FINAL

Shoreline Analysis Report for the Town of Yarrow Point's Lake Washington Shoreline

August 2011

Prepared for:

Yarrow Point
WWW.CI.YARROW-POINT.WA.US

Town of Yarrow Point
4030 95th Ave NE
Yarrow Point, WA 98004

Prepared by:

The Watershed Company

&

Yarrow Point
WWW.CI.YARROW-POINT.WA.US

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TOWN OF YARROW POINT
GRANT NO. G1000071

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Town of Yarrow Point
4030 95th Ave NE
Yarrow Point, WA 98004

Prepared by:

THE WATERSHED COMPANY
750 Sixth Street South
Kirkland . WA 98033
p 425.822.5242
f 425.827.8136
watershedco.com

AND Town of Yarrow Point

WASHINGTON STATE DEPARTMENT OF ECOLOGY

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The Watershed Company Reference Number:
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The Watershed Company Contact Person:
Amy Summe
Town of Yarrow Point Contact Person:
Mona Green

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TOWN OF YARROW POINT: LAKE WASHINGTON SHORELINE

1 INTRODUCTION

1.1 Background and Purpose

The Town of Yarrow Point (Town) obtained a grant from the Washington Department of Ecology (Ecology) in 2009 to complete a comprehensive Shoreline Master Program (SMP) update. One of the first steps of the update process is to inventory and characterize the Town's shorelines as defined by the state's Shoreline Management Act (SMA) (RCW 90.58). This inventory was conducted in accordance with the Shoreline Master Program Guidelines (Guidelines, Chapter 173-26 WAC) and project Scope of Work promulgated by Ecology, and includes all areas within current Town limits. Under these Guidelines, the Town must identify and assemble the most current, accurate and complete scientific and technical information available that is applicable. This shoreline inventory and analysis will describe existing conditions and characterize ecological functions in the shoreline jurisdiction. This will serve as the baseline against which the impacts of future development actions in the shoreline will be measured. The Guidelines require that the Town demonstrate that its updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline due to its implementation.

A list of potential information sources was compiled and an information request letter was distributed to potential interested parties and agencies that may have relevant information. Collected information was supplemented with other resources such as Town documents, scientific literature, personal communications, aerial photographs, Internet data, and a brief physical inventory of the Town's shoreline.

1.2 Shoreline Jurisdiction

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the state are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater, lakes whose area is greater than 20 acres, and all marine waters. Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark;

> floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom… Any city or county may also include in its master program land necessary for buffers for critical areas (RCW 90.58.030)"

The ordinary high water mark is:

> "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on June 1, 1971, as it may naturally change thereafter, or as it may change thereafter in accordance with permits issued by a local government or the department: PROVIDED, That in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining salt water shall be the line of mean higher high tide and the ordinary high water mark adjoining fresh water shall be the line of mean high water" (RCW 90.58.030(2)(b)).

The Town's Shoreline Management Master Program was adopted in 1975. The SMP consists of the goals and policies in the Town's Comprehensive Plan and provisions in the Town's Municipal Code. The Town's existing shoreline management area includes the entirety of Lake Washington shoreline within Town limits. Because Lake Washington exceeds 1,000 acres in size, the lake is considered a Shoreline of Statewide Significance.

Washington Department of Ecology's Digital Atlas was consulted to assess whether any streams within Town limits exceed the 20 cfs cut-off. However, per the data, no streams within the Town have a mean annual flow of 20 cfs or greater. No other waterbodies within the Town boundary exceed 20 acres.

Existing Town of Yarrow Point wetland information (Town of Yarrow Point GIS) and National Wetland Inventory (NWI) data were reviewed to identify known shoreline associated wetlands. Ecology guidance states that an entire wetland is associated if any part of it lies within the area 200 feet from the ordinary high water mark (OHWM) of a state shoreline. Further guidance states that wetlands that are hydraulically connected to a Shoreline also would be considered associated. Wetlands that are separated by an obvious topographic break from

the shoreline are not associated, provided they are outside the shoreland zone and provided that the break is not an artificial feature such as a berm or road.

Based on a review of the Town's wetland inventory along Lake Washington, shoreline-associated wetlands, as included in Appendix A, exist within the Wetherill Nature Preserve at the head of Cozy Cove and within Morningside Park on Yarrow Bay. These wetlands lay within the 200-foot jurisdiction of existing shoreline waterbodies.

1.3 Study Area

The northern portion of Yarrow Point was first developed in the late 1880s by Leigh S. J. Hunt. Development lots elsewhere in the area were first platted and sold in 1907. Later, significant strawberry, vegetable and holly farming took hold throughout the Point. By the 1950s the town's population had grown steadily, as a result of the first Lake Washington bridge, and single-family residences had overtaken much of the farming on the Point. Concerns over zoning-related issues and the preservation of the Yarrow Bay Wetlands eventually led to the incorporation of Yarrow Point in 1959.

