CITY OF BELLEVUE CRITICAL AREAS REGULATIONS TECHNICAL REPORT

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EXECUTIVE SUMMARY

To comply with Growth Management Act (GMA) mandates, the City of Bellevue is currently in the process of updating its Critical Areas Ordinance. The City last comprehensively updated its critical areas regulations in 2006. To support the City's GMA-mandated Critical Areas Ordinance update, The Watershed Company prepared a two-part technical report, Part 1 – Update to Best Available Science and Existing Conditions, and Part 2 – Gap Analysis. These documents 1) identify relevant science related to management of critical areas since the previous critical areas update, as well as significant changes to existing conditions; and 2) recommend updates to the City's critical area provisions that comply with State guidance and best available science (BAS).

Part 1 – Update to Best Available Science and Existing Conditions

This document provides an update to the body of scientific literature and agency guidance since previous BAS documents were prepared in 2003 (Critical Areas Inventories), 2005 (City of Bellevue's Critical Areas Update- 2005 Best Available Science Review), and 2009 (Bellevue Urban Wildlife Habitat Literature Review). Similarly, updates to existing conditions since the completion of the previous BAS and existing conditions review are addressed where relevant. This updated review of science is intended to build on the existing body of literature, and unless otherwise specified, it does not supersede the previous findings. Findings for streams, wetlands, terrestrial wildlife habitat, frequently flooded areas, and geologic hazard areas are briefly summarized below. The BAS review does not address critical aquifer recharge areas, which are not regulated under the current City of Bellevue code. The Critical Aquifer Recharge Areas Guidance Document was published by the Washington Department of Ecology in January 2005, and it has not been updated since that time.

- Streams and Riparian: Recent BAS generally supports the previous understanding of functions and values of instream habitat and the surrounding riparian area. Key updates to the BAS recognize the significant impacts of untreated stormwater and the effectiveness of stormwater treatment, as well as the importance of non-fish bearing streams to downstream habitat, flow, and water quality conditions. Additionally, new science identifies the significance of culverts that pass all flows and woody debris for maintaining habitat functions in urban settings.

- Wetlands: Primary BAS-based updates to wetland protections include wetland identification and classification based on functions, as well as approaches to calculating and implementing wetland mitigation.

- Terrestrial Habitat and Corridors: The BAS presented in 2009 related to urban wildlife in the City of Bellevue remains pertinent. This section identifies several changes to the designation of species at the state and federal level, and it briefly summarizes state and federal management recommendations (where they exist) for species of local importance.

- Frequently Flooded Areas (FFAs): Frequently flooded areas (FFA) are managed to reduce potential risks to public safety. FFAs can also provide valuable instream habitat benefits, such as low-velocity instream habitat during high-flow events. To comply with the conditions of the 2008 FEMA Biological Opinion and incorporate BAS on FFA functions, floodplain habitat assessments are required in addition to standard flood safety measures for projects within floodplains.

- Geological Hazard Areas: This section addresses recent updates in the understanding of seismic hazard areas and the extent and potential threat associated with toe runout below landslide hazard areas. The significance of the issue of toe runout distances became clear following the Oso landslide in 2014.

Part 2 – Gap Analysis reviews the existing critical areas regulations and identifies areas of the code that should be updated to be consistent with science-based recommendations. Recommendations in the gap analysis are based on a review of the GMA requirements, the BAS review (Part 1), and current critical area regulations (Bellevue Land Use Code (LUC) Part 20.25H). Critical area regulations will need to align with BAS practices, and any deviations from BAS recommendations must be documented and justified. In general, recommendations based on BAS-based guidance from the Department of Ecology are fairly prescriptive, whereas recommendations from primary BAS literature allow for more flexibility in interpretation of policy implications and application to revising City code. Recommendations for the City of Bellevue's critical areas code update are summarized in brief below.

- Designation of Critical Areas and Dimensional Standards: Discrepancies are noted between the language used in the recently adopted Comprehensive Plan and the description of critical areas in Part 20.25H. We recommend clarifying the designation of critical areas to ensure consistency with the Comprehensive Plan and state law.

- Streams: In order to maximize consistency with state practices, we propose considerations related to the Permanent and Interim Water Typing System and the location from which to measure stream buffers. Based on the science identifying the significance of stormwater treatment, the City should require that stormwater treatment and low impact development measures are implemented.

- Wetlands: Wetland delineation criteria need to be based on the federal manual and regional supplement to align with Washington Administrative Code (WAC) 173-22-035. Wetland classifications should be based on the current 2014 Wetland Rating System for Western Washington (Ecology publication #14-06-029). The City should consider how and when to allow use of the credit/debit tool, mitigation banking, and in-lieu fee programs.

- Geologic Hazard Areas: Based on the updated understanding of toe-runout distance risks following the Oso landslide, the city should revise the toe-of-slope setback to account for site-specific conditions in landslide hazard areas. The City should also designate areas of high seismic hazard as critical areas.

- Habitat Associated with Species of Local Importance: State and federal listing of sensitive, threatened, and endangered terrestrial species have changed since the last critical areas update. The City should consider adopting the State's priority species list as species of local importance to ensure that suite of species protected by City regulations are consistent with the most up-to-date conditions and scientific understanding.

- Frequently Flooded Areas: A 2008 Biological Opinion required cities enrolled in the National Flood Insurance Program to ensure regulatory standards that protect the habitat value of floodplains for threatened salmonids and southern resident killer whales. The City should update its code standards for frequently flooded areas to describe when a floodplain habitat assessment is required and the necessary components of such an assessment.

CITY OF BELLEVUE CRITICAL AREAS REGULATIONS TECHNICAL REPORT-PART 1

Update to Best Available Science and Existing Conditions

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TABLE OF CONTENTS

Page #

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

With passage of the Growth Management Act (GMA), local jurisdictions throughout Washington State (State), including the City of Bellevue (City), were required to develop policies and regulations to designate and protect critical areas. Critical areas, as defined by the GMA (Revised Code of Washington [RCW 36.70A.030(5)), include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. The GMA directs jurisdictions to periodically conduct a thorough review and update their Comprehensive Plan and regulations (RCW 36.70A.130). When updating critical areas policies and regulations, jurisdictions must include the best available science (BAS). Any deviations from science-based recommendations should be identified, assessed and explained (Washington Administrative Code [WAC] 365-195-915). In addition, jurisdictions are to give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries.

The City of Bellevue last comprehensively updated its critical areas regulations in 2006. This report provides an overview of the science relevant to the functions and values of wetlands, streams, wildlife habitat, and geologic hazards completed since the last comprehensive review. In addition to the summary of BAS-based recommendations, new information on the location, extent, and general conditions of existing critical areas in the City of Bellevue was investigated, and is reported, where available. Information presented in the *City of Bellevue- 2005 BAS Review* and 2003 critical areas inventory reports continues to provide the scientific basis and environmental setting upon which conservation measures are generally based. Rather than reiterate that scientific basis here, this report relies on the understanding conveyed in the earlier reports and highlights additional scientific research and findings, as well as new agency guidance since 2005.

This report is the first of a two-part technical report. Part 2-Gap Analysis reviews the existing critical areas regulations and identifies areas of the code that should be updated to be consistent with science-based recommendations.

2 STREAMS AND RIPARIAN AREAS

2.1 Updates to Best Available Science for Protection of Functions and Values

The recent scientific literature supports and builds on the *City of Bellevue- 2005 BAS Review* document. As noted above, the following discussion is not intended to supersede the previous BAS reports, but rather to identify additional information that builds on the existing understanding. This new information may provide a more nuanced understanding of specific functions and values of streams and riparian areas.

2.1.1 Urbanization and Streams

The *City of Bellevue- 2005 BAS Review* summarized the role of natural disturbances in maintaining stream functions and a diversity of habitats. It also noted that disturbances associated with human activities tend to reduce habitat diversity. In recent years, the interactions between urbanization and hydrology have been further investigated. Urban land cover is correlated with increased high flows, increased variability in daily streamflow, reduced groundwater recharge, and reduced summer low flow conditions (Konrad and Booth 2005, Cuo et al. 2009). Changes in hydrology related to development are generally associated with soil compaction, draining, and ditching across the landscape, increased impervious surface cover, and decreased forest cover (Moore and Wondzell 2005).

In addition to effects on hydrology, significant, new research has helped clarify the ecological effects of stormwater and wastewater discharges. Heavy metals, bacterial pathogens, as well as PCBs, hydrocarbons and endocrine-disrupting chemicals are aquatic contaminants that are commonly associated with urban land uses. Although all metals can be toxic at high concentrations, cadmium, mercury, copper, zinc, and lead are particularly toxic even at low concentrations. Chronic and acute exposure to heavy metals have been found to impair, injure, and kill to aquatic plants, invertebrates, fish, and particularly salmonids (Dethier 2006, Hecht et al. 2007, McIntyre et al. 2008, Baldwin et al. 2011, McIntyre et al. 2012). In general, heavy metals and hydrocarbons are found in road runoff, and these contaminants can reach the City's streams directly through existing stormwater systems. Stormwater systems that circumvent buffers limit the opportunity to filter runoff through adjoining soils and vegetation. Accordingly, stream buffers are typically underutilized for treatment of hydrocarbons and other pollutants found in typical stormwater runoff.

Recent research in the Puget Sound region has identified mature coho salmon that return to creeks and die prior to spawning, a condition called pre-spawn mortality (Feist et al. 2011, Sholz et al. 2011, Spromberg et al. 2015). The condition is linked to urbanized watersheds and is positively correlated with the relative proportion of roads, impervious surfaces, and commercial land cover within a basin (Feist et al. 2011). Pre-spawn mortality was first documented in Bellevue streams in 2000 (City of Bellevue 2016). Between 2000 and 2014, rates of pre-spawn mortality in Kelsey Creek ranged from zero to 100 percent (City of Bellevue 2016). An experimental release of adult coho salmon into Kelsey and Coal Creeks indicated that spawning success was markedly lower in Kelsey Creek (0-0.3% success) compared to Coal Creek (22-41% success) (City of Bellevue 2016).

Recent evidence indicates that some component of untreated road runoff causes pre-spawn mortality, as well as other lethal and sub-lethal effects to juvenile salmonids (McIntyre 2015, Spromberg 2015). Based on a model of the effects of pre-spawn mortality on coho salmon populations, depending on future rates of urbanization, localized extinction of coho salmon populations could occur within a matter of years to decades (Spromberg and Scholz 2011). Recent studies have found that biofiltration of urban stormwater prevents sub-lethal and lethal effects of urban stormwater in juvenile salmon and prevents pre-spawn mortality in coho salmon (McIntyre et al. 2015, Spromberg et al. 2015). These findings point to the critical function of effective riparian buffers, and where that is not possible, the use of green stormwater infrastructure to filter urban runoff.

