 78 feet (18.5 – 24 m)	Waterbirds in Florida: flushing distance from walkers 46 – 112 feet; flushing distance from autos 61 – 78 feet. Nature observation had greatest impact if involving walking activities. Nesting birds tolerated closer human approach than birds that were perching/foraging
Shisler et al.	1987	50 - 100 feet (15 – 30 m) 100 – 164 feet (30 – 50 m)	Low-intensity land uses (agriculture, recreation, and low density residential): 50 - 100 feet High-density residential housing and commercial/industrial: 100 - 164 feet Most effective buffers had steep slopes, dense shrubs
Short and Cooper	1985	328 feet (100 m)	328 feet to buffer nesting great blue herons from human disturbance

5.5.4.3 Maintaining Habitat Connections

Converting habitats to other uses directly increases the isolation of wetlands and the fragmentation of habitats (See Section 4.11 in Chapter 4 for further discussion of the impacts of fragmentation). Buffers can play a role in reducing habitat fragmentation by serving as upland habitat directly adjacent to a wetland. They can also provide an area that can connect, or be part of a corridor that connects, wetlands with upland habitats or other water bodies (National Research Council 2001). However, buffers, as applied in a regulatory context, are rarely designed to provide these connections. Typical buffer widths generally are insufficient to link wetlands to other habitats. In addition, maintaining linkages from one habitat type to another on individual parcels is often not a consideration when properties are reviewed case by case. The authors of Volume I believe that maintaining habitat connectivity is best accomplished through landscape-scale planning and protection measures.

In general, the literature states that for terrestrial species with wide-ranging habits, it is important to maintain connections between sites used for breeding, feeding, and refuge. This is critical for maintaining population viability (Bedford and Preston 1988, Gibbs 1993, Semlitsch and Bodie 1998, National Research Council 2001). One may assume that this applies only to large terrestrial mammals. However, research has shown that many native amphibians on the west side of the Cascades can range 3,280 feet (1,000 m) from source wetlands into other wetlands or surrounding upland habitats (Richter 1997). Ostergaard (2001) found the greatest amphibian richness in sites that had upland forest habitat surrounding the site by 3,280 feet (1,000 m). Richter and Azous (2001b) found that a radius of 1,680 feet (512 m) surrounding a wetland was necessary to include all the bird richness of species utilizing the source wetland.

5.5.4.4 Summary of Key Points

- There is no simple, general answer for what constitutes an effective buffer width for wildlife considerations. The width of the buffer is dependent upon the species in question and its life-history needs, whether the goal is to maintain connectivity of habitats across a landscape, or whether one is simply trying to screen wildlife from human interactions.

- The majority of wildlife species in Washington use wetland habitats for some portion of their life-history needs. Many species that are closely associated with wetlands (those that depend upon wetlands for breeding, brood-raising, or feeding) depend upon surrounding upland habitats as well for some life-history stages.

- Many terrestrial species that are dependent upon wetlands have broad-ranging habits, some over 3,280 feet (1,000 m) from the source wetland. Although this might be expected for large mammals such as deer or black bears, it is also true for smaller species, such as salamanders and other amphibians.

- Human access and land uses adjacent to wetlands influence the use and habits of wildlife through noise and light intrusions, as well as elimination or degradation of appropriate upland habitats. Even "passive" activities, such as bird/nature-watching, have been shown to have effects on roosting and foraging birds.

- Synthesis documents that evaluated many studies discussing the protection of habitat provided by wetland buffers generally recommend buffer widths between 50 and 300 feet (15 to 100 m), depending on specific factors. These factors include the quality of the wetland habitat, the species needing protection, the quality of the buffer, and the surrounding land uses.

5.5.5 Buffer Maintenance and Effectiveness over Time

Buffers can help to protect wetlands for as long as the buffers themselves remain intact. Buffer areas can be altered over time by human disturbance and natural events, such as windstorms. In addition, some researchers have raised the issue of whether buffers have a long-term, carrying capacity with regard to filtration and binding of pollutants. In other words, is there a maximum amount that can be processed before the buffer's ability is overwhelmed?

5.5.5.1 Human Alteration to Buffers

Human activities are the most common mechanism for altering buffers over time. Buffer functions can be reduced if vegetation is cut or trampled, soils are compacted, sediment loading surpasses the filtering capability of the vegetation, or surface-water flows create channels and subsequent erosion.

Cooke (in Castelle et al. 1992b) analyzed 21 wetland sites in western Washington and concluded that buffers less than 50 feet (15 m) wide were more susceptible to being reduced over time by human disturbance. Nearly all of the buffers they studied that were less than 50 feet (15 m) in width were significantly reduced in the few years the buffers had been present on the back of private lots. Some of the buffers were found to have been eliminated through complete clearing of native vegetation. Of the buffers wider than 50 feet (15 m), most still had some portion intact and, overall, showed fewer signs of human disturbance. Cooke also found that fencing buffers (without a gate allowing access) was effective at reducing the alteration of buffers by humans.

In a study in the Monterey Bay area of California, Dyste (1995) examined 15 wetlands with buffers. All of the buffers suffered from human alteration including cutting of vegetation, soil compaction, and dumping of garbage.

5.5.5.2 Loss of Trees to Blowdown

In the Pacific Northwest, forested buffers are often leave-strips around wetlands or along streams when the surrounding forest is cleared for land development. These forested strips are then exposed to winter windstorms, which are common, often resulting in substantial loss of large trees due to blowdown.

Pollock and Kennard (1998) concluded that trees in narrow forested buffers (less than 76 feet [23 m] wide) have a much higher probability of suffering significant mortality from windthrow and blowdown than trees in wider buffers. They conclude that buffers in the range of 76 to 115 feet (23 to 35 m), created when the surrounding forest is cut, are the minimum width that can be expected to withstand the effects of wind in the long term.

5.5.5.3 Reduced Capacity for Sediment/Nutrient Removal

Many of the studies described earlier assessed the effectiveness of buffers in removing sediments and nutrients for short durations (on the order of one to two years, if the time period was discernable in the methods sections of the literature). One study that assessed water quality improvement over longer periods found that effectiveness diminished as the outer margins of the buffers became saturated with sediment (Dillaha and Inamdar 1997). Their findings suggest that buffers have a limited carrying capacity for sediment removal (a maximum amount of sediment that can be removed) and that larger buffers and other methods may be required to ensure long-term control of sediment.

Similarly, Todd (2000) cites work by Dillaha in 1993 that found less than 10% of grass filter strips were effective after three to five years. The grass filter strips became channelized and surface flows were no longer passing through as sheet flow that would allow contact with vegetation to remove sediments and nutrients. Todd emphasizes that, for buffers to be effective, they have to be sustainable over time, and this must be a factor when determining buffer widths.

5.5.5.4 Summary of Key Points

- Human actions can reduce the effectiveness of buffers in the long term through removal of buffer vegetation, soil compaction, sediment loading, and dumping of garbage.
- Buffers may lose their effectiveness to disperse surface flows over time as flows create rills and channels, causing erosion within the buffer.
- Leaving narrow strips of trees can result in tree loss due to blowdown.
- Buffers may become saturated with sediment over time and become less effective at removing pollutants. The literature indicates that this should be considered when determining buffer widths.

5.5.6 Summary of Buffer Ranges and Characteristics from the Literature

The following discussion summarizes the many suggestions and recommendations in the literature for how buffer widths can be established. Many of these were found in synthesis documents that summarize scientific literature on buffers and then draw general conclusions. The recommendations in most of these syntheses are remarkably consistent. Taken together with the great number of site-specific studies cited in the syntheses, they present what should be considered "fundamental principles" for buffers.

At its most basic level, the science on wetland buffers identifies four criteria that should be considered in determining the width of a buffer (Castelle et al. 1992b, Desbonnet et al. 1994, Norman 1996, McMillan 2000, Todd 2000):

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

The feasibility or possibility of incorporating those four considerations into determining buffer dimensions is dependent upon the jurisdiction in question. Ideally, buffer widths should be tailored to these four factors. However, the authors that recommend considering these factors also acknowledge that the scientific basis for determining the width of a buffer is often superseded by political expediency. Buffers are more often determined administratively as standard or fixed dimensions that may, or may not, be correlated with the criteria listed above.

Table 5-7 presents a summary of the buffer ranges recommended by the authors who conducted literature reviews or syntheses on buffer effectiveness. Minimums ranged from 25 feet (8 m) to 197 feet (60 m). Maximums ranged from 98 feet (30 m) for some land uses to 350 feet (107 m).

Table 5-7. Summary of recommendations for buffer dimensions from the literature.