The Town has changed very little since incorporation. Many of the original residences have been replaced by new (and larger) residences, but land use within the Town has remained nearly unchanged since incorporation.

The Town is bordered by incorporated areas of Kirkland to the east, Clyde Hill to the south and Hunts Point to the west. The Town's shoreline includes the entirety of the Yarrow Point peninsula, bordered by Cozy Cove to the west and Yarrow Bay to the east. State Route 520 passes through the southern portion of the Town from east to west. The Town encompasses approximately 0.36 square miles. The study area for this report includes all land currently within the Town's proposed shoreline jurisdiction (Appendices A and B). The total area subject to the Town's updated SMP, not including aquatic area, is approximately 38.9 acres (0.06 square mile), and encompasses approximately 1.49 miles of shoreline.

2 CURRENT REGULATORY FRAMEWORK SUMMARY

2.1 Town of Yarrow Point

The Shoreline Management Act of 1971 brought about many changes for local jurisdictions, including the Town of Yarrow Point. The legislative findings and policy intent of the SMA states:

> "There is, therefore, a clear and urgent demand for a planned, rational, and concerted effort, jointly performed by federal, state, and local governments, to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines (RCW 90.58.020)."

While protecting shoreline resources by regulating development, the SMA is also intended to provide balance by encouraging water-dependent or water-oriented uses while also conserving or enhancing shoreline ecological functions and values. The SMP is based on State guidelines but tailored to the specific conditions and needs of individual communities.

The Town's first Shoreline Master Program was adopted in 1975. Regulations applicable to sensitive areas which are located within shoreline jurisdiction were created in 1994.

Any applicant must comply with all applicable laws prior to commencing any use, development, or activity. Yarrow Point ensures consistency between the SMP and other Town codes, plans and programs by reviewing each for consistency during periodic updates of the Town's Comprehensive Plan as required by State statute.

2.2 State and Federal Regulations

State and federal regulations most pertinent to development in the Town's shorelines include the federal Endangered Species Act, the federal Clean Water Act, the State Shoreline Management Act, and the State Hydraulic Code. Other relevant federal laws include the National Environmental Policy Act, Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. State laws which address shoreline issues include the Growth Management Act, State Environmental Policy Act (SEPA), tribal agreements and case law, Watershed Planning Act, Water Resources Act, Salmon Recovery Act, and the Water Quality Protection Act. A variety of agencies (e.g., U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife

Service, Washington Department of Ecology, Washington Department of Fish and Wildlife) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing.

Depending on the nature of the proposed development, State and federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. With the comprehensive SMP update, the Town will strive to ensure that Yarrow Point's SMP regulations are consistent with other State and Federal requirements and explore ways to streamline the shoreline permitting process. A summary of some of the key regulations and agency responsibilities follows.

Section 10: Section 10 of the federal Rivers and Harbors Appropriation Act of 1899 provides the U.S. Army Corps of Engineers (Corps) with authority to regulate activities that may affect navigation of "navigable" waters. Lake Washington is a designated navigable waterbody. Accordingly, proposals to construct new or modify existing in-water structures (including piers, marinas, bulkheads, breakwaters), to excavate or fill, or to "alter or modify the course, location, condition, or capacity of" navigable waters must be reviewed and approved by the Corps.

Section 404: Section 404 of the federal Clean Water Act provides the Corps, under the oversight of the U.S. Environmental Protection Agency, with authority to regulate "discharge of dredged or fill material into waters of the United States, including wetlands" (http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf). As applicable to the Town of Yarrow Point's shoreline jurisdiction, this means that the Corps must review and approve most activities in streams, wetlands, and the lake. These activities may include lake or wetland fills, stream and wetland restoration, and culvert installation or replacement, among others. Similar to SEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts.

Federal Endangered Species Act (ESA): Section 9 of the ESA prohibits "take" of listed species. Take has been defined in Section 3 as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The take prohibitions of the ESA apply to everyone, so any action that results in a take of listed fish or wildlife would be a violation of the ESA and is strictly prohibited. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and

Wildlife Service (USFWS) via a process called "consultation." As previously mentioned, a Corps permit under Section 10 of the Rivers and Harbors Appropriation Act is required for projects in Lake Washington.

Section 401 Water Quality Certification: Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges to State waters, including wetlands. In Washington, the Department of Ecology is the State agency responsible for conducting that review, with their primary review criteria of ensuring that State water quality standards are met. Actions within streams, lakes or wetlands within the shoreline zone that require a Section 10 or Section 404 permit (see above), will also need to be reviewed by Ecology.

Hydraulic Code: Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny "any construction activity that will use, divert, obstruct, or change the bed or flow of State waters." As applicable to the Town of Yarrow Point's shoreline jurisdiction, however, it generally means that WDFW must review and approve most activities in Lake Washington. These activities may include pier and bulkhead repair or construction, stream alteration, and culvert installation or replacement, among others. WDFW can condition projects to avoid, minimize, restore, and compensate adverse impacts.