In summary, urbanization and urban infrastructure can significantly affect stream habitat, water quality, and aquatic life. Low impact development measures that limit impervious surfaces and encourage infiltration of precipitation can effectively help to counteract these impacts. The City of Bellevue is taking several steps to encourage low impact development and retrofits that improve stormwater runoff. These measures include the development of the Natural Drainage Practices Maintenance Guidelines (2009), the Storm and Surface Water System Plan (City of Bellevue 2016) and the Low Impact Development Principles Project, and revision of the Phase II National Pollutant Discharge Elimination System (NPDES) permit (due in December 2016) to require use of low impact development where feasible.

2.1.2 River Continuum

The *City of Bellevue- 2005 BAS Review* presented the River Continuum concept, which describes various functions and characteristics of rivers, ranging from headwater streams to large rivers. Since the *City of Bellevue- 2005 BAS Review*, several studies have further investigated the River Continuum concept and the significance of non-fish bearing streams and hydrologic source areas, where runoff converges and groundwater rises to form surface water drainageways.

Riparian areas associated with headwater streams produce significant quantities of invertebrates (Wipfli 2005, Wipfli et al. 2007) that are transported downstream to fish-bearing waters. In many cases, small, intermittently flowing channels are productive rearing areas for juvenile salmonids (e.g., Wigington et al. 2006, Colvin et al. 2009).

Hydrologic changes from development are expected to be most significant in small- to intermediate-sized streams with naturally low seasonal and storm flow variability (Konrad and Booth 2005). Qiu et al. (2009) and Tomer et al. (2009) modeled the effects of protecting these hydrologic source areas related to water quality. Because increased surface water flows are responsible for the increased transport of pollutants, they found that buffers were most effective in maintaining water quality conditions in watersheds where these hydrologic source areas were protected in riparian buffers.

Longitudinal continuity of buffers along streams is also an important factor determining the effectiveness of buffers at improving channel conditions. Riparian continuity is correlated with abundance and diversity of sensitive invertebrates (Wooster and DeBano 2006) and metrics of physical stream conditions (McBride and Booth 2005). A watershed-scale study in Southwest Washington found that stream conditions were best maintained with continuous buffers, compared to patch buffers or no buffers (Bisson et al. 2013).

2.1.3 Sediment

As described in the *City of Bellevue- 2005 BAS Review*, fine sediment adversely affects stream habitat by filling pools, embedding gravels, reducing gravel permeability and increasing turbidity. Upland clearing and grading can result in long-term increases in fine sediment inputs to streams (Gomi et al. 2005). Numerous studies have investigated the effectiveness of varying widths of buffers at filtering sediment, typically finding high sediment filtration rates in relatively narrow buffer areas (reviewed in Yuan et al. 2009).

It is significant to note, however, that many of these studies occur in laboratory or field plot experiments, which tend to have much shorter field lengths (hillslope length contributing to drainage) than would be encountered in real-world scenarios (*i.e.*, ~5:1 ratio of field length to riparian width for a field plot compared to 70:1 ratio in NRCS guidelines). Since water velocities tend to increase with field length, field plot experiments may suggest better filtration than would be encountered under real-world conditions. Additionally, field-scale experiments generally do not account for flow convergence, which reduces sediment retention (Helmers et al. 2005) or for stormwater components that bypass filter strips through ditches, stormwater infrastructure, and roads (Verstraeten et al. 2006). Therefore, the effectiveness of filter strips at filtering sediment under real-world conditions and at the catchment scale is likely to be lower than what is reported in field plot experiments.

In addition to width, the slope, vegetation density, and sediment composition of a riparian area have significant bearing on sediment filtration potential. A recent model of sediment retention in riparian zones found that a grass riparian zone as small as 4 m (13 ft) could trap up to 100% of sediment under specific conditions (2% hillslope over fine sandy loam soil), whereas a 30 m (98 ft) grass riparian zone would retain less than 30% of sediment over silty clay loam soil on a 10% hillslope (Dosskey et al. 2008, Figure 2.1). This study exemplifies the effects that soil type and hillslope have on sediment retention.

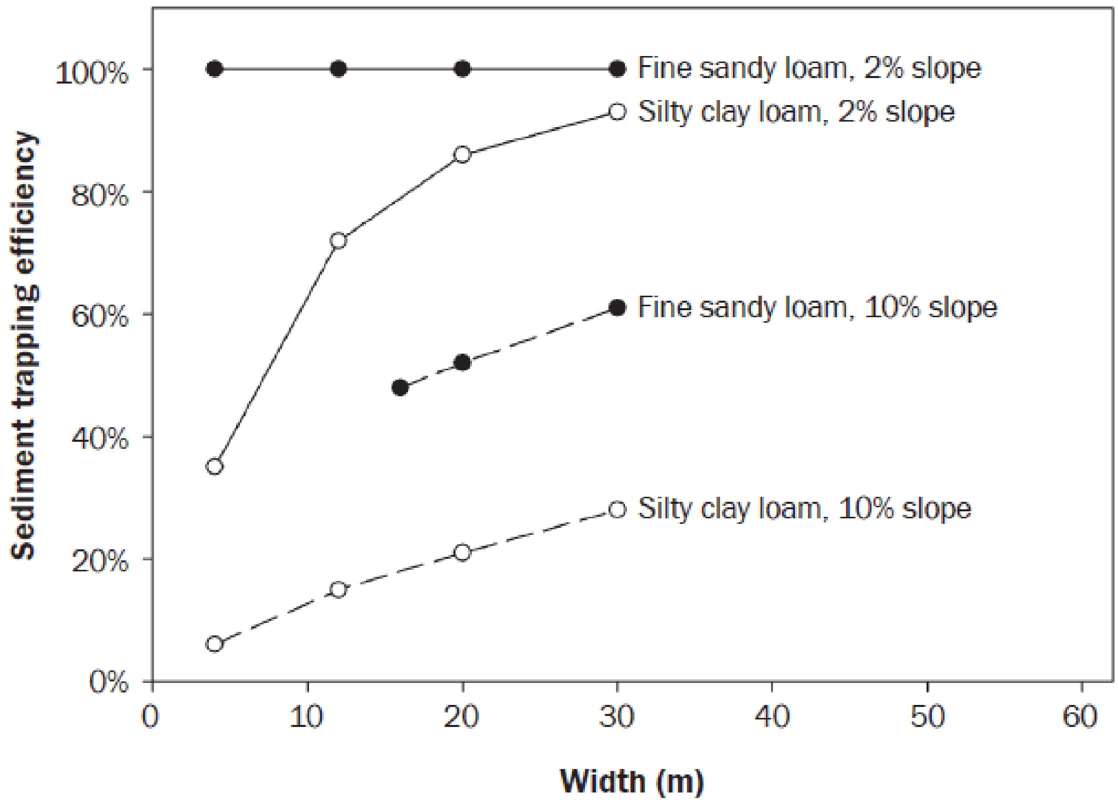

Figure 2.1. Sediment trapping efficiency related to soil type, slope, and buffer width. (Figure from Dosskey et al. 2008).

Vegetative composition within the buffer also affects sediment retention. Vegetation tends to become more effective at sediment and nutrient filtration several years after establishment (Dosskey et al. 2007). Dosskey et al. (2007) did not find a significant difference between the filtration effectiveness of established grass and forested buffers. However, a meta-analysis of 81 buffer studies indicated that all-grass and all-forest buffers tend to more effectively filter sediment compared to buffers with a mix of grass and forested vegetation (Zhang et al. 2010). Additionally, whereas thin-stemmed grasses may become overwhelmed by overland flow, dense, rigid-stemmed vegetation provides improved sediment filtration that is expected to continue to function better over successive storm events (Yuan et al. 2009).

2.1.4 Nutrients

As described in the *City of Bellevue- 2005 BAS Review*, in excess concentrations, nitrogen and phosphorus can lead to poor water quality conditions, including reduced dissolved oxygen rates, increased pH, and eutrophication (Mayer et al. 2005, Mayer et al. 2007)). Excessive amounts of nitrogen and phosphorus speed up eutrophication and algal blooms in receiving waters, which can deplete the dissolved oxygen in the water and result in poor water quality and fish kills (Mayer et al. 2005, Dethier 2006, Heisler et al. 2008). Riparian zones can reduce nitrogen pollution through nutrient uptake, assimilation by vegetation, and through denitrification (Sobota et al. 2012).

The rate of nitrogen removal from runoff varies considerably depending on local conditions, including soil composition, surface versus subsurface flow, riparian zone width, riparian composition, and climate factors (Mayer et al. 2005, Bernal et al. 2007, Mayer et al. 2007). Nutrient assimilation is also dependent on the location of vegetation relative to the nitrogen source, the flowpath of surface runoff, and position in the landscape (Baker et al. 2006).

A meta-analysis of studies of nutrient removal in riparian buffers ranging from 1-200 m (3-656 ft) concluded that buffers wider than 50 m (164 ft) remove nitrogen more effectively than buffers less than 25 m (82 ft) wide; however, within the categories of 0-25 m (0-82 ft), 25-50 m (82-164 ft), and >50 m (164 ft), factors other than buffer width determine nitrogen removal effectiveness (Mayer et al. 2007). Riparian zones less than 15 m (49 ft) actually contributed to nitrogen loading in some cases (Mayer et al. 2007). Another meta-analysis of nutrient removal studied buffers up to 22 m (72 ft) wide, and found that these buffers effectively removed 92 and 89.5 percent of nitrogen and phosphorus, respectively (Zhang et al. 2010).

Mayer et al. (2005, 2007) found that riparian zones ranging from 1-200 m (3-656 ft) generally removed 89% of *subsurface* nitrates regardless of riparian zone width. On the other hand, nitrate retention from *surface* runoff was related to riparian zone width, where 50%, 75%, and 90% surface nitrate retention was achieved at widths of 27 m (88 ft), 81 m (266 ft), and 131 m (430 ft) respectively (Mayer et al. 2007). This suggests that surface water infiltration in the riparian zone should be a priority to promote effective nutrient filtration.

The composition of the riparian zone also affects the efficiency of nutrient removal. Reviews of buffer effectiveness have found that forested riparian zones remove nitrogen and phosphorus more efficiently than grass/forested riparian zones (Zhang et al. 2010). And Mayer et al. (2007) found that herbaceous buffers had the lowest effectiveness compared to forested wetland, forested, and forested/herbaceous buffers. Other studies have found conflicting results, indicating that grass buffers remove nitrogen and phosphorus as well or better than forested buffers (reviewed in Polykov 2005). These findings indicate that the nitrogen removal efficiency of buffers can vary depending on the size and species composition of the buffer.

