3.1 Earth and Water Quality

3.1.1 Affected Environment

Introduction

This section reviews Seattle's existing landforms and natural features, and discusses the relationship of Seattle's environmentally critical areas to future growth that is contemplated in the Comprehensive Plan update.

EXISTING LANDFORMS AND SHORELINES

Seattle's landforms reflect a naturally hilly glacial-influenced terrain, bounded by Lake Washington, Puget Sound and other waterbodies. The landforms also have been extensively modified by development over more than a century. In both east-west and north-south directions, Seattle varies extensively in elevation, encompassing major hills such as Queen Anne Hill and Capitol Hill, the many slopes down toward shorelines and smaller hills in places such as Ravenna, West Seattle and Columbia City. Typically, these hill and valley landforms run in north-south directions reflecting past glacial influences, but there is other variety in the form of drainage-defined ravines, such as along Thornton Creek. Places such as the Greater Duwamish industrial area, Interbay and parts of Rainier Valley were influenced in their form by saltwater marine systems or natural storm drainage systems (and past placement of fill soils). These areas tend to contain alluvial or sandy soil conditions that could be subject to greater movement and/or liquefaction during major earthquake events.

Port and industrial activities in Elliott Bay, Lake Union and Ballard, and engineering activities such as the construction of the Ballard Locks, Montlake Cut, Harbor Island and modifications to the Duwamish Waterway have also influenced the nature, forms and stability of the shoreline habitats in the city. In other parts of the city, shorelines vary in their relationship to human activities: many shorelines along Puget Sound and Lake Washington have low-density residential properties adjacent to them, and still others are in more natural conditions, though features such as the near-shore railroad north of Shilshole Marina inevitably have influenced the existing environment.

The landscape contributes many of Seattle's treasured natural assets and qualities, including:

- Its variety of saltwater and freshwater shorelines;
- Hillsides with varying levels of natural vegetative cover and greenbelts;
- Natural drainage systems such as Thornton Creek and Longfellow Creek;

- Distinctive natural preserves such as Seward Park, Carkeek Park and Discovery Park; and
- The Olmsted-designed system of parks and greenways.

These features have recreational and aesthetic value, and provide natural functions and values that support wildlife presence and fish passage through major waterbodies. They also influence Seattle's planning and stewardship for a wide range of activities and purposes that include parks management, utility improvements (such as those dedicated to eliminating combined sewer overflows (CSOs)), tree canopy restoration and shoreline use management. Review of new development proposals also reflects the incorporation of environmentally protective values in the City's land use regulations, SEPA evaluations and environmental critical areas protections.

OVERVIEW OF ENVIRONMENTALLY CRITICAL AREAS

The nature of Seattle's landforms, soils, streams, marshes and the risks posed by large seismic events and seasonal weather, has led the City to designate environmental critical areas (ECAs). These are places where landslides or floods could occur, or major soil movements during earthquakes, or where there are riparian features with distinct natural values for plant and animal habitat and drainage purposes. Many but not all of these features are in lightly developed areas or are otherwise protected by being in parklands.

The ECAs that are defined primarily by soils or geologic conditions are called geologic hazard areas and include:

- Landslide-prone areas (including steep slope areas, potential landslide areas and known landslide areas)
- Liquefaction-prone areas (sites with loose, saturated soil that can lose the strength needed to support a building during earthquakes)
- Peat-settlement-prone areas (sites containing peat and organic soils that may settle when the area is developed or the water table is lowered)
- Seismic hazard areas
- Volcanic hazard areas

Examples of ECAs in developed areas include steep slope ECAs that were originally defined using topographic maps and soils information. These recognize that steep slopes may be present but also may have been previously altered by grading or improvements such as retaining walls commonly used when residential properties are developed. When a development is proposed on a property with a mapped ECA, a different level of review occurs to ensure that slope stability, drainage and/or riparian values are protected where present, and that structures are designed to minimize risks of future problems. In addition to minimizing development within steep slopes, this includes designing structures to avoid adversely affecting the top or toe of steep slopes, which can cause instability, personal injuries and slope failures that damage property.