3 ELEMENTS OF THE SHORELINE INVENTORY & SPECIFIC CONDITIONS

Development of a shoreline inventory is intended to record the existing or baseline conditions upon which the development of shoreline master program provisions will be examined to ensure the adopted regulations provide no net loss of shoreline ecological functions. At a minimum, local jurisdictions shall gather, to the extent information is relevant and readily available, the following shoreline inventory elements, as found in Table 1. The table also describes the information collected for each of the required inventory elements. Figures are provided in Appendix B and depict the various inventory pieces listed in the table, as well as additional analysis.

Table 1. Shoreline Inventory Elements and Information Sources.

Inventory Element	Information Gathered	Data Sources
Land Use Patterns	Land Use, Zoning	King County Assessor, Comprehensive Plan, Town GIS

Inventory Element	Information Gathered	Data Sources
Transportation	Highways, arterials, local streets, & street ends	King County GIS
Utilities	Wastewater and stormwater facilities	City of Bellevue GIS (wastewater), Town of Yarrow Point (stormwater)
Impervious Surfaces	Roads, parking lots, & buildings; 30m resolution, aerial photo interpretation	USGS, Town GIS (building footprints)
Vegetation	Vegetation and development types at 30m resolution, aerial photo interpretation	NOAA / USGS National Land Cover Data
Shoreline Modifications	Bulkheads, docks, boatlifts, boathouses, & moorage covers	Field Inventory (armoring), WA Department of Natural Resources (overwater cover)
Public Access Areas	Parks and open space, public docks, trails	Field Inventory, Comprehensive Plan
Soils	Soil types	NRCS SSURGO
Critical Areas	Wetlands, geologically hazardous areas, & fish and wildlife habitat conservation areas	WDFW GIS, King County GIS, The Watershed Company
Impaired Waterbodies	303(d) listed waters	WA Department of Ecology
Lake bathymetry	5-foot interval contour isolines created from lidar-based elevation data	King County GIS

In order to break down the shoreline into manageable units and to help evaluate differences between discrete shoreline areas, the shoreline has been sequentially divided into two reaches based on land use. Reach 1 includes the entire shoreline designated for residential land use. Reach 2 has been divided into 2A and 2B and includes both undeveloped public parcels within Town limits (Wetherill Nature Preserve and Morningside Park).

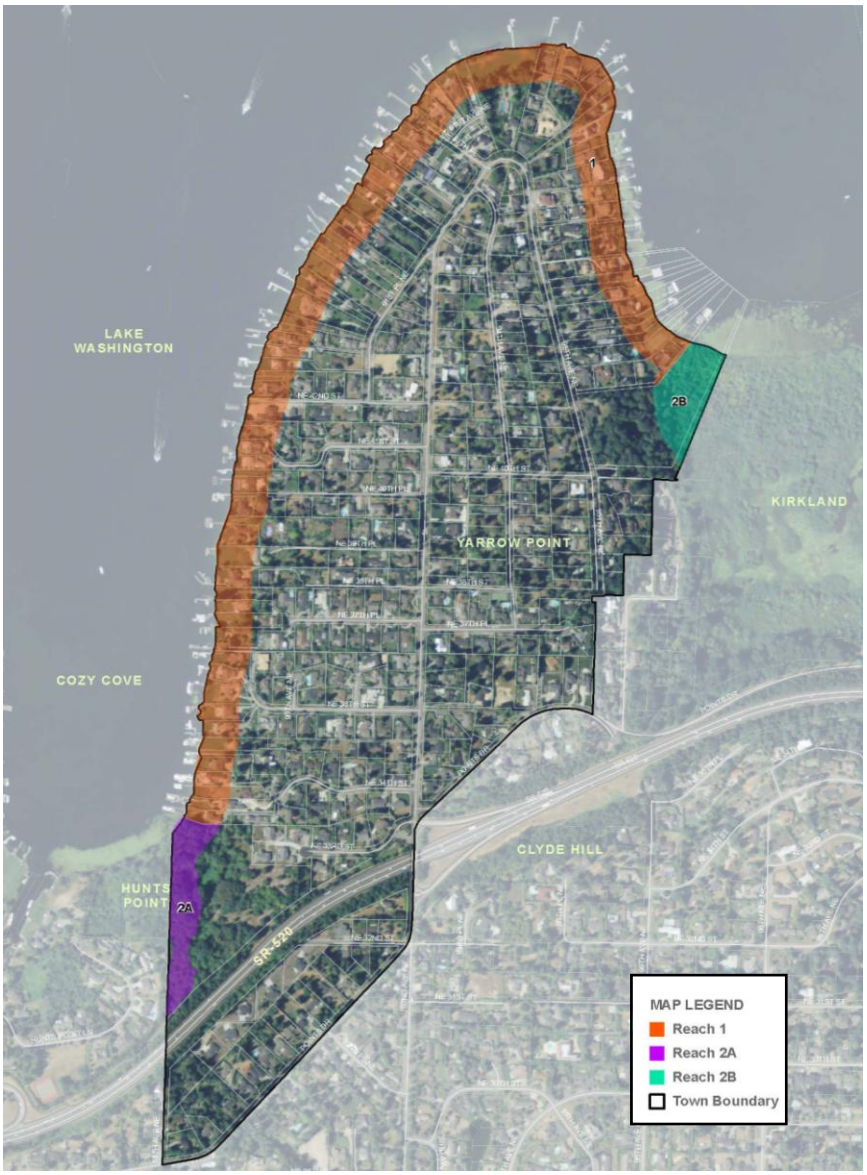

Exhibit 1. Shoreline Reach Breaks.