Removal of phosphorus by riparian buffers is dependent on the form of phosphorus entering the buffer. Whereas phosphorus that is adsorbed by soil particles is effectively removed through sediment retention within a buffer, the retention of soluble phosphorus relies on infiltration and uptake by plants (Polyakov et al. 2005). One long-term study found that phosphorus uptake was directly proportional to the plant biomass production and root area over the four-year study period (Kelly et al. 2007). If a riparian buffer becomes saturated with phosphorus, its capacity for soluble phosphorus removal will be more limited (Polyakov et al. 2005). Another long-term study found that following a 15-year establishment period, a 40-meter (131 ft) wide, three-zoned buffer reduced particulate phosphorus by 22 percent, but dissolved phosphorus exiting the buffer was 26 percent higher than the water entering the buffer, so the buffer resulted in no net effect on phosphorus (Newbold et al. 2010).

In summary, most riparian zones reduce subsurface nutrient loading, but extensive distances are needed to reduce nutrients in surface runoff. Filtration capacity decreases with increasing loads (Mayer et al. 2005), so best management practices across the landscape that reduce nutrient loading will improve riparian function.

2.1.5 Large Woody Debris

The science discussed in the *City of Bellevue- 2005 BAS Review* related to large woody debris is still relevant today. Roni et al. (2014) summarized the scientific understanding of the effectiveness of placed wood. A 2007 report presented information on the large wood loading densities in unmanaged streams in Washington State (Fox and Bolton 2007). The study found that the bankfull width of a stream was the most predictive indicator of wood volume and the overall density of wood. The authors recommended that streams in a degraded state (e.g., below the median) should be managed to meet or exceed the wood loading densities of the 75th percentile of unmanaged streams of a similar bankfull width and geographic position.

A 2012 study by Lassettre and Kondolf identified issues with retaining large wood in urban streams. They found that large wood is often removed from urban streams to address flooding and road maintenance issues. As culverts are replaced, resizing them to allow passage of flood flows and woody debris, consistent with the Washington Department of Fish and Wildlife's 2013 Water Crossing Design Guidelines, should help to allow more large woody debris to be retained in urban stream systems.

2.1.6 Temperature

Building on the science discussed in the *City of Bellevue- 2005 BAS Review*, several studies have documented significant increases in maximum stream temperatures associated with the removal of riparian vegetation (e.g., Moore et al. 2005, Gomi et al. 2006, Pollock et al. 2009).

Two studies in the Pacific Northwest considering the effects of partial forest retention on microclimate found that retention of 15 percent of a forest basal area was not sufficient to maintain microclimate conditions (Heithecker and Halperin 2006, Aubry et al. 2009); however, 40 percent basal area retention resulted in cooler mean air temperatures than clearcut conditions and light conditions similar to an undisturbed forest (Heithecker and Halperin 2006). This indicates that moderate forest cover is necessary to maintain forest microclimate conditions.

2.1.7 Invertebrates

The *City of Bellevue- 2005 BAS Review* noted that aquatic invertebrates are sensitive to water quality, flows, and habitat structure, and they are often considered as indicators of stream habitat conditions (Utz et al. 2009). Hydrologic changes associated with basin and subbasin development have been correlated to degraded indices of invertebrate community integrity (DeGasperi et al. 2009). DeGasperi et al. (2009) proposed that the frequency and range of flood pulses may best explain the correlation between the hydrologic effects of urbanization and the observed degradation of invertebrate communities. Utz et al. (2009) reported that sensitive aquatic invertebrates were not present when impervious cover was in the range of 3 to 23 percent, and the sensitivity of invertebrates to impervious surface cover varied with hydrogeomorphic factors.

Although urbanization at a sub-basin scale is correlated with a reduction in sensitive invertebrate species, those urbanized sub-basins with intact riparian buffers along the longitudinal stream gradient maintain a higher proportion of sensitive species compared to those without vegetated riparian corridors (Walsh et al. 2007, Shandas and Alberti 2009).

2.1.8 Stream Typing

The *City of Bellevue- 2005 BAS Review* referenced the permanent statewide water typing system (WAC 222-16-030), which remains the recommended statewide water typing approach. The *City of Bellevue- 2005 BAS Review* described all non-fish-bearing waters as "Type N." Today, however, the permanent water typing system differentiates between perennial (Type Np) and seasonal (Type Ns) non-fish-bearing streams. The permanent water typing system was intended to be used where stream type mapping is available. DNR water typing has been mapped for most streams in Bellevue (https://fortress.wa.gov/dnr/protectiongis/fpamt/default.aspx); however, some streams are mapped as "unknown" and other streams may not be mapped at all.

In addition to the WAC definition under the permanent statewide water typing system, the state has also established interim statewide water typing system (WAC 222-16-031) intended to apply before water type mapping is complete. The interim stream typing criteria provide additional physical criteria that help to establish whether a stream is likely to be fish-bearing or perennial.

2.1.9 Summary of the Implications of the BAS Update to the Management of Streams

The range of buffer widths for stream protection presented in the *City of Bellevue- 2005 BAS Review* remain valid based on the current review of literature. The updated literature review suggests additional emphasis on the following management considerations:

- Low impact development, with an emphasis on infiltration can help reduce, and in some cases eliminate, significant adverse effects of urban land uses on flows, habitat, water quality, and aquatic life.
- Protection of hydrologic source areas, including intermittent and non-fish bearing streams, as well as headwater wetlands, is particularly significant for protecting downstream habitat and water quality functions.
- Buffer effectiveness varies depending on site-specific conditions, including slope, sediment, and site topography.
- The most effective buffers are densely vegetated to promote infiltration, nutrient uptake, resist erosion.
- Infrastructure improvements that replace culverts with those that meet current Washington Department of Fish and Wildlife (WDFW) guidelines are expected to

improve instream habitat by allowing more large woody debris to remain in urban streams.

2.2 Updates to Existing Conditions

The Final Storm and Surface Water System Plan (SSWSP)(City of Bellevue 2016, including appendices) provides an extensive and up-to-date description of existing conditions relating to both water quality and habitat in the City's streams. That document should be referenced for a summary of existing conditions relative to surface waters in the City of Bellevue. Highlights from that document are summarized below.

2.2.1 Basin conditions

The SSWSP reports that as of 2008, 46 percent of the total area in Bellevue was impervious and that in 2007, 36 percent of the total area of the City was tree canopy. Tree canopy cover in the city decreased 20 percent between 1986 and 2006. American Forests recommends a city-wide goal of 40 percent tree canopy in urban areas to maintain environmental benefits (2008). Basins that currently meet the American Forests recommendation of 40 percent tree canopy include Beaux Arts, Coal Creek, Goff Creek, Lewis Creek, Mercer Slough, North Sammamish, Phantom Creek, South Sammamish, Vasa Creek, and Yarrow (City of Bellevue 2016).

In general, tree canopy is higher and impervious area lower adjacent to streams than in the overall drainage basin. This difference is likely associated with critical area requirements for buffers along streams.

2.2.2 Water quality and Flow

Nine stream segments, two Lake Washington sampling sites, and two Lake Sammamish sampling sites are listed as impaired per the Ecology's 2012 water quality assessment. Streams were rated as impaired due to high fecal coliform bacteria counts, high water temperatures, and/or low dissolved oxygen.

In addition to chemical parameters, a rating system known as the Benthic Index of Biotic Integrity (B-IBI) can be used to assess long-term stream conditions. In Bellevue, 36 sites were sampled for B-IBI ratings between 1998 and 2014. The most recent B-IBI scores show 46 percent of all Bellevue sites ranked as poor and 25 percent ranked as very poor (City of Bellevue). These ratings are similar to other urban sites sampled in the Puget Sound lowlands.

The intensity and frequency of peak flows in Kelsey Creek have increased as Bellevue has become more urbanized (City of Bellevue 2016).

3 WETLANDS

3.1 Updates to Best Available Science for Protection of Functions & Values

3.1.1 Identification and Classification

Per WAC 173-22-035, wetland delineations shall be conducted in accordance with the federal wetland delineation manual and applicable regional supplements. The U.S. Army Corps of Engineers (Corps) Wetland Delineation Manual (Corps 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region Version 2.0* (Regional Supplement) (Corps May 2010) should be the applied methodology.

The Washington Department of Ecology (Ecology) Washington State Wetland Rating System is the most commonly used and regionally accepted wetland classification system. This rating system was last updated in June 2014 (Hruby 2014; Ecology Publication No. 14-06-019). It is a four-tier wetland rating system, which grades wetlands on a points-based system in terms of functions and values. Ecology specifically developed this tool to allow for relatively rapid wetland assessment while still providing some scientific rigor (Hruby 2004). This rating system incorporates other classification elements, such as Cowardin (Cowardin et al. 1979), hydrogeomorphic) classifications (Brinson 1993), and special characteristics such as bogs and mature forests. As described in the Ecology Rating System guidance: "This rating system was designed to differentiate between wetlands based on their sensitivity to disturbance, their significance, their rarity, our ability to replace them, and the functions they provide" (Hruby 2004, Hruby 2014). The rationale for each wetland category under the Ecology Rating System is described below.

- Category I: These are the most unique or rare high-functioning wetland types that are highly sensitive to disturbance and/or relatively undisturbed wetlands with functions that are impossible to replace in a human lifetime.
- Category II: These wetlands are high functioning and difficult, though not impossible, to replace, and provide a high level of some functions.
- Category III: These wetlands provide a moderate level of functions and can often be adequately replaced with a well-planned mitigation project. They have generally been disturbed in some way and are characterized by landscape fragmentation and less diversity.
- Category IV: These wetlands are low functioning and can be replaced or improved. They are characterized by a high level of disturbance and are often dominated by invasive weedy plants.

Wetland categorization provides an important tool for managing impacts. "The intent of the rating categories is to provide a basis for developing standards for protecting and managing the wetlands. Some decisions that can be made based on the rating include the width of buffers needed to protect the wetland from adjacent development and permitted uses in, and around, the wetland" (Hruby 2014).

3.1.2 Wetland Buffers

The synthesis of science review for buffers was re-evaluated by Ecology in 2013 (Hruby 2013). Most of the conclusions from the 2005 literature review are still valid (Sheldon et al. 2005; Hruby 2013). The primary conclusions of the 2013 review are as follows.

- Wetland buffer effectiveness at protecting water quality varies in conjunction with several factors, including width, vegetation type, geochemical and physical soil properties, source and concentration of pollutants, and path of surface water through the buffer.
- Wider buffers are generally higher functioning than narrower buffers.
- Depending on site-specific environmental factors, different buffer widths may be needed to achieve the same level of protection.
- To protect wetland-dependent wildlife, a broader landscape-based approach that considers habitat corridors and connections is necessary.
- Many animals, particularly native amphibians, require undisturbed upland habitats for their survival (Hruby 2013).