Author(s)	Date	Minimum Buffer	Maximum Buffer	Comments
Castelle et al.	1994	50 to 100 feet (15 - 30m)		"Minimum buffers necessary to protect wetlands and streams under most circumstances"
Fischer et al.	2000	98 feet (30 m)	328 feet (100 m)	Larger buffer for reptiles, amphibians, birds and mammals
Groffman et al.	1991a	197 feet (60 m)	328 feet (100 m)	For most wildlife needs
Howard and Allen	1989	197 feet (60 m)		For most wildlife needs
McMillan	2000	25 feet (8 m)	350 feet (107 m)	Case by case, using a rating system and the intensity of proposed or existing land use for protecting most wetland functions
Norman	1996	164 feet (50 m)		To protect wetland functions; more may be required to protect more "sensitive wildlife species"

Table 5-8 is taken from one of the most comprehensive buffer syntheses published (Desbonnet et al. 1994). The authors of the synthesis looked at several hundred articles and reports on buffers. This table presents the information in a format that outlines the general effectiveness of different buffer widths at removing pollutants and providing habitat.

Table 5-8. A summary of the effectiveness of pollutant removal and the value of the wildlife habitat of vegetated buffers according to buffer width (Desbonnet et al. 1994).

Buffer Width in Feet (Meters)	Pollutant Removal Effectiveness	Wildlife Habitat Value
16 feet (5 m)	Approximately 50% or greater sediment and pollutant removal	Poor habitat value; useful for temporary activities of wildlife
32 feet (10 m)	Approximately 60% or greater sediment and pollutant removal	Minimally protects stream habitat; poor habitat value; useful for temporary activities of wildlife
49 feet (15 m)	Greater than 60% sediment and pollutant removal	Minimal general wildlife and avian habitat value
66 feet (20 m)	Greater than 70% sediment and pollutant removal	Minimal wildlife habitat value; some value as avian habitat
98 feet (30 m)	Approximately 70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor as well as general avian habitat
164 feet (50 m)	Approximately 75% or greater sediment and pollutant removal	Minimal general wildlife habitat value
246 feet (75 m)	Approximately 80% or greater sediment and pollutant removal	Fair to good general wildlife and avian habitat value
328 feet (100 m)	Approximately 80% or greater sediment and pollutant removal	Good general wildlife habitat value; may protect significant wildlife habitat
656 feet (200 m)	Approximately 90% or greater sediment and pollutant removal	Excellent general wildlife value; likely to support a diverse community
1,968 feet (600 m)	Approximately 99% or greater sediment and pollutant removal	Excellent general wildlife value; supports a diverse community; protection of significant species

Castelle et al. (1994), summarizing research conducted primarily before 1990, concluded "buffers necessary to protect wetlands and streams should be a minimum of 49 to 98 feet (15 to 30 m) in width under most circumstances." They note that the lower end of the spectrum is the minimum necessary to maintain physical and chemical processes, while the upper end of the spectrum may be the minimum necessary to maintain biological processes. The Castelle et al. report of 1994 does not identify appropriate maximums. McMillan (2000) recommends an approach to determining buffers that attempts to balance predictability with flexibility by setting standard buffer widths that can be altered on a case-by-case basis to adapt to site-specific factors. This approach for determining buffer width incorporates a rating system for wetlands, plus an assessment of the intensity of proposed or existing adjacent land use, to establish buffer widths ranging from 25 to 350 feet (8 to 107 m). It is perhaps the method that is closest to fitting the four bulleted criteria outlined at the beginning of this section. It incorporates an understanding of the condition of the wetland, the buffer, and the proposed adjacent land use.

Several other authors also suggest that considering site-specific factors enhances the effectiveness of buffer strips over using fixed-width buffers (Steinblums et al. 1984, Norman 1996, Todd 2000). Belt and O'Laughlin (1994) note that, "The fixed minimum-width approach enjoys the virtue of simplicity in application, but has the potential for providing either not enough or too much protection."

Liquori (2000) also cautions against using fixed buffer widths to protect long-term ecological functioning of buffers and their associated aquatic resources. He notes that many of the functions that buffers provide are directly related to physical characteristics and biological processes within the buffers. Informed with site-specific information, a case-by-case argument could be made for establishing buffer widths. "The nature of the [functions a buffer provides] may significantly depend upon riparian structure both locally and as a mosaic over the watershed scale."

In urban settings, larger buffer widths are often prescribed in anticipation of future impacts from adjacent land use and activity upstream in the watershed. The most important criterion for determining buffer width is identification of the various functions the buffer is expected to provide (Todd 2000).

In agricultural lands, Welsch (1991) identifies a three-zone approach for establishing buffers:

- **Zone 1** consists of riparian-type trees and shrubs immediately adjacent to the stream, water body, or wetland. It should be a minimum 13 feet (4 m) wide, or adjusted to include the entire riparian area (the area with year-long or seasonal soil-moisture regime influenced by the stream or water body). Minimum length should be the length of the proposed disturbance outside the riparian management zones, or "the longest distance possible."

- **Zone 2** extends upslope from Zone 1 and consists of vegetation that may be periodically harvested as it matures. A minimum distance of 20 feet (6 m) should be allowed for this zone for small streams or water bodies; for larger streams or water bodies the total of Zones 1 and 2 can be increased up to 98 feet (30 m) or 30% of the geomorphic floodplain (whichever is less). Minimum length should match that of Zone 1. Zone 2 can be an active harvest zone, but trees and vegetation need to be left to provide soil holding and filtering capacity.

- **Zone 3** is added upslope of Zone 2 if adjacent land (away from the aquatic resource) is cultivated cropland or another land use with the potential for erosion or sediment production. Zone 3 is a vegetated filter strip and should be wide enough to control "concentrated flow erosion from cultivated cropland." Zone 3 vegetation should be established prior to the establishment of Zones 1 and 2.

This zonal approach is recommended for active agricultural activities, which implies the regular creation of conditions with high erosion potential (grazing or tilling). It also allows more active use of the central portion of the buffer and active management of the outer area of the buffer.

Townsend and Robinson (2001) build on this zonal approach and recommend guidance on maintenance of canopy coverage and closure. They suggest using species that readily resprout from stumps or roots in the areas nearest the stream channels (to allow the vegetation to respond to flood damage and/or beaver activity). They stress the need for ongoing maintenance, especially in Zone 3, to ensure that erosive flows are not causing rills or channelized flows into Zone 2. They also note that, while most of these buffers will be applied on an ownership basis, greater benefit would be realized if the concept of zoned buffers were applied on a watershed basis.

Other recommendations are based on wildlife species of particular interest. Based on their study of waterbirds in Florida, Rodgers and Smith (1997) recommend a buffer width of 328 feet (100 m) to ensure that birds will not be triggered into an "approach" response, a state which occurs prior to actual flushing. They derived this figure by analyzing the flushing distance from human approach for 16 species, then adding 131 feet (40 m) to that distance. The 131-foot (40 m) distance was derived from previous work which found that birds became alert (stopped their ongoing behavior and focused on the approaching human) in a range of 82 to 131 feet (25 to 40 m).

5.5.6.1 Summary of Key Points

- Many researchers have recommended using four basic criteria to determine the width of a buffer:
  - the functions and values of the aquatic resource to be protected by the buffer
  - the characteristics of the buffer itself and of the watershed contributing to the aquatic resource
  - the intensity of the adjacent land use (or proposed land use) and the expected impacts that result from that land use
  - the specific functions that the buffer is supposed to provide including the targeted species to be managed and an understanding of their habitat needs
- Protecting wildlife habitat functions of wetlands generally requires larger buffers than protecting water quality functions of wetlands
- Effective buffer widths should be based on the above factors. They generally should range from:

  25 to 75 feet (8 to 23 m) for wetlands with minimal habitat functions and low-intensity land uses adjacent to the wetland

  75 to 150 feet (15 to 46 m) for wetlands with moderate habitat functions and moderate or high-intensity land uses adjacent to the wetland

  150 to 300+ feet (46 to 92+ m) for wetlands with high habitat functions, regardless of the intensity of the land uses adjacent to the wetland
- Fixed-width buffers may not adequately address the issues of habitat fragmentation and population dynamics. Several researchers have recommended

a more flexible approach that allows buffer widths to be varied depending on site-specific conditions.