From a broader perspective, Seattle's planning and regulatory codes also consider the potential for future development to affect downstream locations by flooding or pollution. Such effects can include damage to ravines and wetland degradation that reduces natural functions relating to water quality and plant/animal habitat. Water quality effects from urban runoff can also occur in natural drainages and downstream waters that include Lake Washington, Puget Sound, Lake Union and the Duwamish Waterway. Design elements such as drainage control systems that meet or exceed minimum standards help to avoid such impacts.

Table 3.1–1 on the following page summarizes how the city's designated urban centers and villages relate to known ECAs. Generally, while there is often a scattered presence of mapped steep slope ECAs within many lower-density residential neighborhoods, the majority of the urban centers' and villages' areas are developed in the flatter and lesser constrained areas of the city. Many of the ECAs are located around the sloping peripheral edges of the city and its hills. However, some urban centers and villages contain limited amounts of more significant critical areas either nearby or at their periphery, such as landslide hazards in places with steeper slopes and certain kinds of soil conditions. In certain other places, such as Greenwood-Phinney Ridge, there are peat soils within portions of the urban village, and similarly situated settlement-prone soils in parts of the Rainier Beach Urban Village. Certain soils' composition and lesser density cause them to be at risk of "liquefaction" (i.e., temporary loss of soil strength and behavior in a fluid-like manner, due to the combination of seismic movement and water within the soils) during severe earthquakes. Fill soils and liquefiable soils are also present in the Greater Duwamish industrial area. These soils are settlement prone, which may influence the design of future development but usually does not preclude it from occurring. When soils in urban areas liquefy due to a seismic event, underground utilities such as water and sewer lines can be damaged, streets and sidewalks may settle or be uplifted, sink-holes may form and structures that are not adequately designed to withstand liquefaction can be damaged.

Other environmentally-protective objectives considered in Seattle's planning activities are related to principles of a shared social responsibility for protecting the environment and growing in ways that allow for long-term sustainment of the natural environment's quality and viability. Concepts of living and growing as a city in ways that allow communities to be "resilient" in the face of possible future challenges are also relevant. Examples of planning for resiliency are to provide or preserve capabilities to grow food locally (as in p-patches) or to tangibly support manners of living that are less dependent on continued consumption of resources at current levels such as electricity or petroleum products.

3.1.2 Impacts

Impacts Common to All Alternatives

Growth will occur under all alternatives in all urban centers and villages, and in places outside these designated areas, in varying amounts. Given the potential for future growth, all

Table 3.1–1 Presence of environmental critical areas In or near urban centers and villages

Urban Centers	Environmental Critical Areas
Downtown	Minor presence of steep slopes at periphery including near Yesler Way/I-5, Pike Place Market and International District; potential settlement prone soils in part of Pioneer Square; known and potential landslide hazards in Little Saigon north of S Jackson St and north of S Dearborn St; shoreline habitat
First/Capitol Hill	Landslide and steep slope hazards at hill edges near I-5 and Melrose Ave northwest of the urban village; minor presence of steep slopes in residential yards
University District	Minimal steep slope presence; shoreline habitat area
Northgate	Thornton Creek riparian corridor and wetland complex, east of 5th Ave NE; wetlands west of I-5 near N Seattle College; peat settlement prone soils near Thornton Creek drainages and N Seattle College
South Lake Union	Occasional presence of steep slopes, including east of Aurora Ave and in Cascade vicinity; Lake Union shoreline
Uptown	Minor steep slope presence at north and southwest edges of urban village

Hub Urban Villages	Environmental Critical Areas
Ballard	Shoreline habitat areas, heron habitat area near Locks, other wildlife habitat area near Locks
Bitter Lake	Bitter Lake, Haller Lake, minimal presence of steep slopes at property edges, former landfill west of Haller Lake
Fremont	Intermittent, relatively frequent presence of steep slopes in a band of residential properties, primarily north of the neighborhood core; shoreline habitat
Lake City	Stream/riparian corridors to east, west and south of urban village core at NE 125th St; peat settlement prone area nearby to north; potential landslide areas nearby to east
Mount Baker	Liquefiable soils throughout valley centered on Rainier Ave S, intermittent presence of steep slopes at periphery east and west of Rainier Ave S
West Seattle Junction	Relatively frequent presence of steep slopes in residential yards surrounding the periphery of the urban village