The following table expands upon the relevant above required inventory elements, providing specific detail and data for both reaches, and providing a narrative where appropriate for each element.

Table 2. Shoreline Inventory Elements by Reach.

Inventory Elements	Reach 1		Reach 2			
			2A (Wetherill Nature Preserve)		2B (Morningside Park)	
Land Use Patterns	**Zoning:** Single-Family Residential (R-15) - 99% Public Uses - 1%		**Zoning:** Public Uses - 100%		**Zoning:** Public Uses - 87% Single-Family Residential (R-15) – 13%	
	Current Land Use: Residential – 98% Public Access to the Lake – 0.7% Private Park – 1% Private Recreation Lot – 0.5%		**Comprehensive Plan Designation:** Public Parks – 100%		**Comprehensive Plan Designation:** Public Parks – 87% Residential – 13% (the residence is outside of shoreline jurisdiction)	
Impervious Surfaces	8.9 acres - 28%		0.08 acres - 2.4%		0.05 acres - 1.4%	
Vegetated Area	7.25 acres - 22.5%		3.2 acres - 90.5%		2.6 acres - 79.2 %	
Shoreline Armoring	6,610 ft - 87%		2.6 ft - 0.03%		0 ft – 0%	
Overwater Cover	**Number of Docks**	**Area of Docks (SF)**	**Number of Docks**	**Area of Docks (SF)**	**Number of Docks**	**Area of Docks (SF)**
	82	179,961	0	---	0	---
Public Access Areas	0.31 acres – 0.7%		3.49 acres - 100% 1,237 linear feet of trail		2.88 acres - 87%	
Sensitive Areas	**Erosion Hazard Areas:** 0.10 acres – 0.3% **Bald eagle and buffer (WDFW PHS)**		**Wetlands:** 3.03 acres - 86.8% **Erosion Hazard Areas:** 2.0 acres – 59% **Bald eagle and buffer (WDFW PHS)**		**Wetlands:** 3.32 acres - 100% **Erosion Hazard Areas:** 0.03 acres – 1% **Bald eagle and buffer (WDFW PHS)** **Great blue heron (WDFW PHS)**	

4 Analysis of Ecological Functions and Ecosystem-Wide Processes

4.1 Lake Washington Watershed (WRIA-8)

4.1.1 Geographic Context

The Town of Yarrow Point is located on Lake Washington in the Puget Sound Region and contains freshwater shorelines associated with Washington State's Water Resource Inventory Area (WRIA) 8 (Exhibit 2) (http://www.ecy.wa.gov/services/gis/maps/wria/mpl/mpl8.pdf). WRIA 8 encompasses 692 square miles, collecting water from two major rivers (the Cedar and Sammamish rivers) before flowing through Lake Union and ultimately into Puget Sound via the Lake Washington Ship Canal and Hiram Chittenden locks.

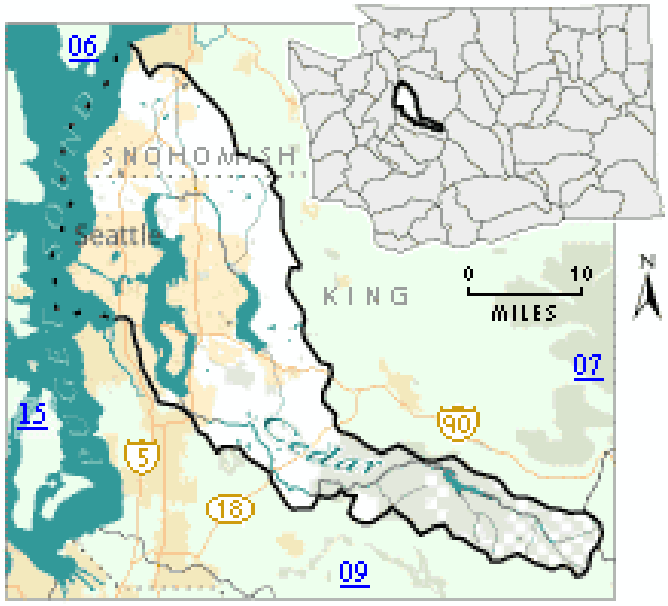

Exhibit 2. Overview of the Cedar Sammamish Water Resource Inventory Area (WRIA) 8.