5.6 Chapter Summary and Conclusions

Wetlands are defined using well established language that is generally consistent between federal and state laws. However, certain wetland types are sometimes excluded from regulation. These include small wetlands, isolated wetlands, and wetlands that are designated as Prior Converted Croplands (PCC). The scientific literature makes clear that small wetlands and isolated wetlands provide important functions and does not provide any rationale for excluding these wetlands from regulation. Little scientific information is available on PCC, but there is no evidence to suggest that they are unimportant in providing wetland functions. They retain many of the characteristics necessary to provide multiple wetland functions.

Wetland delineation is conducted according to either the federal or state delineation manual. These manuals are consistent and, when applied correctly, will result in the same wetland boundary. Wetland rating systems are a useful tool for grouping wetlands based on their needs for protection. The most widely used method in Washington is the state's rating system which places wetlands in categories based on their rarity, sensitivity, irreplaceability, and functions.

Wetland buffers are a critical tool for protecting wetland functions. Findings regarding buffer functions and effectiveness are consistent in recommending that the width of a buffer should be related to the wetland functions that need protection, the land-use activities from which the wetland is being buffered, and the characteristics of the buffer itself. These factors, derived from the many studies of wetland buffers and other aquatic resources, can be thought of as the "fundamental principles" that are recommended to determine the widths and characteristics of buffers.

The literature confirms that for water quality improvement (e.g., sediment removal and nutrient uptake) there is a non-linear relationship between buffer width and increased effectiveness. Sediment removal and nutrient uptake are provided at the greatest rates within the immediate outer portions of a buffer (nearest the source of sediment/nutrient), with increasingly larger widths of buffers required to obtain measurable increases in those functions. Additionally, the long-term effectiveness of buffers in providing such mechanical and biological processes is not well documented in the literature. However, the literature suggests that buffers may have a carrying capacity or limit to their ability to remove pollutants. Future research on this topic is needed.

Compared to the widths needed for sediment removal and nutrient uptake, the literature has documented the need for significantly wider buffers to protect or maintain habitat functions for wildlife species that are closely associated with wetlands, as well as for populations that use wetlands. Research confirms that many wildlife species and guilds are dependent upon wetlands for only portions of their life cycles, and that they require upland habitats adjacent to the wetland to meet all their life needs. Without adequate upland habitat adjacent to wetlands, these habitat functions are lost. Some species use upland habitats that are far from the source wetland. The literature documents that, without access to appropriate upland habitat and the opportunity to move between wetlands and other habitats across a landscape, it is not possible to maintain viable populations of many species. Beyond simply providing adequate upland habitat adjacent to a single wetland, the literature on the maintenance of wildlife populations finds that it is necessary to link habitat types, including wetlands and uplands, across a landscape in order to maintain genetically viable populations.

Several authors who suggested recommendations for buffer widths based on their own synthesis of the literature have recommended variable widths based on the conditions of the wetland, the conditions of the buffer, the proposed land uses adjacent to the buffer, and what functions are intended to be managed. For protection and maintenance of wildlife habitat functions of wetlands, these studies suggest that effective buffer widths should be based on the above factors and generally should range from: 25 to 75 feet (8 to 23 m) for wetlands with minimal habitat functions and low-intensity land uses adjacent to wetlands; 50 to 150 feet (15 to 46 m) for wetlands with moderate habitat functions and moderate or high-intensity land use that is adjacent; and 150 to 300+ feet (46 to 92+ m) for wetlands with high habitat functions depending on the intensity of the adjacent land use. However, several authors noted that protection and maintenance of viable wildlife populations for many species requires habitat connections via corridors and large habitat patches.

Chapter 6 continues the discussion of regulatory tools used to manage wetlands by discussing wetland compensatory mitigation and its effectiveness.

Appendix 8-C

Guidance on Widths of Buffers and Ratios for Compensatory Mitigation for Use with the Western Washington Wetland Rating System

8C.1 Introduction

This appendix provides guidance on widths of buffers, ratios for compensatory mitigation, and other measures for protecting wetlands that are linked to the *Washington State Wetland Rating System for Western Washington-Revised* (Hruby 2004b). Refer to Appendix 8-D for guidance for eastern Washington. Appendices 8-C through 8-F have been formatted similar to the main text of this volume (i.e., with a numbering system) to help with organization.

The tables below list the recommended widths of buffers for various alternatives, examples of measures to minimize impacts, and ratios for compensatory mitigation.

- **Table 8C-1.** Width of buffers needed to protect wetlands in western Washington if impacts from land use and wetland functions are NOT incorporated (Buffer Alternative 1). [Page 4]
- **Table 8C-2.** Width of buffers based on wetland category and modified by the intensity of the impacts from changes in proposed land use (Buffer Alternative 2). [Page 5]
- **Table 8C-3.** Types of land uses that can result in high, moderate, and low levels of impacts to adjacent wetlands (used in Buffer Alternatives 2 and 3). [Page 5]
- **Table 8C-4.** Width of buffers needed to protect Category IV wetlands in western Washington (Buffer Alternative 3). [Page 6]
- **Table 8C-5.** Width of buffers needed to protect Category III wetlands in western Washington (Buffer Alternative 3). [Page 6]
- **Table 8C-6.** Width of buffers needed to protect Category II wetlands in western Washington (Buffer Alternative 3). [Page 7]
- **Table 8C-7.** Width of buffers needed to protect Category I wetlands in western Washington (Buffer Alternative 3). [Page 8]
- **Table 8C-8.** Examples of measures to minimize impacts to wetlands from different types of activities. [Page 10]

- **Table 8C-9.** Comparison of recommended buffer widths for high intensity land uses between Alternative 3 (step-wise scale) and Alternative 3A (graduated scale) based on score for habitat functions [Page 14].
- **Table 8C-10.** Comparison of recommended widths for buffers between Alternative 3 and Alternative 3A for proposed land uses with high impacts with mitigation for impacts. [Page 15]
- **Table 8C-11.** Mitigation ratios for projects in western Washington. [Page 21]

The guidance in this appendix can be used in developing regulations such as critical areas ordinances for protecting and managing the functions and values of wetlands. The recommendations are based on the analysis of the current scientific literature found in Volume 1. The detailed rationale for the recommendations is provided in Appendices 8-E and 8-F.

> The recommendations on buffer widths and mitigation ratios are general, and there may be some wetlands for which these recommendations are either too restrictive or not protective enough. The recommendations are based on the assumption that a wetland will be protected only at the scale of the site itself. They do not reflect buffers and ratios that might result from regulations that are developed based on a larger landscape-scale approach.

8C.2 Widths of Buffers

Requiring buffers of a specific width has been one of the primary methods by which local jurisdictions in Washington have protected the functions and values of wetlands. Generally, buffers are the uplands adjacent to an aquatic resource that can, through various physical, chemical, and biological processes, reduce impacts to wetlands from adjacent land uses. The physical characteristics of buffers (e.g., slope, soils, vegetation, and width) determine how well buffers reduce the adverse impacts of human development. These characteristics are discussed in detail in Chapter 5, Volume 1.

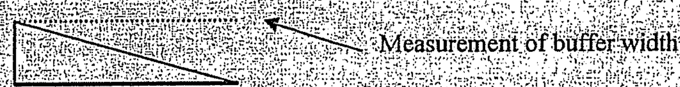
In addition to reducing the impacts of adjacent land uses, buffers also protect and maintain a wide variety of functions and values provided by wetlands. For example, buffers can provide the terrestrial habitats needed by many species of wildlife that use wetlands to meet some of their needs.

The review of the scientific literature has shown, however, that buffers alone cannot adequately protect all functions that a wetland performs. Additional guidance is, therefore, provided on other ways in which wetlands can be managed and regulated to provide some of the necessary protection that buffers alone do not provide. The following guidance for protecting the functions and values of wetlands is based on their category as determined through the rating system for western Washington.

Basic assumptions for using the guidance on widths for buffers

Recommendations for widths of buffers assume that:

- The wetland has been categorized using the *Washington State Wetland Rating System for Western Washington-Revised* (Hruby 2004b).
- The buffer is vegetated with native plant communities that are appropriate for the *ecoregion* or with a plant community that provides similar functions. Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. The U.S. Environmental Protection Agency maintains updated maps of ecoregions that are available at http://www.epa.gov/naaujydh/pages/models/ecoregions.htm . Ecoregions currently mapped for Washington are: Coast Range, Puget Lowland, Cascades, Eastern Cascades Slopes and Foothills, North Cascades, Columbia Plateau, Blue Mountains, and Northern Rockies.
- If the vegetation in the buffer is disturbed (grazed, mowed, etc.), proponents planning changes to land use that will increase impacts to wetlands need to rehabilitate the buffer with native plant communities that are appropriate for the ecoregion, or with a plant community that provides similar functions.
- The width of the buffer is measured along the horizontal plane (see drawing below):



- The buffer will remain relatively undisturbed in the future within the width specified.