Residential Urban Villages	Environmental Critical Areas
23rd & Union-Jackson	Minor presence of steep slopes near 23rd Ave S and east of Rainier Ave S; wetland near 23rd Ave S/S Dearborn St
Admiral	Minimal steep slope presence except at ravine east of the urban village; past slides noted at top of slope there; wildlife habitat in the ravine
Aurora-Licton Springs	Licton Springs Park at east edge of urban village, includes stream corridor and peat settlement prone soils; minimal steep slope presence in urban village
Columbia City	Intermittent presence of steep slopes east and west of Rainier Ave S; three scattered wetlands
Crown Hill	None identified
Eastlake	Shoreline habitat; relatively frequent presence of steep slopes in residential yards; past landslides
Green Lake	Green Lake, minimal presence of steep slopes in residential yard edges
Greenwood-Phinney Ridge	Peat settlement prone soils distributed in and near Greenwood core north of N 84th St; minimal steep slope presence
Madison-Miller	Minor steep slope presence; landslide hazard areas nearby to the east
Morgan Junction	Minor presence of steep slopes in residential yard edges; steep ravine located nearby to the west of the urban village
North Beacon Hill	Extensive steep slope and landslide hazard areas at east and west periphery of this urban village, but only minor presence within core neighborhood. Past landslides noted.
Othello	Minimal presence of steep slopes at periphery of urban village; four scattered small wetlands in or near the urban village
Upper Queen Anne	Minor steep slope presence, southern periphery of urban village
Rainier Beach	Liquefiable and settlement prone soils in much of the neighborhood core; Mapes Creek corridor; steep slopes and landslide hazard areas at peripheral edges south and west of the urban village
Roosevelt	Minimal presence of steep slopes in residential yard edges; Ravenna Park ravine and stream nearby to southeast
South Park	Extensive liquefiable soils, shoreline habitat, scattered steep slopes
Wallingford	Minimal presence of steep slopes in residential yard edges
Westwood-Highland Park	Minor presence of steep slopes including at Denny Middle School, Longfellow Creek riparian corridor and wetland north of SW Thistle St, wetlands at Roxhill Park

Source: DPD, 2014.

of these places could experience adverse impacts generated during future construction and by increased density of urban uses and activities after construction.

DURING CONSTRUCTION

Future development across the city will lead to grading, demolition and similar construction activities that will generate the potential for disturbed soil to be conveyed off sites and into nearby drainage systems, primarily through stormwater runoff and tracking of soils and leaking of petroleum products on surfaces in the local vicinity. Releases could be intentional or unintentional in nature, and could make their way into local streams or wetlands through stormwater washoff and drainage. On construction sites that are close to natural vegetated areas and/or ECAs, there may be increased potential for disturbance to generate adverse impacts, such as when potentially unstable steep slopes or poor quality soils are present.

The City's rules require protective measures such as erosion controls that limit areas subject to construction-related disturbance and minimize the transport of soils and pollutants off site. This includes protections through critical areas regulations that will continue to be applied where relevant, such as buffers or prohibitions on disturbance or limitations on the nature and extent of development activities.

In a variety of places, future development in properties without ECAs could indirectly lead to adverse effects upon critical areas such as natural ravine drainages that lie in nearby downstream locations. This could occur in places that drain to natural streams, or via drainage utility systems that are designed to outfall to natural receiving waterbodies, if soils and other pollutants are washed off and conveyed far enough away from construction sites. Compliance with on-site regulations by future development is anticipated to sufficiently address and minimize the potential for adverse impacts of these kinds.

AFTER CONSTRUCTION

Even after construction, future possible activities on residential or commercial properties could adversely affect ECAs directly or indirectly. Examples include: landscaping involving earth movement in or near sensitive areas, improper tree cutting or other vegetation management that violates City rules, paving areas without including appropriate stormwater control features, or the cumulative effects of multiple parties' actions that could potentially alter drainage patterns and/or affect soil and slope stability.