As noted above, the Wetland Rating System was developed to categorize wetlands in accordance with the level of sensitivity and significance, and the categories may be used as a tool to assign appropriate buffer widths. For example, it is appropriate to provide the greatest buffer protection for the highest functioning wetlands that are most difficult to replace. In addition, because habitat protection requires the large buffers to protect the most vulnerable and sensitive species, those wetlands with higher habitat scores warrant wider buffers. On the other hand, lower functioning wetlands with low habitat scores typically primarily support water quality functions, and buffers at the smaller end of the range would tend to provide adequate protection for those functions. Buffers at the smaller end of the scale may be appropriate for small, structurally simple wetlands, with fragmented landscape connections resulting from adjacent development in the city.

Based on the above type of rationale, Ecology developed recommended buffer width management strategies in Appendix 8-C of Wetlands in Washington State, Volume 2 – Protecting and Managing Wetlands (Granger et al. 2005). Hruby's 2013 literature review of wetland buffer science did not prompt any new buffer width recommendations, although Ecology has updated its buffer width recommendations to correspond with the current outputs of the Wetland Rating System for Western Washington (Hruby 2014).

3.1.3 Mitigation Sequencing

To bolster protection of our national wetland resources, no net loss policy was adopted in 1988 and has been upheld through the present administration. The no net loss policy requires a balance between wetland loss due to development and wetland mitigation to prevent further loss of the country's total wetland acreage. In 2008, the U.S. Environmental Protection Agency (EPA) issued the Wetlands Compensatory Mitigation Rule. This rule emphasizes BAS to promote innovation and focus on results.

Wetland mitigation is typically achieved through a series of steps known as mitigation sequencing, a sequence of steps taken "to reduce the severity of an action or situation" (Ecology et al. 2006). Ecology recommends that the CAO contain clear language regarding mitigation sequencing. The mitigation sequence according to the implementing rules of the State Environmental Policy Act (SEPA) (Chapter 197-11-768 WAC) follows:

(1) Avoiding the impact altogether by not taking a certain action or parts of an action;

(2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;

(3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

(4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;

(5) Compensating for the impact by replacing, enhancing, or providing substitute resources or environments; and/or

(6) Monitoring the impact and taking appropriate corrective measures.

3.1.4 Compensatory Mitigation

Per Ecology, compensatory mitigation should replace lost or impacted wetland and buffer functions, unless out-of-kind mitigation can meet formally identified goals for the watershed. Ecology recommends prioritizing mitigation actions, location(s), and timing. Following mitigation sequencing, after demonstrating that a proposed wetland impact is unavoidable and has been minimized to the extent practical, compensatory mitigation is required by local, state and federal agencies. In general order of preference the agencies recommend wetland compensation in the form of: 1) re-establishment or rehabilitation, 2) creation (establishment), 3) enhancement, and 4) preservation (WDOE et al. 2006).

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

Wetland creation is the development of a wetland at a site where a wetland did not naturally exist. Proximity to a reliable water source and landscape position are key design requirements for successful wetland creation (WDOE et al. 2006).

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

3.1.4.1 Mitigation Ratios

Mitigation ratios are intended to replace lost functions and values stemming from a proposed land use while also accounting for temporal losses. Mitigation ratios recommended by Ecology in 2005 for wetland impacts can be found in Table 3-2 below. As noted above, the Corps and Ecology have a mandate to maintain "no net loss" of wetlands. Wetland creation and restoration are preferable to enhancement alone because wetland enhancement does not replace wetland area, and therefore, enhancement alone would result in a loss of wetland area. Ecology guidance does allow for enhancement as sole compensation for wetland impacts at quadruple the standard ratio (Granger et al. 2005). The higher ratios for enhancement-only are intended to encourage actions that maintain existing wetland acreage and to ensure sufficient area of enhancement to retain wetland functions and values when a net loss of wetland acreage results.

Table 3-2. Ecology Recommended Mitigation Ratios (Granger et al. 2005)*

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

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

3.1.4.2 Credit-Debit Method

To give regulators and applicants a functions-based alternative to set mitigation ratios, the Washington State Department of Ecology recently developed a tool called the credit-debit method. This method, like the Ecology wetland rating form, is a peer reviewed rapid assessment tool. The credit-debit approach may be used to calculate functional gain of the proposed mitigation and functional loss due to proposed wetland impacts. This generates acre-points that can be compared in a balance sheet. Depending on specific site conditions, this may result in less or more mitigation than would be required under a set the standard mitigation ratio guidance (Hruby 2011). Both the ratios from Table 3-2 and the Credit-Debit Method are scientifically defensible methods to calculate required compensatory mitigation.

At present, the credit-debit method is used primarily for calculating credits for mitigation banks and in-lieu fee programs, such as the King County Mitigation Reserves Program. Other local jurisdictions still use mitigation ratios, as described above, yet many also allow the use of the credit-debit method to enable use of mitigation banks and in lieu fee programs. Because it is still early in the application of the credit-debit method, it is difficult to directly compare the outcomes of the credit-debit approach to use of mitigation ratios. Because it is a site-specific tool, it is expected that the credit-debit approach may result in higher or lower mitigation requirements relative to mitigation ratios depending on specific site conditions.

3.1.4.3 Mitigation Location

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

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

In the past decade, national and state policies have shifted toward using a broader scale approach for mitigation site selection. A recent forum convened by Ecology and composed of regulators, businesses, and environmental/land use professionals recommend that local jurisdictions "establish an ecosystem- or watershed-based approach to mitigation" (WDOE 2008). The ecosystem and watershed-based approach to mitigation looks beyond the property where the impact is proposed to evaluate if off-site compensatory mitigation within the local watershed is a viable option and would have greater benefit to ecosystem functions in the long-term. This is becoming more relevant as land use intensity increases and on-site mitigation has the potential to be more isolated on a landscape-scale, thus reducing some functional potential. Due to the limited success of on-site mitigation, particularly in highly developed areas, a broader watershed scale approach is increasingly desirable and is viewed by the regulatory agencies as more sustainable (WDOE 2008). To guide practical applications of BAS-based compensatory mitigation, the Agencies issued an Ecology publication, *Selecting Wetland Mitigation Sites Using a Watershed Approach* (Hruby et al. 2009). As noted by Azous and Horner 2001 (in Hruby et al. 2009), recreating or maintaining wetland functions in a highly developed landscape may not be sustainable. To account for this, the watershed approach may require a combination of on- and off-site mitigation to achieve functional gains equivalent to the proposed losses (WDOE et al. 2006).

Watershed-based planning is a way for local jurisdictions to manage ecologic resources sustainably. Ecology recently developed a Puget Sound Watershed Characterization project.

This project provides a landscape-scale perspective to help planners manage their wetland and wildlife resources in a targeted and effective manner. It is a coarse-scale tool that uses GIS-based water flow, water quality, and habitat assessments to compare areas within a watershed for restoration and protection value (WDOE 2010).

3.1.4.4 Mitigation Timing

Mitigation actions may occur concurrent with the impact or before project impacts. The mitigation ratios provided by Ecology (Table 3-2) assume concurrent mitigation actions. The amount of mitigation required may be reduced for an advanced mitigation project that reduces the temporal loss of functions. In other words, compensatory mitigation that is completed at the time of impact will take several years to reach full functions; however, when mitigation is completed in advance of the impact, the mitigation area will be more mature and higher functioning at the time the impact occurs. Because the lag period between impact and mitigation is reduced or eliminated with advance mitigation, mitigation ratios may be reduced.

3.1.4.5 Compensatory Mitigation Alternatives

Compensatory mitigation can occur through permittee-responsible mitigation (on-site or off-site), mitigation banks, or in-lieu fee programs. In recent years, with permittee-responsible mitigation as the typical approach, several studies have concluded that despite regulatory mechanisms to ensure "no net loss" of wetlands, substantial loss has occurred, both in terms of wetland area and wetland functions (Matthews and Endress 2008). Losses through compensatory mitigation have been attributed to poor restoration success and a lag time between impacts and mitigation (Bendor 2009).

The increased establishment and use of wetland mitigation banking and in-lieu fee programs has been proposed as a solution to the issues that affect on-site mitigation because 1) regulators can devote more time to monitoring and ensuring the success of mitigation banks, 2) mitigation bank sites are generally situated in an ecologically significant area, and 3) mitigation banks tend to aggregate projects into larger wetlands that may provide more functions than small, isolated wetlands (Bendor and Brozovic 2007, Keddy et al. 2009). The Agencies have stated that, "Mitigation banks provide an opportunity to compensate for impacts at a regional scale and provide larger, better-connected blocks of habitat in advance of impacts" (WDOE et al. 2006). Mitigation banks are also advantageous because mitigation credits generally become available in stages as the wetland permit conditions are met and restoration is successful. This helps minimize the lag time that can create a temporal loss in wetland function (Bendor 2009). Based on this and similar rationale, in 2008, EPA and the U.S. Army Corps of Engineers jointly promulgated regulations revising and clarifying requirements regarding compensatory mitigation, and establishing the following hierarchal preference for implementation of compensatory mitigation:

1. Mitigation banks
2. In-lieu fee programs
3. Permittee-responsible mitigation under a watershed approach

4. Permittee-responsible mitigation through on-site and in-kind mitigation
5. Permittee-responsible mitigation through off-site or out-of-kind mitigation

Despite the theoretical merits of wetland banking, studies of wetland banking success have been largely equivocal in terms of its documented merits (Mack and Micacchion 2006, Reiss et al. 2009). Currently in King County, the Springbrook Creek Mitigation Bank is approved, but its service area does not extend into Bellevue, meaning that impacts in the city cannot be mitigated at the Springbrook Creek Mitigation Bank. Ecology and the Corps are reviewing the Keller Farm Mitigation Bank in Redmond, the service area of which would be expected to include the City of Bellevue. Approved mitigation banks go through a rigorous state certification process. The certification process includes financial assurance requirements. Oversight from Ecology, the Corps, and other relevant agencies and a phased release of bond funds as mitigation bank performance standards are achieved help support mitigation success.

Another mitigation option is an in-lieu fee program. In-lieu fee programs are similar to mitigation banks, except that projects are implemented after credits are purchased, rather than before. In-lieu fee programs are operated by public agencies. The King County Mitigation Reserves Program (MRP) is an in-lieu fee program that was certified under 2008 federal rules. The program is designed to satisfy mitigation obligations for a wide variety of permit types and may be applied to City permits if the city code allows it. The City of Bellevue is within the MRP service area. If allowed by local code, applicants within King County can use the MRP to buy credits for off-site mitigation. By purchasing credits, the applicant satisfies compensatory mitigation requirements and has no further involvement in the mitigation implementation. The MRP pools funds from the sale of credits in a given service area to develop mitigation sites from a predefined roster. The MRP plans, implements, monitors and maintains projects at chosen sites. At multiple points in the process, an Interagency Review Team will review and approve project proposals.