Three alternatives for protecting the functions of wetlands using buffers are described in the following sections:

- **Buffer Alternative 1.** Width based only on wetland category.
- **Buffer Alternative 2.** Width based on wetland category and the intensity of impacts from proposed changes in land use.
- **Buffer Alternative 3.** Width based on wetland category, intensity of impacts, and wetland functions or special characteristics. This alternative has two options for determining the widths of buffers when they are based on the score for habitat. Alternative 3 provides three buffer widths based on habitat scores, while Alternative 3A provides a graduated scale of widths for buffers based on habitat scores.

The buffer widths recommended for each alternative were based on the review of scientific information in Volume 1. The guidance in this appendix synthesizes the information about the types and sizes of buffers needed to protect the functions and special characteristics of wetlands.

Appendices 8-C and 8-D do not provide the metric equivalents for buffer widths even though most of the research on buffers uses the metric scale. This decision was made because most local governments use the English Customary measures. For example, a buffer width is set at 50 feet rather than 15 meters.

8C.2.1 Buffer Alternative 1: Width Based Only on Wetland Category

This alternative, in which the width of buffers is based only on the category of the wetland, is the simplest (Table 8C-1). The width recommended for each category of wetland in Alternative 1 is the widest recommended for that category in both Alternatives 2 and 3 (discussed below). Alternative 1 provides the least flexibility because many different types of wetlands and types of human impacts are combined. For example, not all wetlands that fall into Category I or II need a 300-foot buffer. If no distinctions are made between the wetlands that fall into Category I or II, all wetlands that fall into these categories have to be protected with a 300-foot buffer so adequate protection is provided for those wetlands that do need a buffer this wide. Also, the widths recommended for this alternative are those needed to protect the wetland from proposed land uses that have the greatest impacts since no distinctions between impacts are made.

Table 8C-1. Width of buffers needed to protect wetlands in western Washington if impacts from land use and wetland functions are NOT incorporated (Buffer Alternative 1).

Category of Wetland	Widths of Buffers
IV	50 ft
III	150 ft
II	300 ft
I	300 ft

8C.2.2 Buffer Alternative 2: Width Based on Wetland Category and Modified by the Intensity of the Impacts from Proposed Land Use

The second alternative increases the regulatory flexibility by including the concept that not all proposed changes in land uses have the same level of impact (Table 8C-2). For example, one new residence being built on 5 acres of land near a wetland is expected to have a smaller impact than 20 houses built on the same 5 acres. Three categories of impacts from proposed land uses are outlined: land uses that can create high impacts, moderate impacts, and low impacts to wetlands. Different land uses that can cause these levels of impacts are listed in Table 8C-3.

Table 8C-2. Width of buffers needed to protect wetlands in western Washington considering impacts of proposed land uses (Buffer Alternative 2).

Category of Wetland	Land Use with Low Impact *	Land Use with Moderate Impact *	Land Use with High Impact*
IV	25 ft	40 ft	50 ft
III	75 ft	110 ft	150 ft
II	150 ft	225 ft	300 ft
I	150 ft	225 ft	300 ft

* See Table 8C-3 below for types of land uses that can result in low, moderate, and high impacts to wetlands.

Table 8C-3. Types of proposed land use that can result in high, moderate, and low levels of impacts to adjacent wetlands.

Level of Impact from Proposed Change in Land Use	Types of Land Use Based on Common Zoning Designations *
High	• Commercial • Urban • Industrial • Institutional • Retail sales • Residential (more than 1 unit/acre) • Conversion to high-intensity agriculture (dairies, nurseries, greenhouses, growing and harvesting crops requiring annual tilling and raising and maintaining animals, etc.) • High-intensity recreation (golf courses, ball fields, etc.) • Hobby farms
Moderate	• Residential (1 unit/acre or less) • Moderate-intensity open space (parks with biking, jogging, etc.) • Conversion to moderate-intensity agriculture (orchards, hay fields, etc.) • Paved trails • Building of logging roads • Utility corridor or right-of-way shared by several utilities and including access/maintenance road
Low	• Forestry (cutting of trees only) • Low-intensity open space (hiking, bird-watching, preservation of natural resources, etc.) • Unpaved trails • Utility corridor without a maintenance road and little or no vegetation management.

* Local governments are encouraged to create land-use designations for zoning that are consistent with these examples.

8C.2.3 Buffer Alternative 3: Width Based on Wetland Category, Intensity of Impacts, Wetland Functions, or Special Characteristics

The third alternative provides the most flexibility by basing the widths of buffers on three factors: the wetland category, the intensity of the impacts (as used in Alternative 2), and the functions or special characteristics of the wetland that need to be protected as determined through the rating system. The recommended widths for buffers are shown in Tables 8C-4 to 8C-7. Using this alternative, a wetland may fall into more than one category in the table. For example, an interdunal wetland may be rated a Category III wetland because it is an isolated interdunal wetland, but it may be rated a Category II wetland based on its score for functions.

If a wetland meets more than one of the characteristics listed in Tables 8C-4 to 8C-7, the buffer recommended to protect the wetland is the widest one. For example, if a Category I wetland (Table 8C-7) scores 32 points for habitat and 27 points for water quality functions, a 300-foot buffer is needed for land uses with high impacts because the widths needed to protect habitat are wider than those needed for the other functions.

Table 8C-4. Width of buffers needed to protect Category IV wetlands in western Washington (Buffer Alternative 3 for wetlands scoring less than 30 points for all functions).

Wetland Characteristics	Buffer Widths by Impact of Proposed Land Use	Other Measures Recommended for Protection
Score for all 3 basic functions is less than 30 points	Low - 25 ft Moderate – 40 ft High – 50 ft	No recommendations at this time[1]

Table 8C-5. Width of buffers needed to protect Category III wetlands in western Washington (Buffer Alternative 3 for wetlands scoring 30 – 50 points for all functions).

Wetland Characteristics	Buffer Widths by Impact of Proposed Land Use	Other Measures Recommended for Protection
Moderate level of function for habitat (score for habitat 20 - 28 points)	Low - 75 ft Moderate – 110 ft High – 150 ft	No recommendations at this time[1]
Not meeting above characteristic	Low - 40 ft Moderate – 60 ft High – 80 ft	No recommendations at this time[1]

[1] No information on other measures for protection was available at the time this document was written. The Washington State Department of Ecology will continue to collect new information for future updates to this document.

Table 8C-6. Width of buffers needed to protect Category II wetlands in western Washington (Buffer Alternative 3 for wetlands scoring 51-69 points for all functions or having the "Special Characteristics" identified in the rating system).

Wetland Characteristics	**Buffer Widths by Impact of Proposed Land Use** (Apply most protective if more than one criterion is met.)	**Other Measures Recommended for Protection**
High level of function for habitat (score for habitat 29 - 36 points)	Low - 150 ft Moderate – 225 ft High – 300 ft*	Maintain connections to other habitat areas
Moderate level of function for habitat (score for habitat 20 - 28 points)	Low - 75 ft Moderate – 110 ft High – 150 ft	No recommendations at this time[2]
High level of function for water quality improvement and low for habitat (score for water quality 24 - 32 points; habitat less than 20 points)	Low - 50 ft Moderate – 75 ft High – 100 ft	No additional surface discharges of untreated runoff
Estuarine	Low - 75 ft Moderate – 110 ft High – 150 ft	No recommendations at this time[2]
Interdunal	Low - 75 ft Moderate – 110 ft High – 150 ft	No recommendations at this time[2]
Not meeting above characteristics	Low - 50 ft Moderate – 75 ft High – 100 ft	No recommendations at this time[2]
* Fifty of the 122 wetlands used to calibrate the rating system for western Washington were Category II. Of these 50, only five (10%) would require 300-foot buffers to protect them from high-impact land uses. The maximum buffer width for the remaining 45 wetlands would be 150 feet.		

[2] See footnote on the previous page.

Table 8C-7. Width of buffers needed to protect Category I wetlands in western Washington (Buffer Alternative 3 for wetlands scoring 70 points or more for all functions or having the "Special Characteristics" identified in the rating system).