4.1.2 Historic Drainage Patterns and Lake Washington Alterations

The lowering of the lake that resulted from the construction of the Lake Washington Ship Canal and Hiram Chittenden locks (completed in 1916) and the concurrent elimination of the Black River and the diversion of the Cedar River into Lake Washington were the most monumental modifications. Lake Union

was connected to Lake Washington via the Montlake Cut, and the former outlet to Lake Union was enlarged to form the Fremont Cut. Locating the locks near the western terminus of Salmon Bay converted the formerly saltwater inlet into a freshwater channel, eliminating over 7 km (4 mi.) of estuarine habitat. Lowering Lake Washington and diverting the Cedar River affected both the fish populations and the condition of the habitat. Cedar River fish stocks were locally adapted to a riverine migration and an extensive estuary, instead of the current lengthy lacustrine migration and an abrupt transition between warm, fresh water and significantly colder, more saline conditions below the locks. Lake Washington fish stocks, while accustomed to the lengthy lacustrine migration, were also adapted to an extensive estuary. The approximately 9-foot reduction in lake level eliminated much of the available shallow-water and freshwater marsh habitat, and decreased the length of the shoreline. Chrzastowski (1983) reports a loss of 15.3 km (9.5 miles) of shoreline, and an estimated loss of 410 hectares (1,013 acres) of wetland resulting from the lowering of the lake.

The construction of the Hiram Chittenden locks and subsequent water level regulation in Lake Washington by the Corps eliminated the annual flood-driven seasonal inundation of the shoreline that historically shaped the structure of the vegetation community. The hardstem bulrush- and willow-dominated community that existed prior to 1916 has been replaced by developed shorelines with landscaped yards. The management of the lake level by the Corps to maintain a high water volume throughout the summer and subsequently lowering the lake during the late fall and winter essentially reverses the natural lake hydrograph. This reversal impacts the growth of many species of native terrestrial and emergent vegetation. Conversely, this hydrograph reversal indirectly acts to buffer shorelines from potential wind-driven wave impacts during winter storms. The loss of natural shoreline has reduced complex shoreline features such as overhanging and emergent vegetation, woody debris (especially fallen trees with branches and/or rootwads intact), and gravel/cobble beaches. Evermann and Meek (1897) noted in 1896 that "the shore of Lake Washington is not well adapted to collecting with a seine" due to the abundant submerged woody debris, and dense underbrush, small trees, and tule (hardstem bulrush) that fringed the shoreline. The loss of native shoreline vegetation and wetlands has also reduced naturally occurring nutrients and food resources.

The woody debris, once abundant along the shoreline of Lake Washington in its historical condition has been replaced with structurally simple piers. A survey of 1991 aerial photos estimated that 4 percent of the shallow-water habitat within 30.5 meters (100 feet) of the shore was covered by residential piers (ignoring coverage by commercial structures and vessels) (Malcom, pers. comm., 22 November 1999). A study conducted in 2000 reported that there were 2,737 docks in Lake Washington, and that approximately 71 percent of the shoreline

was armored (Toft 2001). The loss of complex habitat features (i.e., woody debris, overhanging vegetation, emergent vegetation), and shallow-water habitat in Lakes Washington and Sammamish has reduced the availability of prey refuge habitat and forage for juvenile salmonids. As NOAA Fisheries- and USFWS-mandated standard conservation measures are implemented with individual shoreline projects, and bioengineering methods and other "fish-friendly" designs for shore protection are adapted to lakeshore use, the condition of the Lake Washington shoreline, in terms of fish and wildlife habitat may improve over time. However, the present availability of quality shoreline habitat for salmonids and their prey species remains substantially below its historical level. Recent and ongoing efforts to address the concern of growth management within the watershed and facilitate recovery efforts for salmon and salmon habitat, specifically for Chinook salmon, include working with local jurisdictions to implement shared strategies for salmon recovery (WRIA 8 Steering Committee 2005; WRIA 8 Steering Committee 2002).

While water quality in Lake Washington is often considered moderate to good, the present state is a tremendous improvement from its condition just 50 years ago. Prior to the formation of Metro (now part of King County's Department of Natural Resources and Parks) in 1958, local sewage treatment plants around Lake Washington discharged effluent directly into the lake, resulting in large cyanobacteria (*Oscillatoria rubescens*) blooms that made the lake unsafe for recreation. After the construction of regional wastewater treatment facilities in Renton and at West Point in Seattle, effluent discharges dropped from approximately 20 million gallons per day to zero (Edmondson 1991). The subsequent reduction in phosphorus loading from the effluent discharges resulted in relatively immediate improvements to the lake's water quality. While water clarity was measured to be only 30 inches in 1964, clarity improved to 10 feet by 1968, reaching 25 feet by 1993.