As well, increased density and activity levels for residential or commercial purposes and the associated use of automobiles and other activities, could contribute to additional increments of adverse water quality impacts in ECAs. For example, wetlands and streams may be impacted by washoff of pollutants from street surfaces and discharge of pollutants into drains. However, the City's current level of requirements for stormwater and water quality controls mean that future development would in most cases be expected to lead to net increases in protection of nearby ECAs or other natural resources, due to the slowing, redirection and treatment of stormwater and surface runoff by on-site systems.

Impacts of the Alternatives

The distinctions among the alternative growth strategies defined for this EIS may generate different levels or distributions of potential adverse critical area impacts. Findings regarding the cumulative potential for impacts are summarized at a programmatic level of review. The range of potential adverse impacts relate to the potential for future development over the next two decades in given locations, and the relative degree of presence of the following physical conditions in or near particular urban centers and villages:

- Steep slope/landslide prone soils;
- Natural drainage features;
- Peat soils or other soil conditions that are susceptible to earthquake movement; and
- The combined presence of those ECA types.

Future site-specific development review would determine whether and how future development could be designed in ways that would avoid or reduce the potential impacts to ECAs.

Alternative 1: Continue Current Trends (No Action)

STEEP SLOPES/LANDSLIDE HAZARDS

Information in Table 3.1–1 indicates that certain neighborhoods have a somewhat greater presence of steep slopes than is typical of urban villages' average conditions. Those places are: Downtown, First/Capitol Hill, South Lake Union, Uptown, Fremont, West Seattle Junction and Eastlake.

Most of the steep slopes in these areas are either at peripheral locations of the urban village and/or are primarily located in front or rear yard edges of properties. Many are in low-density or low-to-moderate zoned properties. These locations are or were part of naturally sloping hillsides but many such locations have also been affected by past grading for development that has occurred over many decades. Future development in some of these locations potentially could occur over the next twenty years.

In the identified areas:

Areas with greater potential risk of ECA disturbance:

- Most or all of the steep slopes present in South Lake Union are likely to be affected due to their central locations within the neighborhood and within properties that are likely to be developed within the next twenty years.
- In the portions of Uptown Queen Anne where steep slopes are located in the most accessible and developable places, disturbance of steep slopes is relatively likely.
- Under Alternative 1, projected levels of growth in Eastlake are greater than under the other alternatives, which could increase the total amounts of future disturbance of existing steep slope edges in this neighborhood.

Area with low potential risk:

- For First/Capitol Hill, the limited nature of the affected area (just east of I-5 near Lakeview Boulevard E) and its remoteness from the primary neighborhood core suggests a low potential for development risks to ECAs.

PEAT SOILS/SETTLEMENT PRONE SOILS

Peat soils or soils that are otherwise susceptible to movement in a large earthquake are present in certain neighborhoods: Northgate, Mount Baker, Greenwood-Phinney Ridge, Pioneer Square, South Park and Rainier Beach. Such soil conditions can put physical constraints on future development or can require additional engineering and specialized structural design to ensure that stable development can occur. The City also has pertinent development regulations such as those in SMC 25.09. In the worst case, liquefaction effects and related property, roads and infrastructure damage could occur, which could displace households living in such areas until the damaging effects could be remedied.

To the extent that future development would occur as a result of Alternative 1 in areas potentially constrained by these soil conditions, this is identified as generating a potential adverse impact, that can be mitigated through application of the City's existing policies and regulations. Future site-specific development review would determine whether and how future development could be designed and conditioned in ways to avoid or reduce the potential impacts.

Areas with greater potential risk of ECA disturbance:

- In Greenwood, Rainier Beach, South Park and North Rainier, the soil conditions are relatively widespread in the neighborhoods' core areas and thus the degree of adverse impact would relate to the amount of future development anticipated.
  - For Greenwood-Phinney Ridge, Rainier Beach and South Park, the projected amounts of growth are relatively similar for all alternatives, including Alternative 1.
  - For Mount Baker, compared to the other alternatives, the residential and employment growth projected under Alternative 1 is less than the other alternatives, meaning a lesser exposure of the neighborhood's settlement prone soils to potential adverse impacts.
- Comparatively, Northgate has a lesser overall presence of these potentially unstable soils than the other neighborhoods, but several of the properties with such soils could be subject to future development under any alternative. The residential and employment growth projected under Alternative 1 is less than the other alternatives, meaning a lesser exposure of the neighborhood's settlement prone soils to potential adverse impacts.