Wetland Characteristics	**Buffer Widths by Impact of Proposed Land Use** (Apply most protective if more than one criterion is met)	**Other Measures Recommended for Protection**
Natural Heritage Wetlands	Low - 125 ft Moderate – 190 ft High – 250 ft	No additional surface discharges to wetland or its tributaries No septic systems within 300 ft of wetland Restore degraded parts of buffer
Bogs	Low - 125 ft Moderate – 190 ft High – 250 ft	No additional surface discharges to wetland or its tributaries Restore degraded parts of buffer
Forested	Buffer width to be based on score for habitat functions or water quality functions	If forested wetland scores high for habitat, need to maintain connections to other habitat areas Restore degraded parts of buffer
Estuarine	Low - 100 ft Moderate – 150 ft High – 200 ft	No recommendations at this time[3]
Wetlands in Coastal Lagoons	Low - 100 ft Moderate – 150 ft High – 200 ft	No recommendations at this time[3]
High level of function for habitat (score for habitat 29 - 36 points)	Low – 150 ft Moderate – 225 ft High – 300 ft	Maintain connections to other habitat areas Restore degraded parts of buffer
Moderate level of function for habitat (score for habitat 20 - 28 points)	Low – 75 ft Moderate – 110 ft High – 150 ft	No recommendations at this time[3]
High level of function for water quality improvement (24 – 32 points) and low for habitat (less than 20 points)	Low – 50 ft Moderate – 75 ft High – 100 ft	No additional surface discharges of untreated runoff
Not meeting any of the above characteristics	Low – 50 ft Moderate – 75 ft High – 100 ft	No recommendations at this time[3]

[3] See footnote on page 6.

8C.2.4 Special Conditions for a Possible Reduction in Buffer Widths

8C.2.4.1 Condition 1: Reduction in Buffer Width Based on Reducing the Intensity of Impacts from Proposed Land Uses

The buffer widths recommended for proposed land uses with high-intensity impacts to wetlands can be reduced to those recommended for moderate-intensity impacts under the following conditions:

- For wetlands that score moderate or high for habitat (20 points or more for the habitat functions), the width of the buffer can be reduced if both of the following criteria are met:

  1) A relatively undisturbed, vegetated corridor at least 100-feet wide is protected between the wetland and any other Priority Habitats as defined by the Washington State Department of Fish and Wildlife ("relatively undisturbed" and "vegetated corridor" are defined in questions H 2.1 and H 2.2.1 of the *Washington State Wetland Rating System for Western Washington – Revised,* (Hruby 2004b)). Priority Habitats in western Washington include:

     - Wetlands
     - Riparian zones
     - Aspen stands
     - Cliffs
     - Prairies
     - Caves
     - Stands of Oregon White Oak
     - Old-growth forests
     - Estuary/estuary-like
     - Marine/estuarine shorelines
     - Eelgrass meadows
     - Talus slopes
     - Urban natural open space (for current definitions of Priority Habitats, see http://wdfw.wa.gov/hab/phshabs.htm)

     The corridor must be protected for the entire distance between the wetland and the Priority Habitat by some type of legal protection such as a conservation easement.

  2) Measures to minimize the impacts of different land uses on wetlands, such as the examples summarized in Table 8C-8, are applied.

- For wetlands that score less than 20 points for habitat, the buffer width can be reduced to that required for moderate land-use impacts by applying measures to minimize the impacts of the proposed land uses (see examples in Table 8C-8).

Table 8C-8. Examples of measures to minimize impacts to wetlands from proposed change in land use that have high impacts. (This is not a complete list of measures.)

Examples of Disturbance	Activities and Uses that Cause Disturbances	Examples of Measures to Minimize Impacts
Lights	• Parking lots • Warehouses • Manufacturing • Residential	• Direct lights away from wetland
Noise	• Manufacturing • Residential	• Locate activity that generates noise away from wetland
Toxic runoff*	• Parking lots • Roads • Manufacturing • Residential areas • Application of agricultural pesticides • Landscaping	• Route all new, untreated runoff away from wetland while ensuring wetland is not dewatered • Establish covenants limiting use of pesticides within 150 ft of wetland • Apply integrated pest management
Stormwater runoff	• Parking lots • Roads • Manufacturing • Residential areas • Commercial • Landscaping	• Retrofit stormwater detention and treatment for roads and existing adjacent development • Prevent channelized flow from lawns that directly enters the buffer
Change in water regime	• Impermeable surfaces • Lawns • Tilling	• Infiltrate or treat, detain, and disperse into buffer new runoff from impervious surfaces and new lawns
Pets and human disturbance	• Residential areas	• Use privacy fencing; plant dense vegetation to delineate buffer edge and to discourage disturbance using vegetation appropriate for the ecoregion; place wetland and its buffer in a separate tract
Dust	• Tilled fields	• Use best management practices to control dust
* These examples are not necessarily adequate for minimizing toxic runoff if threatened or endangered species are present at the site.		

8C.2.4.2 Condition 2: Reductions in Buffer Widths Where Existing Roads or Structures Lie Within the Buffer

Where a legally established, non-conforming use of the buffer exists (e.g., a road or structure that lies within the width of buffer recommended for that wetland), proposed actions in the buffer may be permitted as long as they do not increase the degree of non-conformity. This means no increase in the impacts to the wetland from activities in the buffer.

For example, if a land use with high impacts (e.g., building an urban road) is being proposed next to a Category II wetland with a moderate level of function for habitat, a 150-foot buffer would be needed to protect functions (see Table 8C-6). If, however, an existing urban road is already present and only 50 feet from the edge of the Category II wetland, the additional 100 feet of buffer may not be needed if the road is being widened. A vegetated buffer on the other side of the road would not help buffer the existing impacts to the wetland from the road. If the existing road is resurfaced or widened (e.g., to add a sidewalk) along the upland edge, without any further roadside development that would increase the degree of non-conformity, the additional buffer is not necessary. The associated increase in impervious surface from widening a road, however, may necessitate mitigation for impacts from stormwater.

If, however, the proposal is to build a new development (e.g., shopping center) along the upland side of the road, the impacts to the wetland and its functions may increase. This would increase the degree of non-conformity. The project proponent would need to provide the additional 100 feet of buffer extending beyond the road or apply buffer averaging (see Section 8C.2.6).

8C.2.4.3 Condition 3: Reduction in Buffer Widths Through an Individual Rural Stewardship Plan

A Rural Stewardship Plan (RSP) is the product of a collaborative effort between rural property owners and a local government to tailor a management plan specific for a rural parcel of land. The goal of the RSP is better management of wetlands than what would be achieved through strict adherence to regulations. In exchange, the landowner gains flexibility in the widths of buffers required, in clearing limits, and in other requirements found in the regulations. For example, dense development in rural residential areas can be treated as having a low level of impact when the development of the site is managed through a locally approved RSP. The voluntary agreement includes provisions for restoration, maintenance, and long-term monitoring and specifies the widths of buffers needed to protect each wetland within the RSP.

8C.2.5 Conditions for Increasing the Width of, or Enhancing, the Buffer

8C.2.5.1 Condition 1: Buffer is Not Vegetated with Plants Appropriate for the Region

The recommended widths for buffers are based on the assumption that the buffer is vegetated with a native plant community appropriate for the ecoregion or with one that performs similar functions. If the existing buffer is unvegetated, sparsely vegetated, or vegetated with invasive species that do not perform needed functions, the buffer should either be planted to create the appropriate plant community or the buffer should be widened to ensure that adequate functions of the buffer are provided. Generally, improving the vegetation will be more effective than widening the buffer.

8C.2.5.2 Condition 2: Buffer Has a Steep Slope

The review of the literature (Volume 1) indicates that the effectiveness of buffers at removing pollutants before they enter a wetland decreases as the slope increases. If a buffer is to be based on the score for its ability to improve water quality (see Tables 8C-4 through 8C-7) rather than habitat or other criteria, then the buffer should be increased by 50% if the slope is greater than 30% (a 3-foot rise for every 10 feet of horizontal distance).

8C.2.5.3 Condition 3: Buffer Is Used by Species Sensitive to Disturbance

If the wetland provides habitat for a species that is particularly sensitive to disturbance (such as a threatened or endangered species), the width of the buffer should be increased to provide adequate protection for the species based on its particular, life-history needs. Some buffer requirements for priority species are available on the Washington State Department of Fish and Wildlife web page (http://wdfw.wa.gov/hab/phsrecs.htm). The list of priority species for vertebrates is at http://wdfw.wa.gov/hab/phsvert.htm; for invertebrates it is at http://wdfw.wa.gov/hab/phsinvrt.htm. Information on the buffer widths needed by some threatened, endangered, and sensitive species of wildlife is provided in Appendix 8-H.