The conditions present in the surrounding watershed and tributary streams are also important influences on Lake Washington's water quality and ecological processes. Elimination of the Black River and the diversion of the Cedar River into the lake effectively doubled the amount of water moving through the Lake Washington system. Concurrent changes to the lakes water level and outflow, from the Black River to the Hiram Chittenden locks, reduced the lakes ability to naturally regulate its water quality by decreasing the quantity and quality of available wetlands and estuaries. Wetlands are critical to lake water quality, often functioning as a natural water storage and filtration system that removes excess nutrients and toxic compounds. Similarly, wetlands are an important source of food and shelter for a diverse range of terrestrial and aquatic species. The Cedar River is now the largest source of clean freshwater input into Lake Washington, providing over 50% of the mean annual flow. Similarly, the Cedar River contributes significantly to the lakes biological diversity as the primary

spawning and juvenile rearing grounds for many of the lakes diverse trout and salmon populations including coho, Chinook, sockeye, steelhead, coastal cutthroat trout, and bull trout. Minimal development in the Cedar River and its tributary streams has been a key factor in maintaining the health of salmon and trout populations and the moderate to good level of water quality currently found in Lake Washington.

4.1.3 Major Land Use Changes and Current Shoreline Condition

A key feature of urban areas is impervious surface coverage. Increases in impervious surface coverage, and the consequent reduction in soil infiltration, have been correlated with increased velocity, volume and frequency of surface water flows. This hydrologic shift alters sediment and pollutant delivery to streams and ultimately to downstream receiving water bodies (Booth 1998; Arnold and Gibbons 1996). Increased surface water flows associated with impervious surface coverage of suburban areas (20-30%) has been linked to decreased bank stability and increased erosion (May et al. 1997a). Knutson and Naef (1997), in their literature review, concluded that as little as 10 percent impervious surface coverage is sufficient to alter streambank stability and erosion. Changes in hydrology and stream morphology brought on by impervious surfaces have also been linked to shifts in macroinvertebrate community composition, which could have profound and far-reaching impacts on the productivity of a watershed (Pederson and Perkins 1986, as cited in Leavitt 1998).

Changes in fish assemblages have been correlated with changes in stream temperature and base flow as a result of increased impervious surface coverage (Wang et al. 2003). Increases in flood frequency and volume have been correlated to declining salmon populations in some Puget Sound lowland streams (Moscrip and Montgomery 1997). Riparian areas can protect against these factors by moderating surface water and sediment inputs. However, while riparian quality has been shown to be inversely proportional to the level of urbanization (May et al. 1997b), impervious surface area alone is not the only component to predicting stream biological conditions (Booth et al. 2004).

Many concerns have arisen in recent years over the impacts from the urbanization of predominantly forested areas, especially areas which contain erosion-susceptible geologic substrate and relatively high gradients (Booth and Henshaw 2001). Booth et al. (2002) conclude that under typical rural land uses, impacts to watershed ecology from reduced forest-cover area can be as great or greater than similar increases in impervious area. Threshold levels of 10 percent impervious coverage and 35 percent deforested area have been found to mark a distinct transition towards severely degraded stream conditions (Booth 2000).

In general, development is known to have detrimental effects on salmonids, particularly with spawning abundance and success. Pess et al. (2002) found that wetland occurrence, local geology, stream gradient, and land use were significantly correlated with adult coho salmon abundance. While positive correlations were found between spawner abundance and forested areas, negative correlations were found between spawner abundance and areas converted to agriculture or urban development. Fish species diversity has been found to decline with increasing levels of urban development, while cutthroat trout tend to become the dominant salmonid species (Lucchetti and Fuerstenberg 1993; Ludwa et al. 1997). The WRIA 8 Steering Committee has recently recognized the need to restore coho salmon spawning habitat in order to reduce the population of cutthroat trout, a known predator of juvenile Chinook salmon (WRIA 8 Steering Committee 2005).

The following information is presented to give historical context to the analysis of existing ecological functions and processes (i.e. baseline conditions). The urbanization of the Lake Washington watershed has increased impervious area, reduced forest cover, and increased nutrient and chemical loading to environmentally sensitive areas. These factors eventually contribute to increased storm flows, channel incision, sedimentation, and reduction in water quality, to name a few, ultimately impacting downstream receiving water bodies such as Lake Washington. The *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)* (Kerwin 2001) identifies the following five "limiting habitat factors and impacts on Lake Washington:"

- The riparian shoreline of Lake Washington is highly altered from its historic state. Current and future land use practices all but eliminate the possibility of the shoreline to function as a natural shoreline to benefit salmonids;
- Introduced plant and animal species have altered trophic interactions between native animal species;
- The known historic practices and discharges into Lake Washington have contributed to the contamination of bottom sediments at specific locations;
- The presence of extensive numbers of docks, piers and bulkheads have highly altered the shoreline; and
- Riparian habitats are generally non-functional.

The remainder of this discussion describes the baseline conditions within Lake Washington in terms of the following parameters as enumerated by NOAA Fisheries' draft Lake Matrix of Pathways and Indicators established for Chinook salmon (Table 1): 1) water quality, 2) habitat access, 3) habitat elements, 4) shoreline conditions.