From an economic perspective, it may be more cost effective for small projects to pay a third party for mitigation credits through a mitigation bank or in-lieu fee program than to proceed with the design, permitting, and implementation of a small mitigation project (Bendor and Brozovic 2007). However, where in-lieu fee programs and mitigation banks include the cost of land acquisition, such as the MRP, credits tend to cost significantly more than on-site mitigation. Additionally, large projects may be able to plan, permit, and implement a large mitigation project for less than the cost of mitigation bank credits.

The City may wish to develop a policy prioritizing use of on-site versus off-site mitigation. The following considerations should factor into such a policy. From a landscape perspective, mitigation banking and in-lieu fee programs have a tendency to drive wetland mitigation from urban to rural areas (Bendor and Brozovic 2007). This migration may be driven by the lower cost of land in rural areas compared to urban areas or the availability of large areas of land for wetland restoration in rural areas (Bendor and Brozovic 2007; Robertson and Hayden 2008). A shift from small, urban wetlands to larger, rural wetlands may allow for a net increase in functions; however, small urban wetlands provide significant water quality functions and may be particularly important for controlling flooding in highly urbanized environments (Boyer and Polasky 2004), such as in the City of Bellevue. Urban wetlands may also provide recreational and educational opportunities and aesthetic values (Ehrenfeld 2000). Finally, developing urban wetlands may entail high "opportunity costs," meaning that once lost they will be difficult to replace because of the high price of land in urban areas (Boyer and Polasky 2004). These factors should be considered when developing policies related to the use of mitigation banking and in-lieu fee programs in the City of Bellevue.

3.1.5 Assuring Mitigation Success

The Agencies recommend requiring financial assurances to ensure the success of a mitigation project. "Financial assurances may take the form of performance bonds or letters of credit. Applicants should check with their local planning department to determine if the local government will require performance bonds or other forms of financial assurances. A bond should estimate all costs associated with the entire compensatory mitigation project, including site preparation, plant materials, construction materials, installation oversight, maintenance, monitoring and reporting, and contingency actions expected through the end of the required monitoring period" (WDOE et al. 2006).

Compensatory mitigation projects should be protected in perpetuity. Legal mechanisms, such as deed restrictions and conservation easements, are typically used to achieve this (WDOE et al. 2006).

Additionally, physical site protection may be needed to keep people, pets, and equipment out of mitigation sites. Split-rail fencing and/or critical area signs indicating that the area should not be disturbed are typically required for site protection (WDOE et al. 2006).

3.2 Updates to Existing Conditions

Aerial photos, LiDAR, and GIS data are commonly used for broad-scale analysis of wetland resources. The USFWS's National Wetland Inventory uses aerial imagery to map likely wetland areas (Figure 3.1).

In 2011, the Washington State Department of Ecology released the Puget Sound Watershed Characterization tool, which utilizes GIS data to perform various basin-scale analyses (Stanley et al. 2011). The Puget Sound Watershed Characterization provides interactive mapping that identifies priority areas on a landscape basis for the protection and restoration of functions related to water flow and water quality (available at https://fortress.wa.gov/ecy/coastalatlas/wc/landingpage.html). These maps can help inform the significance of wetland functions at various locations along the landscape. Figure 3.2 below shows a snapshot of the City of Bellevue indicating the relative density of wetlands and undeveloped floodplains (Wilhere et al. 2013).

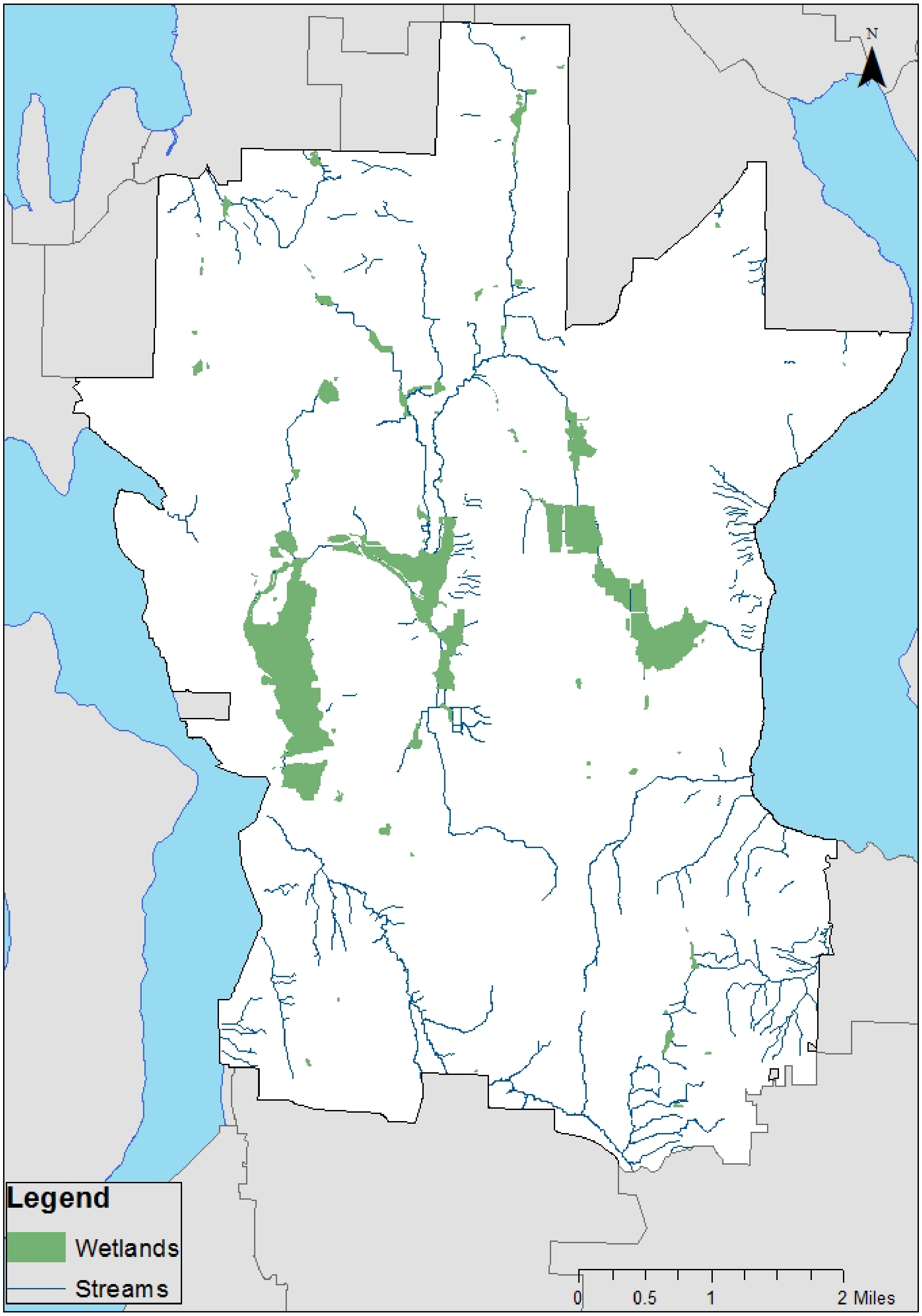

Figure 3.1. Map of wetlands in the City of Bellevue (data from USFWS and City of Bellevue)

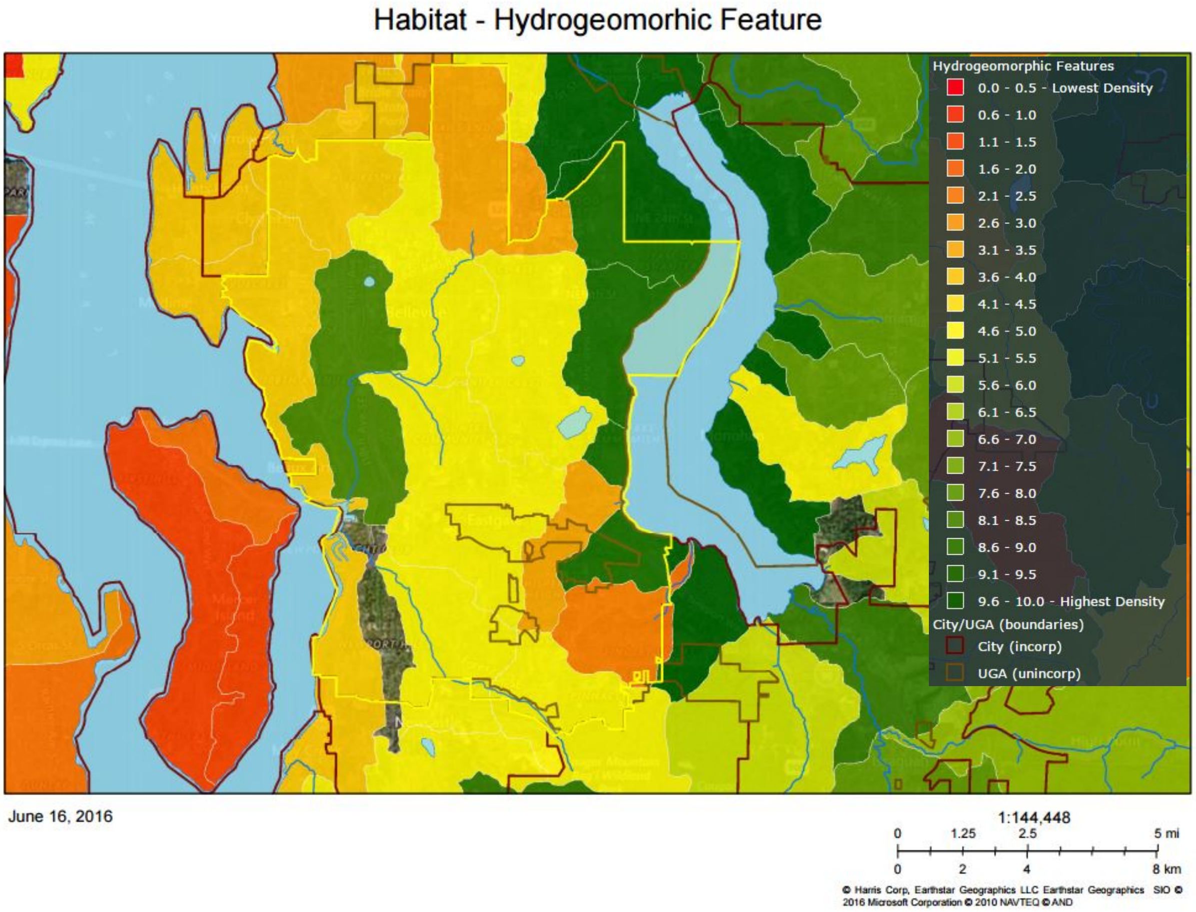

Figure 3.2. Relative density of hydrogeomorphic features, wetlands and undeveloped floodplains, within the city of Bellevue using the Puget Sound Watershed Characterization Tool.