8C.2.6 Buffer Averaging

The widths of buffers may be averaged if this will improve the protection of wetland functions, or if it is the only way to allow for reasonable use of a parcel. There is no scientific information available to determine if averaging the widths of buffers actually protects functions of wetlands. The authors have concluded that averaging could be allowed in the following situations:

Averaging may not be used in conjunction with any of the other provisions for reductions in buffers (listed above).

- Averaging to **improve wetland protection** may be permitted when all of the following conditions are met:
  - The wetland has significant differences in characteristics that affect its habitat functions, such as a wetland with a forested component adjacent to a degraded emergent component or a "dual-rated" wetland with a Category I area adjacent to a lower rated area
  - The buffer is increased adjacent to the higher-functioning area of habitat or more sensitive portion of the wetland and decreased adjacent to the lower-functioning or less sensitive portion
  - The total area of the buffer after averaging is equal to the area required without averaging
  - The buffer at its narrowest point is never less than 3/4 of the required width
- Averaging to **allow reasonable use** of a parcel may be permitted when all of the following are met:
  - There are no feasible alternatives to the site design that could be accomplished without buffer averaging
  - The averaged buffer will not result in degradation of the wetland's functions and values as demonstrated by a report from a qualified wetland professional (see Appendix 8-G for a definition of a qualified wetland professional)
  - The total buffer area after averaging is equal to the area required without averaging
  - The buffer at its narrowest point is never less than 3/4 of the required width

8C.2.7 Modifying Buffer Widths in Alternative 3 Using a Graduated Scale for the Habitat Functions (Alternative 3A)

Alternative 3 contains recommendations for protecting the habitat functions of wetlands using only three groupings of scores (0-19, 20-28, 29-36). As a result, a one-point difference between 28 and 29 can result in a 150-foot increase in the width of a buffer around a wetland. The habitat scores were divided into three groups to simplify the regulations based on this guidance. This division is not based on a characterization of risks since the scientific information indicates that the decrease in risk with increasing widths of buffers is relatively continuous for habitat functions.

Such a large increase in width with a one-point increase in the habitat score may be contentious. A jurisdiction may wish to reduce the increments in the widths for buffers by developing a more graduated (but inherently more complicated) scale based on the scores for habitat. Table 8C-9 provides one example of a graduated scale for widths of buffers where the width increases by 20 feet for every one point increase in the habitat score (Figure 8C-1 shows the buffer widths graphically).

Table 8C-9. Comparison of widths for buffers in Alternatives 3 (step-wise scale) and 3A (graduated scale) for proposed land uses with high impacts based on the score for habitat functions in western Washington

Points for Habitat from Wetland Rating Form	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Alternative 3	100	150	150	150	150	150	150	150	150	150	300	300	300	300	300	300	300	300
Alternative 3A	100	100	100	120	140	160	180	200	220	240	260	280	300	300	300	300	300	300

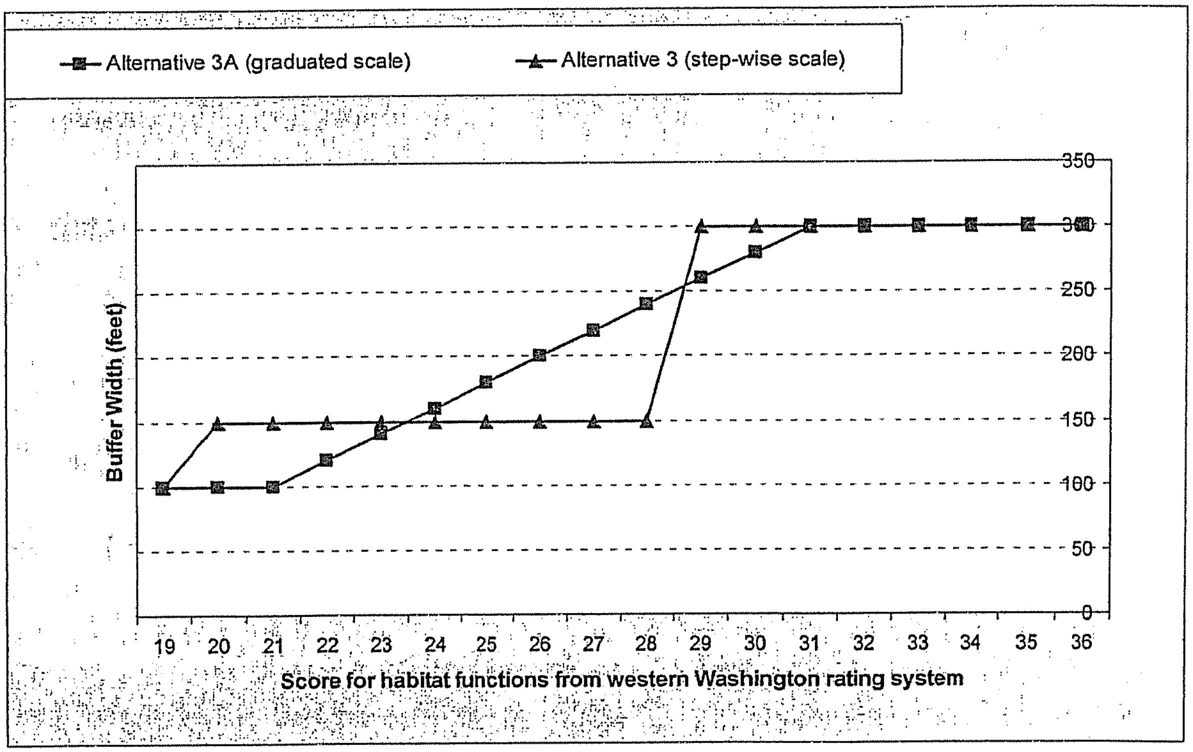


Figure 8C-1. Graphical comparison of widths for buffers in Alternative 3 and 3A for proposed land uses with high impacts based on the score for habitat functions in western Washington.

Other scales are possible as long as they keep within the limits established from the scientific information currently available: wetlands with scores for habitat that are higher than 31 points need buffers that are at least 300-feet wide; wetlands with a score of 26 points need buffers of at least 150 feet; and wetlands with a score of 22 points need buffers that are at least 100-feet wide.

These buffer widths can be further reduced by 25 percent if a proposed project with high impacts implements the mitigation measures such as those described in Table 8C-8. The measures are part of "Condition 1" in Section 8C.2.4 (Special Conditions for a Possible Reduction in Buffer Widths). The buffer widths under Buffer Alternatives 3 and 3A, and the corresponding 25 percent reduction (per buffer reduction condition 1) are shown in Table 8C-10 and represented graphically below in Figure 8C-2.

Table 8C-10. Comparison of widths for buffers in Alternatives 3 (step-wise scale) and 3A (graduated scale) for proposed land uses with high impacts based on the score for habitat functions in western Washington if the impacts are mitigated.

Points for Habitat from Wetland Rating Form	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
Alternative 3 (with mitigation of impacts)	75	110	110	110	110	110	110	110	110	110	225	225	225	225	225	225	225	225
Alternative 3A (with mitigation of impacts)	75	75	75	90	105	120	135	150	165	180	195	210	225	225	225	225	225	225

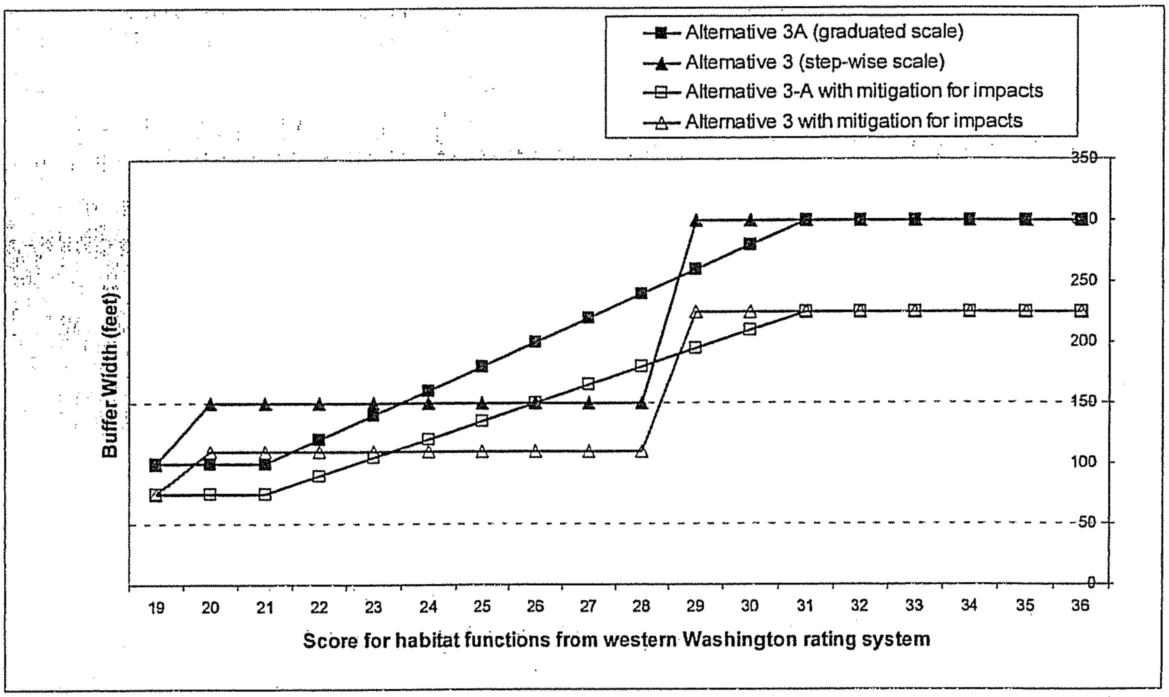


Figure 8C-2. Graphical comparison of widths for buffers in Alternatives 3 and 3A based on the score for habitat functions in western Washington with and without mitigating impacts of proposed development outside the buffer.