Table 3. Checklist for Documenting Environmental Baseline of Relevant Indicators – Draft modified by NOAA Fisheries for lakes.

PATHWAYS INDICATORS	SUMMARY OF LAKE WASHINGTON CONDITIONS
Water Quality	
Temperature/Dissolved Oxygen	At Risk: Surface water temperatures often exceed the critical threshold for juvenile salmonids, creating inhospitable shallow nearshore areas typically between July and October. However, juvenile salmonids are not likely to be present in the nearshore at this time of year. Conversely, Dissolved Oxygen (DO) rarely falls below acceptable levels in surface waters (1-10m). However, DO concentrations below dense growths of aquatic macrophytes, Eurasian milfoil in particular, can be lethally low.
pH	At Risk: pH levels are found typically within acceptable levels, but can become higher during the late spring/early summer months.
Chem. Contamination	At Risk: Chemical contamination consists primarily of hydrocarbon input from the urbanized watershed, but the lake has also been on the 303d list for fecal coliform, ammonia, and PCBs.
Nutrients/Total P	At Risk: Nutrient levels in Lake Washington typically do not represent a problem for salmonids. However, localized algal blooms have occurred at various points throughout the lake.
Habitat Access	
Physical Barriers	At Risk: While fish passage is not physically blocked by the locks, the barrier presented by the locks and corresponding fish ladder causes stress and mortality for migrating salmonids.
Habitat Elements	
Exotic Species (in water)	Not Properly Functioning: Many invasive aquatic plants, such as Eurasian milfoil, have become extremely prevalent throughout the lake, often times outcompeting native species and reducing overall structural complexity.
Shoreline Upwelling/ Downwelling	Not Properly Functioning: The extent of shoreline armoring has reduced the natural influx of gravel via erosion processes and increased rates of sediment transport, which in turn has decreased the extent of shoreline upwelling/downwelling.
Structural Complexity (LWD/emergent/ submergent vegetation)	At Risk: Much of the loss in structural complexity dates back to the lowering of the lake by the U.S. Army Corps of Engineers during construction of the Hiram Chittenden Locks. The manual control of the lake elevation and the subsequent reversal of the natural hydrograph does not support the natural establishment of emergent vegetation similar to the historical condition. Shoreline development has decreased shoreline vegetation and subsequently removed and prevented further additions of LWD. Most shoreline wetlands have been lost with the notable exception of a few locations around the lake (e.g. Yarrow Bay, Forbes Creek).
Substrate Composition	Not Properly Functioning: Due to the extent of shoreline armoring around Lake Washington, which effectively limits the natural erosion processes leading to sediment transport, the composition of most shoreline substrates do not contain habitat suitable to most salmonids. The extensive armoring also results in a lack of habitat structure used for rearing and allocthonous inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits allocthonous input of both detritus and invertebrates.
Shoreline Conditions	
Shoreline Vegetation and Riparian Structure	Not Properly Functioning: Residential development around much of the lakeshore has resulted in a general lack of shoreline vegetation and riparian structure. The historical shoreline of Lake Washington included a mix of willow, dogwood, and other large shrubs along with upland conifers. The development of the lakeshore has effectively removed this native vegetation and replaced it with small shrubs and grass lawns, neither of which provide the habitat complexity of the historical shoreline.
Shoreline Gradient	Not Properly Functioning: Similar to the concerns regarding Shoreline Upwelling/Downwelling and Substrate Composition, Shoreline Gradient has also been negatively affected by shoreline armoring.

1. Water Quality: In general, Lake Washington surface water temperatures between 1 and 10 meters deep exceed 17°C from July to October. This temperature appears to be a critical threshold for the distribution of juvenile anadromous salmonids. The expectation is that shallow nearshore areas of Lake Washington would be inhospitable for bull trout and juvenile Chinook and coho salmon during periods of high temperatures.

   Conversely, dissolved oxygen (DO) levels rarely fall below 8 mg/L at similar depths. DO levels below 4 mg/L are considered dangerous for salmonids. Thus, ambient DO levels exceed acceptable levels for salmonids. However, DO concentrations below dense growths of aquatic macrophytes, Eurasian water-milfoil in particular, can be lethally low (Frodge et al. 1995).

   From 2003 through 2008, measures of pH at a 1-meter depth (King County Metro monitoring station 0814, located in Yarrow Bay) were typically between 7 and 9, exceeding 8.5 during most years in the late spring/early summer months. A pH of 9 was exceeded four times, all in May and June of 2006. Other water quality concerns include chemical contaminants and fecal coliform levels. Lake Washington was on the U.S. EPA 2004 303(d) list for fecal coliform at fifteen sample locations, ammonia at two locations, and polychlorinated biphenyls (PCBs) at one location. Chemical contamination of the waters of Lake Washington consists primarily of hydrocarbon input from the urbanized watershed. Wakeham (1977) computed a hydrocarbon budget for Lake Washington and determined that the majority of the hydrocarbons were from stormwater runoff either directly to the lake or via rivers, while 85 percent of the hydrocarbon removal is via sedimentation. Wakeham (1977) indicated that the primary source of hydrocarbons in the urban runoff to Lake Washington is automotive, both oil and grease, and products of combustion (polycyclic aromatic hydrocarbons - PAHs); outboard engine operation likely contributes a very small fraction of total input (less than 1%). PAHs are a common pyrolytic byproduct of all internal combustion engines and are now commonly found in most aquatic systems, near industrialized and urbanized centers (Green and Trett 1989).