4 TERRESTRIAL HABITAT AND CORRIDORS

4.1 Updates to Best Available Science for Protection of Functions and Values

The *City of Bellevue- 2005 BAS Review* gave a general overview of terrestrial habitat functions and values. The City supplemented the *City of Bellevue- 2005 BAS Review* with a *Bellevue Urban Wildlife Habitat Literature Review* (2009 Urban Wildlife Study) (The Watershed Company 2009). The following analysis builds on these two documents and identifies changes in the science, regulatory listings, or management recommendations since they were written.

4.1.1 Urban Wildlife Habitat

The 2009 Urban Wildlife Study described the significant issues and features associated with wildlife in an urban setting. The precepts discussed in that document hold true today with only minor nuanced updates in the body of scientific literature related to the role of habitat gaps and disturbance (e.g., Ficetola et al. 2009, Tremblay and St. Clair 2009) and corridors (Gilbert-Norton et al. 2010) in urban wildlife habitat.

4.1.2 Endangered, Threatened, or Sensitive Species, Species of Local Importance

The City of Bellevue Code specifies 23 Species of Local Importance (LUC 20.25H.150). These species encompass all state and federally listed sensitive, threatened, and endangered species, as well as priority species likely to occur within the city, and some species that do not have any state or federal status (Table 4.1). Changes in the state and federal designations of species designated since 2005 are noted in Table 4.1.

State and federal species-specific management recommendations for designated terrestrial species of local importance are summarized below. WDFW species-specific recommendations are often referenced in local jurisdictions' critical areas regulations.

Table 4-1 Species of Local Importance per LUC 20.25H.150

Species	State Listing	Federal Listing	Change to listed status since 2005?	State or Federal Management Recommendations?
Bald eagle *Haliaeetus leucocephalus*	Sensitive	Species of Concern	Yes- no longer state or federally threatened (state- 2008) (federal-2007) Proposed to be removed from State sensitive list (July 2016)	Yes (USFWS)
Peregrine falcon *Falco peregrinus*	Sensitive	Species of Concern	Proposed to be removed from State sensitive list (July 2016)	Yes
Common loon *Gavia immer*	Sensitive			Yes
Pileated woodpecker *Dryocopus pileatus*	Candidate			Yes
Vaux's swift *Chaetura vauxi*	Candidate			Yes
Merlin *Falco columbarius*			Yes- No longer State Candidate	No
Purple martin *Progne subis*	Candidate			Yes
Western grebe *Aechmophorus occidentalis*	Candidate			No
Great blue heron *Ardea herodias*	Priority Species			Yes

Species	State Listing	Federal Listing	Change to listed status since 2005?	State or Federal Management Recommendations?
Osprey *Pandion haliaetus*			No- no longer State priority species (1999)	No
Green heron *Butorides striatus*				No
Red-tailed hawk *Buteo jamaicensis*				No
Western big-eared bat *Plecotus townsendii*	Candidate	Species of Concern		Yes
Keen's myotis *Myotis keenii*	Priority Species			Yes
Long-legged myotis *Myotis volans*	Priority Species			Yes
Long-eared myotis *Myotis evotis*	Priority Species			Yes
Oregon spotted frog *Rana pretiosa*	Endangered	Threatened	Yes- federally threatened (2013)	Yes
Western toad *Bufo boreas*	Candidate		Yes- no longer federal Species of concern	No
Western pond turtle *Clemmys marmorata*	Endangered	Species of Concern		Yes
Chinook salmon *Oncorhynchus tshawytscha*	Candidate	Threatened		see Stream section
Bull trout *Salvelinus confluentus*	Candidate	Threatened		see Stream section
Coho salmon *Oncorhynchus kisutch*		Species of Concern		see Stream section
River lamprey *Lampetra ayresi*	Candidate	Species of Concern		see Stream section

The meaning of state and federal statuses are described as follows:

- Federal Endangered: a species in danger of extinction throughout all or a significant portion of its range
- Federal Threatened: a species likely to become endangered in the foreseeable future throughout all or a significant portion of its range
- Federal Species of Concern: informal term, not defined in the federal Endangered Species Act, which commonly refers to species that are declining or appear to be in need of conservation
- State Endangered: wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state
- State Threatened: wildlife species native to the state of Washington that is likely to become an endangered species within the foreseeable future throughout a significant

portion of its range within the state without cooperative management or removal of threats

- State Sensitive: wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of their range within the state without cooperative management or removal of threats
- State Candidate: fish and wildlife species that the Department will review for possible listing as State Endangered, Threatened, or Sensitive
- State Priority Species: species that require protective measures for their survival due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. Priority species include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations (e.g., heron colonies, bat colonies) considered vulnerable; and species of recreational, commercial, or tribal importance that are vulnerable.
- State Monitor Species are those that require management, survey, or data emphasis for one or more of the following reasons:
    - They were classified as endangered, threatened, or sensitive within the previous five years.
    - They require habitat that is of limited availability during some portion of their life cycle.
    - They are indicators of environmental quality.
    - There are unresolved taxonomic questions that may affect their candidacy for listing as endangered, threatened, or sensitive species.

4.1.3 State and Federal Species-specific Management Recommendations

Where State or federal management recommendations for species of local importance area available, they are described below. For those species for which specific state or federal management recommendations do not exist, available management recommendations are also summarized.

These were summarized for nine species in the 2003 *Bellevue Critical Areas Update Best Available Science Paper: Wildlife* (City of Bellevue 2003). Currently applicable state and federal management recommendations are described below.

4.1.3.1 Bald Eagle

WDFW previously required bald eagle management plans for development within the vicinity of a bald eagle nest. Since the state changed the bald eagle status from threatened to sensitive in 2007, it no longer asserts regulatory authority over bald eagle management, nor does it provide current management recommendations. The USFWS provides management recommendations under the regulatory purview of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. These recommendations focus on establishing management areas associated with different habitat features (e.g., nesting, roosting, perching), as summarized in the national bald eagle guidelines (USFWS 2007). Nesting recommendations are relevant to the City of Bellevue.

4.1.3.2 Peregrine Falcon

WDFW maps two known occurrences of peregrine falcon in Bellevue, one near the Interstate 90 bridge over Lake Washington and another in downtown Bellevue. WDFW recommends protection of Peregrine falcons through year-round and season buffering, wetland protection, pesticide restrictions, powerline avoidance, retaining trees and snags, maintaining nest sites and winter feeding habitats. Year-round a protective buffer width of 1,310 feet is recommended around any nest site. During nesting season the buffer width increases to 2,620 feet for forest practices and 1,640 feet for aircraft approaches. Nesting season is March 1 – June 30 (Hays and Milner 1999).

4.1.3.3 Common Loon

Loons are not known to breed in or near the City, but they may over-winter in the area (Lewis et al. 1999). Loons are sensitive to mercury levels; activities that may elevate mercury levels should be avoided (Lewis et al. 1999). Other recommendations relate to breeding habitat, which is not known to occur in Bellevue.

4.1.3.4 Pileated Woodpecker

WDFW management recommendations to protect pileated woodpecker habitat include, maintaining large stands of dead and decaying trees used for nesting, and retaining stumps and large woody debris used for foraging (Lewis and Azerrad 2003). Coniferous forest stands about 60 year old or older should be retained at >70% canopy cover and have at least 2 snags/10 acres that are 30-inches in diameter. Seven snags per acre, at least 90-feet tall with diameters of 61-122-inches are recommended for nesting and roosting habitat (Lewis and Azerrad 2003). These recommendations apply in areas with intact forested areas.

4.1.3.5 Vaux's Swift

Vaux's swifts are summer residents throughout wooded areas of Washington (Lewis et al. 2002). WDFW recommends protecting existing forest stands, particularly old growth, retaining large hollow snags and future snag trees, and retaining large defective or rotting trees (Lewis et al. 2002). Chimneys occupied by nesting or roosting Vaux's swifts should not be disturbed between May and September. Pesticide use in or near nests and roosts should be avoided; appropriate buffer widths for pesticide applications range from 100 feet to 1,640 feet (Lewis et al. 2002).

4.1.3.6 Merlin

Merlins were placed on the Washington candidate list in 1997 due to apparent rarity and a concern about the effects of timber harvest practices. However, they were removed from the list in 2010. Although merlins are rare and localized breeders, they are not particularly sensitive to human activities and there does not seem to be any immediate or widespread threat to their populations (WDFW 2012).

4.1.3.7 Purple Martin

To protect purple martin, WDFW recommends retaining any pilings or snags with purple martin nests, retain snags in or near water, and create snags at forest openings and edges (Hays and Milner 2003). Pileated woodpeckers and northern flickers create cavities that can be used by purple martins, so habitats should be managed to support these mutually beneficial birds (Hays and Milner 2003). Pesticide use in purple martin habitat should be avoided or highly restricted (Hays and Milner 2003).

4.1.3.8 Western Greebe

Western greebes breed in inland lakes of Eastern Washington in the summer, and migrate west to the Puget Sound region and the Pacific Coast in winter (WDFW 2012). Threats to over-wintering western grebe are thought to be diminishing forage fish prey populations and oil spills. Other factors that may threaten over-wintering western greebes include fishing bycatch and derelict fishing gear (WDFW 2012). Specific management recommendations that would apply to the City of Bellevue are not indicated.

4.1.3.9 Great Blue Heron

One great blue heron rookery is mapped by WDFW in the City of Bellevue along Kelsey Creek. WDFW recommends protection mechanisms for Heron Management Areas, which consist of the nesting colony, year-round and seasonal buffers, foraging habitat, and congregation areas where they exist (Azerrad 2012). Specifically, clearing vegetation, grading, and construction should never occur in the core zone (breeding area and year-round management zone), and other potential disturbances, including recreation and vegetation management, should be minimized or restricted to the period outside of the breeding season. Foraging habitat should be protected with riparian buffers, and activities such as vegetation removal, logging, perch tree disturbance, wetland filling, and construction should be minimized. Heron colonies closer to human activity may tolerate more disturbance than colonies in more undisturbed areas; therefore, appropriate buffers may be smaller in more developed areas. Year-round and seasonal management recommendations are provided in Table 4-2.

Table 4-2. Great blue heron recommended management zones from Azerrad 2012

Adjacent land use	Distance from Nesting Colony	Management Practice
Undeveloped (0-2% developed area)	300 m (984 feet)	Avoid clearing vegetation, grading, and construction year-round
Suburban/rural (3-49% developed area)	200 m (656 feet)	
Urban (>50% developed area)	60 m (196 feet)	
All Uses	200 m (656 feet)	Avoid loud noises February-September
	400 m (1320 feet)	Avoid extreme loud noises February-September

4.1.3.10 Osprey, Green Heron, and Red-Tailed Hawk

No specific WDFW management recommendations are available for the osprey, green heron, or red-tailed hawk. As noted in Table 4-1, WDFW removed osprey from the priority species list in 1999. Red-tailed hawks and green herons are also not included in the priority species list. Red-tailed hawks are the most common and widespread hawk in North America. Populations of both osprey and red-tailed hawks numbers are increasing in Washington State (BirdWeb, electronic reference). Population trends for green heron are not documented in Washington. Protection of small wetlands is especially important for green heron (BirdWeb, electronic reference).