> Alternatives 3 and 3A represent two separate approaches for determining widths of buffers for wetlands scoring between 20 and 31 points for the habitat functions. Local governments should select one of the two approaches and should not hybridize the approaches or adopt both at the same time.

8C.3 Ratios for Compensatory Mitigation

When the acreage required for compensatory mitigation is divided by the acreage of impact, the result is a number known variously as a *replacement, compensation,* or *mitigation* ratio. Compensatory mitigation ratios are used to help ensure that compensatory mitigation actions are adequate to offset unavoidable wetland impacts by requiring a greater amount of mitigation area than the area of impact. Requiring greater mitigation area helps compensate for the risk that a mitigation action will fail and for the time lag that occurs between the wetland impact and achieving a fully functioning mitigation site.

8C.3.1 Definitions of Types of Compensatory Mitigation

The ratios presented are based on the type of compensatory mitigation proposed (e.g., restoration, creation, and enhancement). In its *Regulatory Guidance Letter 02-02*, the U.S. Army Corps of Engineers provided definitions for these types of compensatory mitigation. For consistency, the authors of this document use the same definitions which are provided below.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a former or degraded wetland. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- **Re-establishment.** The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural or historic functions to a **former** wetland. Re-establishment results in a gain in wetland acres (and functions). Activities could include removing fill material, plugging ditches, or breaking drain tiles.
- **Rehabilitation.** The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural or historic functions of a **degraded** wetland. Rehabilitation results in a gain in wetland function but does not result in a gain in wetland acres. Activities could involve breaching a dike to reconnect wetlands to a floodplain or return tidal influence to a wetland.

Creation (Establishment): The manipulation of the physical, chemical, or biological characteristics present to develop a wetland on an upland or deepwater site where a wetland did not previously exist. Establishment results in a gain in wetland acres. Activities typically involve excavation of upland soils to elevations that will produce a wetland hydroperiod, create hydric soils, and support the growth of hydrophytic plant species.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of a wetland site to heighten, intensify, or improve specific function(s) or to change the growth stage or composition of the vegetation present. Enhancement is undertaken for specified purposes such as water quality improvement, flood water retention, or wildlife habitat. Enhancement results in a change in some wetland functions and can lead to a decline in other wetland functions, but does not result in a gain in wetland acres. Activities typically consist of planting vegetation, controlling non-native or invasive species, modifying site elevations or the proportion of open water to influence hydroperiods, or some combination of these activities.

Protection/Maintenance (Preservation): Removing a threat to, or preventing the decline of, wetland conditions by an action in or near a wetland. This includes the purchase of land or easements, repairing water control structures or fences, or structural protection such as repairing a barrier island. This term also includes activities commonly associated with the term *preservation.* Preservation does not result in a gain of wetland acres, may result in a gain in functions, and will be used only in exceptional circumstances.

Distinction between rehabilitation and enhancement

The distinction between rehabilitation and enhancement as defined above is not clear-cut and can be hard to understand. Actions that rehabilitate or enhance wetlands span a continuum of activities that cannot be defined by specific criteria.

Rehabilitation ←——————————→ *Enhancement*

In general, rehabilitation involves actions that are more sustainable and that reinstate environmental processes, both at the site and landscape scale (e.g., reinstating hydrologic processes in a diked floodplain by breaching the dikes). Rehabilitation actions often focus on restoring environmental processes that have been disturbed or altered by previous or ongoing human activity. Ecology further defines *rehabilitation* as:

- Actions that restore the original hydrogeomorphic (HGM) class, or subclass, to a wetland whose current HGM class, or subclass, has been changed by human activities
- Actions that restore the water regime that was present and maintained the wetland before human activities changed it.

Any other actions taken in existing wetlands would be considered *enhancement.* Enhancement typically involves actions that provide gains in only one or a few functions and can lead to a decline in other functions. Enhancement actions often focus on structural or superficial improvements to a site and generally do not address larger-scale environmental processes.

For example, a wetland that was once a forested, riverine wetland was changed to a depressional, emergent wetland by the construction of a dike and through grazing. Rehabilitating the wetland would involve breaching the dike so the wetland becomes a riverine wetland again, discontinuing the grazing, and reforesting the area. Discontinuing the grazing and reforesting the wetland without re-establishing the links to the riverine system would be considered enhancement.

Basic assumptions for using the guidance on ratios

- The ratios are for a compensatory mitigation project that is concurrent with impacts to wetlands. If impacts are to be mitigated by using an approved and established mitigation bank, the rules and ratios applicable to the bank should be used.
- The ratios are based on the assumption that the category (based on the rating system for western Washington) and hydrogeomorphic (HGM) class or subclass of the wetland proposed as compensation are the same as the category and HGM class or subclass of the affected wetland (e.g., impacts to a Category II riverine wetland are compensated by creating, restoring, or enhancing a Category II riverine wetland).
- Ratios for projects in which the category and HGM class or subclass of wetlands proposed as compensation is not the same as that of the wetland affected will be determined on a case-by-case basis using the recommended ratios as a starting point. The ratios could be higher in such cases.
- The ratio for using rehabilitation as compensation is 2 times that for using re-establishment or creation (R/C) (2 acres of rehabilitation are equivalent to 1 acre of R/C). The ratio for using enhancement as compensation is 4 times that for using R/C (4 acres of enhancement are equivalent to 1 acre of R/C).
- Re-establishment or creation can be used in combination with rehabilitation or enhancement. For example, 1 acre of impact to a Category III wetland would require 2 acres of R/C. If an applicant provides 1 acre of R/C (i.e., replacing the lost acreage at a 1:1 ratio), the remaining 1 acre of R/C necessary to compensate for the impact could be substituted with 2 acres of rehabilitation or 4 acres of enhancement.
- Generally the use of enhancement alone as compensation is discouraged. Using enhancement in combination with the replacement of wetland area at a minimum of 1:1 through re-establishment or creation is preferred.

These ratios were developed to provide a starting point for further discussions with each proponent of compensatory mitigation. They are based on the observations of the success and risk of compensatory mitigation, as reviewed in Volume 1, and do not represent the specific risk or opportunities of any individual project.

As noted above, the ratios for compensatory mitigation are based on the assumption that the category and hydrogeomorphic (HGM) class or subclass of the affected wetland and the mitigation wetland are the same. The ratios may be adjusted either up or down if the category or HGM class or subclass of the wetland proposed for compensation is different. For example, ratios may be lower if impacts to a Category IV wetland are to be mitigated by creating a Category II wetland. The same is true for impacts to wetlands that currently would be considered *atypical* (see definition below).

Also, compensatory mitigation should not result in the creation, restoration, or enhancement of an atypical wetland. An atypical wetland is defined as a wetland whose design does not match the type of wetland that would be found in the geomorphic setting of the proposed site (i.e., the water source(s) and hydroperiod proposed for the mitigation site are not typical for the geomorphic setting). In addition, any designs that provide exaggerated morphology or require a berm or other engineered structures to hold back water would be considered atypical. For example, excavating a permanently inundated pond in an existing seasonally saturated or inundated wetland is one example of an enhancement project that could result in an atypical wetland. Another example would be excavating depressions in an existing wetland on a slope that required the construction of berms to impound water.