PRESENCE OF STREAMS OR WETLAND ECAS NEARBY

Certain neighborhoods include the presence of streams or wetlands either within the urban village or in relatively close proximity to its core area: Northgate, Lake City, Columbia City,

Morgan Junction and Westwood-Highland Park, with conditions as summarized in Table 3.1–1. In such areas, direct destruction or infringement upon these ECA resources is a relatively lower risk (due to current regulatory protections) than the possible indirect contributions of additional pollutants that could be generated by future development in the upstream vicinities. Also, the risk of indirect impacts would be mitigated to some degree by the use of drainage control and water quality best management practices in future development. However, despite such assumptions there would remain a risk of added pollution or other incremental increase in damage potential to streams or wetlands present in these locations near future urban village growth areas. This would represent a potential adverse impact.

Areas with greater potential risk of ECA disturbance:

- Given the combination of proximity of these natural features to future development, and the amount of projected residential and employment growth, the neighborhoods facing a greater risk of adverse impacts on these ECAs under Alternative 1 are: Northgate, Lake City and Columbia City.

Area with low potential risk:

- Given the relatively limited amounts of growth, the risk of ECA disturbance under Alternative 1 would be less in Westwood-Highland Park and Morgan Junction than in the other neighborhoods identified above.

PRESENCE OF STEEP SLOPES OR RAVINES NEARBY BUT OUTSIDE URBAN VILLAGES

Two neighborhoods are in relatively close proximity to steep slopes, but the slopes are either outside the urban village boundaries, or the slope edges are mostly already developed with residential uses, or both. Those places include: North Beacon Hill and Admiral. In both of these places, past slide events have been noted near the edges of the slopes, but in locations that are peripheral to the neighborhood cores and unlikely to experience elevated future development risks. However, there is a minor risk that future development in the urban villages might indirectly and adversely affect such slopes. Under Alternative 1, the risk related to the potential for added residential and employment growth is the lowest among all the alternatives.

LIKELY IMPACTS APPROXIMATELY RELATE TO AMOUNT OF GROWTH UNDER THE ALTERNATIVES

Table 2–2 and Table 2–3 in Chapter 2 summarize the projected residential and employment growth associated with each alternative in the urban centers and villages. These projected growth levels inform the impact analysis, with respect to the potential growth pressure that may lead to the eventual disturbance of known ECAs. However, this is only an approximate relationship. In Downtown, for example, the projected variations in residential and employment growth might or might not lead to pressures on the particular properties that have steep slope or landslide ECAs. It would depend on whether the sites with such constraints would develop or not.

Alternatives 2, 3 and 4: Guide Growth to Urban Centers, Guide Growth to Urban Villages near Light Rail and Guide Growth to Urban Villages near Transit

Table 3.1–2 on the following page describes the potential for adverse impacts to critical areas that could be generated by future growth patterns under alternatives 2, 3 and 4, in relation to the findings for Alternative 1. Like the Alternative 1 evaluation, these findings focus on the subset of urban centers and villages where such critical areas are present and most likely to be adversely affected.

Compared to Alternative 1's findings, the potential adverse impacts related to alternatives 2, 3 and 4 are:

- A somewhat elevated risk of peat/settlement-prone soil ECA disturbances with future development in Northgate and Rainier Beach, given amounts of projected growth;
- Elevated risks of peat/settlement-prone soil ECA disturbances in Mount Baker and Rainier Beach;
- A somewhat elevated risk of downstream creek or wetland ECA disturbances in Northgate (alternatives 2, 3 and 4), Columbia City (alternatives 3 and 4) and Westwood-Highland Park (alternatives 3 and 4).

3.1.3 Mitigation Strategies

This section has identified comparative differences in the potential for adverse impacts related to disturbance of ECAs by potential future development. However, none of these identified impacts are concluded to be significant adverse impacts. The continued application of the City's existing policies, review practices and regulations, including the operational practices of Seattle Public Utilities, would help to avoid and minimize the potential for significant adverse impacts to critical areas discussed in this section.

3.1.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to earth and water quality are anticipated.