4.1.3.11 Western big-eared bat

WDFW recommends maintaining and repairing old buildings and mines used by bat colonies for roosting. Sites that support nursery and hibernation roosts are not suitable for recreational use. Bat access to contaminated water should be restricted and pesticide use should be avoided or highly restricted. Retention of forest patches and snags and riparian/aquatic systems used for foraging and roosting are important for conservation of the species (Woodruff et al. 2005, Hayes and Wiles 2013).

4.1.3.12 Myotis Bats- Keen’s Myotis, Long-legged myotis, and Long-eared myotis

Keen’s myotis, long-legged myotis, and long-eared myotis are primarily associated with forested areas (Hayes and Wiles 2013). Keen’s myotis have not been documented to occur in King County (WDFW 2012). Maintenance a high density of snags, both away from and in proximity to aquatic areas, provides significant habitat for these species (Hayes and Wiles 2013). Buffers around snag areas should be considered where bat colonies are present (Hayes and Wiles 2013).

4.1.3.13 Oregon Spotted Frog

The Oregon spotted frog was federally listed as threatened in 2013 (Federal Register August 29, 2013). In Washington, Oregon spotted frogs are known to occur only within six subbasins/ watersheds: the Sumas River; Black Slough in the lower South Fork Nooksack River; the Samish River; Black River (a tributary to the Chehalis River); Outlet Creek (a tributary to the Middle Klickitat River); and Trout Lake Creek (a tributary of the White Salmon River) (Federal Register, May 11, 2016). Based on the Oregon Spotted Frog Screening Model (Germaine and Costentino 2004), wetlands in the City of Bellevue are unlikely to meet all the criteria necessary to support the presence of Oregon spotted frogs. Specifically, wetlands in Bellevue are unlikely to meet the criterion that less than 9.8% of the area within a mile of the wetland’s perimeter is developed. Critical habitat has recently been designated for the Oregon spotted frog (Federal Register, May 11, 2016), but does not include any portion of the Cedar/Sammamish watershed.

4.1.3.14 Western Toad

No specific WDFW management recommendations are available for the western toad.
The western toad is widely distributed in the western United States and Canada (Stebbins 1954, 1985 as cited in Davis 2002). Declining populations have been documented in areas across the

range, even in relatively pristine environments (Davis 2002). Local population trends are not known.

4.1.3.15 Western Pond Turtle

WDFW recommends managing any watercourse within 0.5 mile of a site known to contain western pond turtles. A protective 1,300-1,600 foot buffer is recommended around all water bodies inhabited by western pond turtles. Emergent logs or stumps should be retained; the turtles utilize them for basking. Logs should be provided if such habitat is lacking. Wetland alterations should be avoided. Sunny embankments and open sites should be protected from vehicles and other trampling uses; these areas are used for nesting. Native fish and amphibian populations should be retained; new species should not be introduced. Additionally, pesticide use should be avoided. Logging should be restricted with 1,300 feet of waters inhabited by these turtles (McAllister 1999).

4.2 Updates to Existing Conditions

The Storm and Surface Water System Plan (2016, including appendices) provides an extensive and up-to-date description of existing conditions relating to both riparian corridors and forest cover within the city. That document should be referenced for a summary of existing conditions relative to terrestrial habitat and corridors within the City of Bellevue.

Figure 4.1 below, shows terrestrial open space blocks in the City of Bellevue and ranks them based on ecological integrity. Ecological integrity is defined as the ability to support and sustain a biologic community typical of natural habitat in this region (Parrish et al. 2003 in Wilhere et al. 2013). The ecologic or landscape integrity of open space blocks is a function of size, shape, proximity to other open space blocks and land use patterns (Wilhere et al. 2013). As is typical of urban environments, the ecological integrity of open space block in the City of Bellevue is relatively low. As described in the 2003 Bellevue Critical Areas Update Best Available Science Paper: Wildlife (City of Bellevue), riparian areas and forested steep slopes comprise the majority of Bellevue’s remaining habitat corridors and linkages.

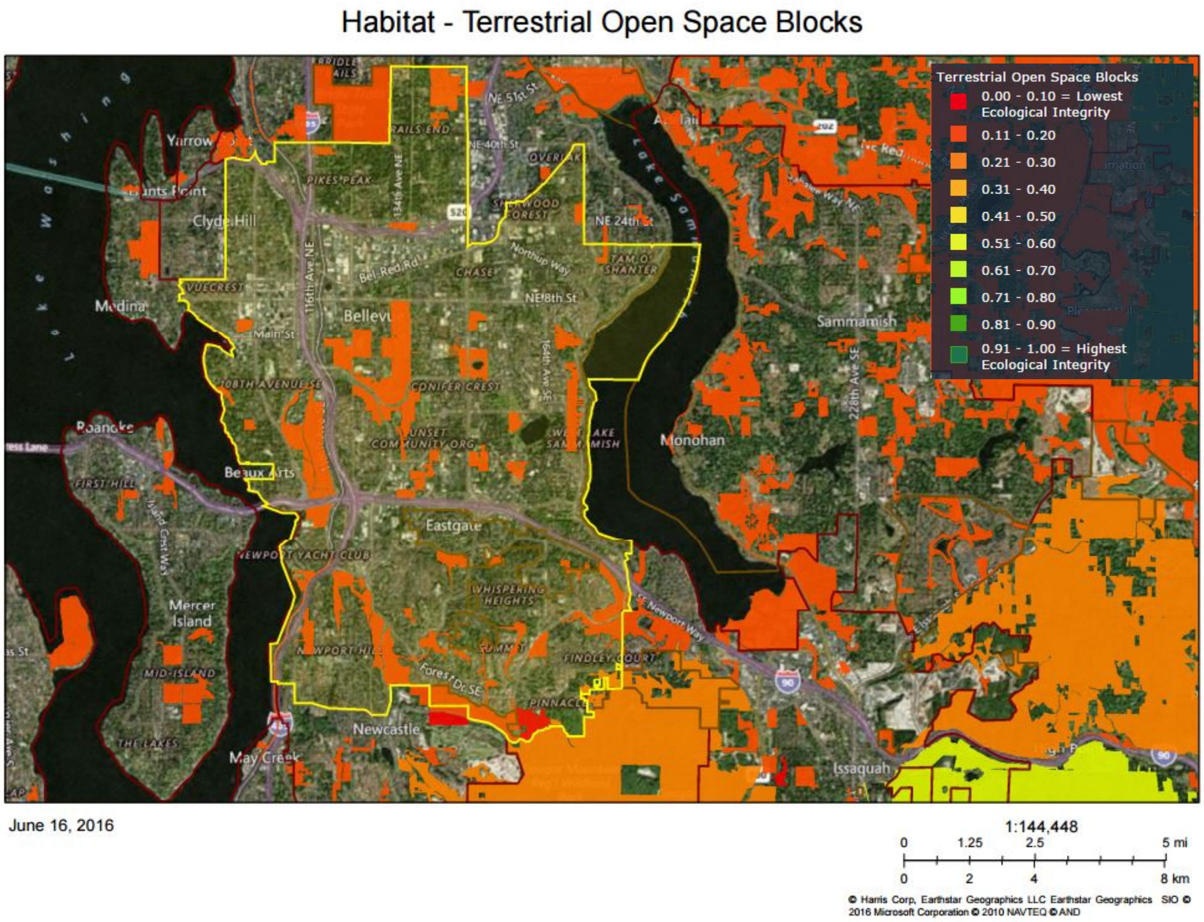

Figure 4.1. Terrestrial Open Space Blocks in City of Bellevue.

5 Frequently Flooded Areas

5.1 Update to Best Available Science for Protection of Functions and Values

Frequently flooded areas (FFA) are regulated to manage potential risks to public safety. Such areas also provide valuable instream habitat benefits, such as low velocity habitat during flood events.

A 2008 National Marine Fisheries Service (NMFS) biological opinion related to the implementation of the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) in the Puget Sound Region summarizes the importance of floodplain functions for threatened salmonids and endangered southern resident killer whales (NMFS 2008). As a result of this biological opinion, cities and counties in the Puget Sound region are required to either amend regulations to protect floodplain functions or require habitat assessments for development in the floodway or floodplain. Through either approach, the city must ensure that development within the Special Flood Hazard Area (100-year floodplain) and riparian buffer zone, which extends 250 feet from the ordinary high water mark where a flood feature is present, does not adversely affect water quality, water quantity, flood volumes, flood velocities, spawning substrate, or floodplain refugia for listed salmonids. The biological opinion also applies to mapped floodways and channel migration zones.

Standards that continue to protect human life from flood hazards and provisions that ensure compliance with the 2008 NFIP biological opinion will help ensure that floodplain ecological functions are maintained.

5.2 Updates to Existing Conditions

FEMA completed a Flood Insurance Study (FIS) for King County in 2010, which was supplemented in 2013. The preliminary Digital Flood Insurance Rate Maps (DFIRM) resulting from the FIS update are listed as “on hold,” and are not yet in effect. A comparison of the existing Flood Insurance Rate Map (Q3) and the preliminary DFIRM indicates that few areas have changed with the updated floodplain study information (Figure 5.1).