On a case-by-case basis, it is possible to use the scores from the Washington State wetland rating system to compare functions between the mitigation wetland and the impacted wetland. This information may also be used to adjust replacement ratios. Scores from the methods for assessing wetland functions (Hruby et al. 1999) provide another option to establish whether the functions lost will be replaced if both the affected wetland and the wetland used for compensation are of the same HGM class and subclass.

Mitigation ratios for projects in western Washington are shown in Table 8C-11. Refer to the text box on the basic assumptions on the previous page before reading the table. As mentioned previously, these ratios were developed to provide a starting point for further discussions with each proponent of compensatory mitigation. They only factor in the observations of mitigation success and risk at a programmatic level, and do not represent the specific risk or opportunity of any individual project.

Table 8C-11. Mitigation ratios for projects in western Washington.

Category and Type of Wetland Impacts	Re-establishment or Creation	Rehabilitation Only[4]	Re-establishment or Creation (R/C) and Rehabilitation (RH)[4]	Re-establishment or Creation (R/C) and Enhancement (E)[4]	Enhancement Only[4]
All Category IV	1.5:1	3:1	1:1 R/C and 1:1RH	1:1 R/C and 2:1 E	6:1
All Category III	2:1	4:1	1:1 R/C and 2:1 RH	1:1 R/C and 4:1 E	8:1
Category II Estuarine	Case-by-case	4:1 Rehabilitation of an estuarine wetland	Case-by-case	Case-by-case	Case-by-case
Category II Interdunal	2:1 Compensation has to be interdunal wetland	4:1 Compensation has to be interdunal wetland	1:1 R/C and 2:1 RH Compensation has to be interdunal wetland	Not considered an option[5]	Not considered an option[5]
All other Category II	3:1	6:1	1:1 R/C and 4:1 RH	1:1 R/C and 8:1 E	12:1
Category I Forested	6:1	12:1	1:1 R/C and 10:1 RH	1:1 R/C and 20:1 E	24:1
Category I based on score for functions	4:1	8:1	1:1 R/C and 6:1 RH	1:1 R/C and 12:1 E	16:1
Category I Natural Heritage site	Not considered possible[6]	6:1 Rehabilitation of a Natural Heritage site	R/C Not considered possible[6]	R/C Not considered possible[6]	Case-by-case
Category I Coastal Lagoon	Not considered possible[6]	6:1 Rehabilitation of a coastal lagoon	R/C not considered possible[6]	R/C not considered possible[6]	Case-by-case
Category I Bog	Not considered possible[6]	6:1 Rehabilitation of a bog	R/C Not considered possible[6]	R/C Not considered possible[6]	Case-by-case
Category I Estuarine	Case-by-case	6:1 Rehabilitation of an estuarine wetland	Case-by-case	Case-by-case	Case-by-case
NOTE: Preservation is discussed in the following section.					

[4] These ratios are based on the assumption that the rehabilitation or enhancement actions implemented represent the average degree of improvement possible for the site. Proposals to implement more effective rehabilitation or enhancement actions may result in a lower ratio, while less effective actions may result in a higher ratio. The distinction between rehabilitation and enhancement is not clear-cut. Instead, rehabilitation and enhancement actions span a continuum. Proposals that fall within the gray area between rehabilitation and enhancement will result in a ratio that lies between the ratios for rehabilitation and the ratios for enhancement.

[5] Due to the dynamic nature of interdunal systems, enhancement is not considered an ecologically appropriate action.

[6] Natural Heritage sites, coastal lagoons, and bogs are considered irreplaceable wetlands because they perform some special functions that cannot be replaced through compensatory mitigation. Impacts to such wetlands would therefore result in a net loss of some functions no matter what kind of compensation is proposed.

8C.3.2 Conditions for Increasing or Reducing Replacement Ratios

Increases in replacement ratios are appropriate under the following circumstances:

- Success of the proposed restoration or creation is uncertain
- A long time will elapse between impact and establishment of wetland functions at the mitigation site
- Proposed mitigation will result in a lower category wetland or reduced functions relative to the wetland being impacted
- The impact was unauthorized

Reductions in replacement ratios are appropriate under the following circumstances:

- Documentation by a qualified wetland specialist (see Appendix 8-H) demonstrates that the proposed mitigation actions have a very high likelihood of success based on prior experience
- Documentation by a qualified wetland specialist demonstrates that the proposed actions for compensation will provide functions and values that are significantly greater than the wetland being affected
- The proposed actions for compensation are conducted in advance of the impact and are shown to be successful
- In wetlands where several HGM classes are found within one delineated boundary, the areas of the wetlands within each HGM class can be scored and rated separately and the ratios adjusted accordingly, if **all of the following** apply:
  - The wetland does not meet any of the criteria for wetlands with "Special Characteristics" as defined in the rating system
  - The rating and score for the entire wetland is provided along with the scores and ratings for each area with a different HGM class.
  - Impacts to the wetland are all within an area that has a different HGM class from the one used to establish the initial category
  - The proponents provide adequate hydrologic and geomorphic data to establish that the boundary between HGM classes lies at least 50 feet outside of the footprint of the impacts

8C.3.3 Replacement Ratios for Preservation

In some cases, preservation of existing wetlands may be acceptable as compensation for wetland losses. Acceptable sites for preservation include those that:

- Are important due to their landscape position
- Are rare or limited wetland types
- Provide high levels of functions

Ratios for preservation in combination with other forms of mitigation generally range from 10:1 to 20:1, as determined on a case-by-case basis, depending on the quality of the wetlands being impacted and the quality of the wetlands being preserved. Ratios for preservation as the sole means of mitigation generally start at 20:1. Specific ratios will depend upon the significance of the preservation project and the quality of the wetland resources lost.

See Chapter 8 (Section 8.3.7.2) and Appendix 8-B for more information on preservation and the criteria for its use as compensation.

8C.3.4 Replacement Ratios for Temporal Impacts and Conversions

When impacts to wetlands are not permanent, local governments often require some compensation for the temporal loss of wetland functions. *Temporal impacts* refer to impacts to those functions that will eventually be replaced but cannot achieve similar functionality in a short time. For example, clearing forested wetland vegetation for pipeline construction could result in the temporal loss of functions, such as song bird habitat provided by the tree canopy. It may take over 20 years to re-establish the level of function lost as a result of clearing the trees. Although the wetlands will be re-vegetated and over time it is anticipated that their previous level of functioning will be re-established, a temporal loss of functions will occur. There is also some risk of failure associated with the impacts or alterations, especially when soil is compacted by equipment, deep excavation is required, and pipeline trenches alter the water regime at the site.

Therefore, in addition to restoring the affected wetland to its previous condition, local governments should consider requiring compensation to account for the risk and temporal loss of wetland functions. Generally, the ratios for temporal impacts to forested and scrub-shrub wetlands are <u>one-quarter</u> of the recommended ratios for permanent impacts (refer to Table 8C-11), provided that the following measures are satisfied:

- An explanation of how hydric soil, especially deep organic soil, is stored and handled in the areas where the soil profile will be severely disturbed for a fairly significant depth or time

- Surface and groundwater flow patterns are maintained or can be restored immediately following construction
- A 10-year monitoring and maintenance plan is developed and implemented for the restored forest and scrub-shrub wetlands
- Disturbed buffers are re-vegetated and monitored
- Where appropriate, the hydroseed mix to be applied on re-establishment areas is identified

When impacts are to a native emergent community and there is a potential risk that its re-establishment will be unsuccessful, compensation for temporal loss and the potential risk should be required in addition to restoring the affected wetland and monitoring the site. If the impacts are to wetlands dominated by non-native vegetation (e.g., blackberry, reed canarygrass, or pasture grasses), restoration of the affected wetland with native species and monitoring after construction is generally all that is required.

Loss of functions due to the permanent conversion of wetlands from one type to another also requires compensation. When wetlands are not completely lost but are converted to another type, such as a forested wetland converted to an emergent or shrub wetland (e.g., for a utility right-of-way), some functions are lost or reduced.

The ratios for conversion of wetlands from one type to another will vary based on the degree of the alteration, but they are generally one-half of the recommended ratios for permanent impacts (refer to Table 8C-11).

Refer to Appendix 8-F for the rationale for the ratios provided in this appendix.

> Specific guidance has been developed for conversions of wetlands to cranberry bogs. Please refer to the 1998 *Guidelines for Implementation of Compensatory Mitigation Requirements for Conversion of Wetlands to Cranberry Bogs* for information on ratios associated with this activity (Washington State Department of Ecology, U.S. Environmental Protection Agency Region 10, U.S. Army Corps of Engineers Seattle District, and U.S. Fish and Wildlife Service. 1998. Special Public Notice: http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/ACF101C.pdf).