Table 3.1–2 Potential critical area disturbance impacts of alternatives 2, 3 and 4, compared to Alternative 1

Urban Centers	Alternative 2	Alternative 3	Alternative 4
Steep slopes/ landslide hazards	**First/Capitol Hill:** Same as Alt. 1. **South Lake Union:** Same as Alt. 1. **Uptown:** Similar but lower risk of disturbance than Alt. 1. **Eastlake:** Lower risk of disturbance than Alt. 1; lesser growth.	**First/Capitol Hill:** Same as Alt. 1. **South Lake Union:** Same as Alt. 1; projected growth between Alt. 1 & 2 **Uptown:** Similar but lower risk of disturbance than Alt. 1. **Eastlake:** Lower risk of disturbance than Alt. 1; half as much growth.	**First/Capitol Hill:** Same as Alt. 1. **South Lake Union:** Nearly the same as Alt. 3. **Uptown:** Same as Alt. 3: a similar but lower risk of disturbance than Alt. 1. **Eastlake:** Lower risk of disturbance than Alt. 1; Same as Alt. 3.
Peat/ Settlement-prone soils	Findings same as Alt. 1 in Mount Baker, Greenwood-Phinney Ridge, South Park. In Rainier Beach, a higher projected growth of 500 dwellings rather than 100 dwellings indicates a greater potential for adverse impacts. **Northgate:** Alt.2 has a higher risk of disturbance than any other alternative. Development more likely & perhaps at greater densities. A possibly elevated risk of on-site or downstream adverse impacts re: soil settlement or changes in sub-surface drainage.	Findings same as Alt. 2 in Greenwood-Phinney Ridge & South Park. **Northgate:** Alt. 3's potential for adverse impacts is between that of Alt. 1 & Alt. 2. **Mount Baker:** Alt. 3's projected higher growth (approx. 2,200 more dwellings & 2,400 more employees than Alt. 2) mean a higher risk of peat/settlement prone soil disturbance. **Rainier Beach:** A projected higher growth (1,000 more dwellings & 300 more employees than Alt. 2) mean a higher risk of peat/settlement prone soil disturbance.	Findings similar to but slightly greater than Alt. 2 in Greenwood-Phinney Ridge & South Park. **Northgate:** Alt. 4's potential for adverse impacts is the same as for Alt. 3. **Mount Baker:** Alt 4's findings are similar to but somewhat greater than Alt. 3, given an added potential for 500 more dwelling units growth than Alt. 3. **Rainier Beach:** Findings are the same as for Alt. 3.
Nearby streams or wetland ECAs	**Northgate:** For Alt. 2, given more development than Alt. 1, there is a possibly elevated risk of downstream adverse impacts on streams & wetlands. **Lake City:** Given a lower projected growth in Lake City, potential impacts are lower than Alt. 1. **Columbia City:** Given a lower projected growth in Columbia City, potential impacts are lower than Alt. 1. **Morgan Junction:** A low potential for adverse impacts, similar to Alt. 1. **Westwood-Highland Park:** A low potential for adverse impacts, similar to Alt. 1.	**Northgate:** Given projected growth that is midway between that for Alt. 1 & 2, there is potential for possibly elevated risks, on-site & downstream, that are greater than for Alt. 1.. **Lake City:** Given a lower projected growth in Lake City, potential impacts are the same as Alt. 2, & less than Alt. 1. **Columbia City:** Alt. 3's projected higher growth (500 more dwellings than Alt. 1) mean the potential for impacts is somewhat greater than Alt. 1. **Morgan Junction:** A low potential for adverse impacts, similar to Alt. 1. **Westwood-Highland Park:** Up to 200 more dwelling units growth slightly increases the risk of adverse impacts to streams, wetlands compared to Alt. 1.	**Northgate:** Same findings as Alt. 3. **Lake City:** Slightly more potential for growth-related impacts than Alt.2 or 3, but less than potential impacts for Alt. 1. **Columbia City:** Same findings as Alt. 3. **Morgan Junction:** A low potential for adverse impacts, nearly the same as for Alt. 1. **Westwood-Highland Park:** Same findings as Alt. 3.

Source: DPD, 2014.