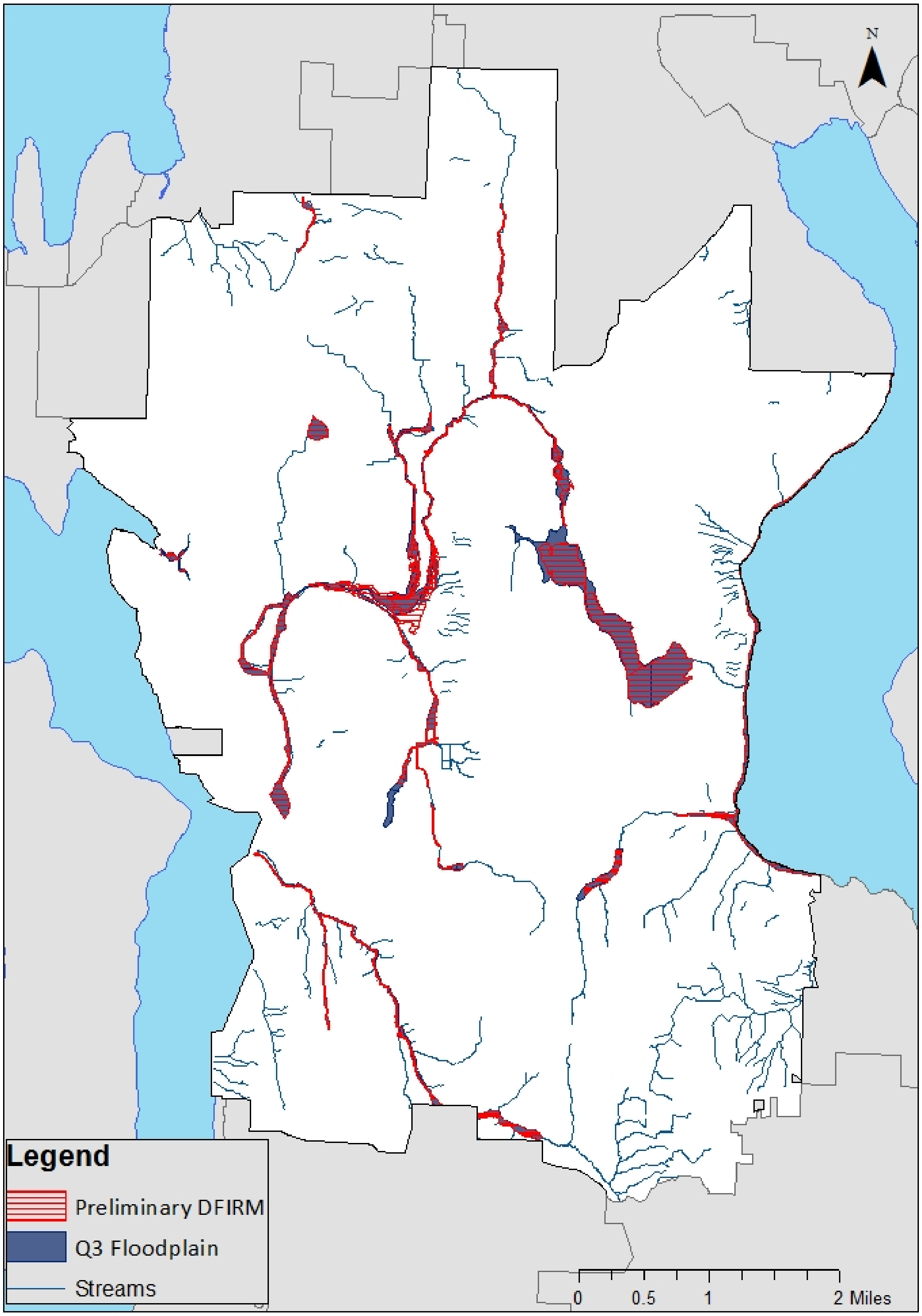

Figure 5.1 Map showing currently effective (Q3) and preliminary (DFIRM) floodplain mapping.

6 Geologic Hazard Areas

6.1 Updates to Best Available Science for Protection of Functions and Values

Geologically Hazardous Areas are generally regulated in order to identify areas where naturally occurring geologic processes may pose a threat or hazard to the health and safety of citizens if development activity is inappropriately sited in areas of significant hazard. The 2003 *Bellevue Critical Areas Update Geologically Hazardous Areas Inventory* (City of Bellevue) identified five types of potential geologic hazard areas. These areas include:

- Steep slopes/landslide hazard areas: includes areas potentially susceptible to landslide based on a combination of topographic, geologic, and hydrologic factors.
- Erosion Hazard areas: includes at least those areas identified by the Natural Resources Conservation Service (NRCS) as having a "severe" rill and inter-rill erosion hazard.
- Seismic hazard areas: includes areas subject to severe risk of damage as a result of earthquake induced ground shaking, slope failure, settlement, soil liquefaction, or surface faulting. In addition, the City of Bellevue identified seiche hazard areas along the City's shorelines adjacent to Lake Washington and Lake Sammamish.
- Coal mine hazard areas
- Liquefaction hazard areas

In addition to those areas listed above, the *City of Bellevue- 2005 BAS Review* also addressed potential local effects of volcanic hazards.

All of these potential geologic hazards have the potential to adversely affect the City of Bellevue's community function and impair the value of human life and property.

The delineation and review of existing geologic hazard areas are generally consistent with current science. However a few areas could use updating based on more current information since the last Best Available Science (BAS) Review in 2005.

Seismic Hazard Areas

A high resolution seismic reflection survey was completed in 2008 by Liberty and Pratt (2008) in portions of the Seattle Fault zone. Areas covered included Bellevue, Sammamish, Newcastle, and Fall City, Washington. The Seattle fault zone is a broad (5-7 km wide) east-west striking zone of faulting and deformed shallow strata. The faulting has been interpreted as reverse-slip displacement with the south-side having moved up relative to the north side of the fault zone. Geologic models have generally postulated a south-dipping reverse fault with multiple strands and back-thrusts in the hanging wall (Pratt et al., 1997; ten Brink et al, 2002 and Fisher et al. 2006). This leading edge has been termed a "deformation front" by Liberty and Pratt (2008), mainly in the form of a monoclinal fold, termed the Seattle monocline by Johnson et al (1999). The general stratigraphy consists of Quaternary age sediments overlying more reflective northward dipping Tertiary age bedrock. In addition, the Vasa Park segment of the Seattle Fault Zone has been trenched by Sherrod (2002) and has shown direct evidence of thrusting of older strata over younger strata. The younger strata being a paleosoil dated at 11,500 +/- 40 radiocarbon years B.P. (before present).

Based on the results of the seismic reflection survey, Liberty and Pratt interpret the leading edge of the Seattle Fault zone approximately 3 km farther north than the northern edge of the Seattle Fault Zone as shown on Figure G-2, Geologic Hazards map in the 2003 Bellevue Critical Areas Update Geologically Hazardous Areas Inventory.

The potential for mitigation of surface fault rupture hazards will depend on the accuracy by which fault traces can be delineated as well as the recurrence intervals for which earthquakes capable of producing surface rupture occur. This can be difficult because of the glacially modified and urbanized landscape has obscured or removed most surface evidence. As more information is gained on the limits of the Seattle fault zone and the potential for surface fault rupture, consideration should be given by the City of Bellevue to encourage studies to better delineate limits of the Seattle fault zone as well as the recurrence intervals of earthquake events. As was mentioned in the 2005 BAS Review, the City can assist such efforts by compiling a database of geotechnical reports for properties located within and around the Seattle fault zone.

The City might consider requiring disclosure statements from property owners as part of property transactions if known documented evidence of surface faulting or deformation exists on a particular parcel.

The Geologic Hazards map shown on Figure G-2 of the 2003 Bellevue Critical Areas Update Geologically Hazardous Areas Inventory does not include the Mercer Slough area as a Liquefaction Hazard area. The Mercer Slough area is a wetland area and presents a liquefaction hazard. The King County Flood Control District Map 11-5 for Liquefaction Susceptibility, dated May 2010, shows a moderate to high level of liquefaction for the Mercer Slough area. The Liquefaction Susceptibility Map of the Greater Eastside Area, King County, Washington (Palmer et al., 2002) shows the Mercer Slough area as underlain by peat deposits. Peat by itself is not susceptible to liquefaction but may experience settlement resulting from earthquake shaking. Peat is commonly interstratified with sand strata and lenses that are liquefiable.

Landslide Hazard Areas

Debris flow run out distances have come to the forefront since the March 2014 Oso landslide. Landslide and steep slope regulations commonly focus on setback distances from the crest of slopes, with minimal attention given to the setback distance from the toe of slopes. Of concern are setback recommendations from the toes of slopes where incised drainages in the slope may be the source of shallow debris flows and associated run out distance from mouth of the ravine. Site specific evaluations should be required by a qualified geologist to determine the potential for debris flow/slide occurrence. The SR530 Landslide Commission Final report (2014) recommends identifying "critical area buffer widths based on site specific geotechnical studies" as an "innovative development regulation," that counties and cities should adopt (SR 530 Landslide Commission).

6.2 Updates to Existing Conditions

Given the geologic timescale, existing conditions as described in the 2003 Bellevue Critical Areas Update Geologically Hazardous Areas Inventory are considered current.

7 CRITICAL AQUIFER RECHARGE AREAS

Drinking water in the City of Bellevue is supplied through the Cascade Water Alliance. Critical Aquifer Recharge Areas (CARAs) are not addressed in this report. Best available science and recommendations for these types of critical areas were included in the *City of Bellevue- 2005 BAS Review*. However, given the limited number of wells in the City, the availability of public water supply to those areas that currently use wells, and state Safe Water Drinking Act requirements for wellhead protection, the City did not address critical aquifer recharge areas in its critical areas code. The Critical Aquifer Recharge Areas Guidance Document was published by the Washington Department of Ecology in January 2005, and it has not been updated since that time.

Since the 2005 BAS Review, the City has updated its Water System Plan. The City's 2016 Water System Plan identifies four emergency water supply wells maintained by the City, as well as several more that are held in reserve for emergency use. The City intends to eventually use these groundwater wells, which the City acquired through incorporation of water districts into the City's water service area, for emergency-only water production. The wells currently do not provide potable water. The Washington State Department of Health has not yet required a Wellhead Protection Plan because of the limited approved use of the wells. A Wellhead Protection Plan will be required before expanded use of the wells.

Since the 2006 critical areas update, the City annexed the Hilltop neighborhood, which includes an additional Class A well serving 40 connections (Department of Health Electronic Reference). Aquifer susceptibility in the vicinity of the well is rated as moderate (Department of Health Electronic Reference). Hilltop was annexed from unincorporated King County, and under the King County Code, the Hilltop area was not designated as a CARA.

8 SHORELINES

The City is in the process of updating its Shoreline Management Act. Under the proposed update, shorelines themselves are not regulated as critical areas, and critical areas within shoreline jurisdiction would be regulated under LUC Part 20.25H. The review of best available science addressed throughout this document is also applicable to shoreline critical areas.

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10 Acronyms and Abbreviations

BAS .... Best Available Science
CAO .... Critical Areas Ordinance
CARA .... Critical Aquifer Recharge Area
City .... City of Bellevue
Corps .... U.S. Army Corps of Engineers
Ecology .... Washington State Department of Ecology
EPA .... U.S. Environmental Protection Agency
FEMA .... Federal Emergency Management Agency
FFA .... Frequently Flooded Areas
FWHCA .... Fish and Wildlife Habitat Conservation Areas
GMA .... Growth Management Act
LUC .... Bellevue Land Use Code
NFIP .... National Flood Insurance Program
PHS .... Priority Habitats and Species
SEPA .... State Environmental Policy Act
State .... Washington State
SSWSP .... Storm and Surface Water System Plan
WAC .... Washington Administrative Code
WDFW .... Washington Department of Fish and Wildlife