   Overall, relatively little is known about the impacts of PAHs to aquatic organisms. Arkoosh et al. (1998) reported evidence for immunosuppression resulting from exposure to PAHs, determining that Chinook smolts from urban estuaries (Duwamish) exhibited a higher cumulative mortality after exposure to the marine pathogen

Vibrio anguillarum than smolts from a non-urban estuary. Tissue examinations of the Chinook smolts indicated that those from the urban estuary had been exposed to higher levels of PAHs and PCBs than smolts from the non-urban estuary (Arkoosh et al. 1998).

Present nutrient levels in Lake Washington do not represent a problem for salmonids. Total phosphorus, as measured from 1995 through 2000 at Metro station 0840, varied little between seasons, and has generally been below 4 mg/L.

The *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* listed Lake Union, the Ship Canal and the Sammamish River as waterbodies with degraded water quality, but did not include Lake Washington (WRIA 8 Steering Committee 2005). The *Lake Washington Existing Conditions Report* (Tetra Tech ISG, Inc. and Parametrix, Inc. 2003) summarizes and analyzes 12 years of water quality data. The Report concludes the following:

"Overall, Lake Washington has recovered from the eutrophic, over enriched state that existed in the 1950s to 1960s. The key to rapid recovery was the lake's depth, which contained large stores of dissolved oxygen and the reduction in P loading that occurred with sewage diversion. The lake is sensitive to P loading, and the maintenance of present-day water quality is dependent on keeping P loading at or below current levels. Minimal development of the Cedar River basin has been a key factor in recovery and maintenance of lake water quality."

Note: Phosphorus (P) loading is the delivery of Phosphorus to the aquatic environment via external or internal means. External P loading is often derived from outside sources such as fertilizers and septic/sewage systems, but also occurs naturally at low background levels. Internal P loading is derived through the release of existing nutrients lying within the lake sediments that can be released both by anoxic conditions as well as physical disturbance of sediments.

2. Habitat Access: The Hiram Chittenden Locks represent a barrier to fish passage by creating a combination of physical and biological obstacles to fish migration. While fish passage is not physically blocked by the locks, the physical and biological obstacles that the locks create result in a significant level of stress and mortality for adult and juvenile salmonid migrants.

3. Habitat Elements: Exotic aquatic plant and animal species inhabit much of the Lake Washington system. Milfoil and fragrant white water lily are exotic aquatic macrophytes in Lake Washington that have demonstrated a negative effect on fish on occasion (Frodge et al. 1995). Reduced DO levels and consequent fish mortality has been observed within dense patches of either species in shallow, poorly circulating water (Frodge et al. 1995). Low DO conditions under aquatic macrophytes have only been observed in small lakes or in sheltered bays of Lake Washington. Yellow perch, brown bullhead, smallmouth bass, and largemouth bass are exotic predators with the potential to prey on juvenile Chinook and coho salmon. Yellow perch utilize "non-structural" areas (Paxton and Stevenson 1979) and brown bullhead are lake bottom foragers, and are thus less likely than bass to utilize developed areas. Yellow perch of predatory size are also generally deep water oriented. Largemouth bass are the most likely exotic predators in nearshore areas because of the abundant aquatic vegetation. Observing where sockeye salmon beach spawn best identifies the presence of shoreline upwelling or downwelling in Lake Washington. While sockeye spawning locations have been mapped by WDFW, very little beach spawning has been documented in recent years. Shoreline hardening and the lack of erodible soils and subsequent sediment drift has likely resulted in a negative impact to shoreline upwelling/downwelling conditions.

   Structural complexity in Lake Washington currently consists of submerged aquatic macrophytes, some small and large woody debris primarily located along undeveloped shorelines, and piers or other man-made in-water structures. The lake is generally lacking in structural complexity relative to natural shorelines. The implications for juvenile salmonids are that the present lack of complex structure throughout most of Lake Washington provides an advantage to large predatory fish.

   Substrate composition throughout Lake Washington is influenced by shoreline hardening, which restricts erosional sediment input. Without supplemental substrate to cover and replace contaminated areas, exposed areas with high levels of PCBs and PAHs may be available to impact the aquatic food chain. Although not specifically studied in Lake Washington, immunosuppression responses have been observed in salmonids migrating through similar Puget Sound urban areas (Arkoosh et al. 1998). Lake Washington was on the U.S. EPA 1998 303(d) list for sediment bioassay at one location near the mouth of May Creek in Renton, and the 2004 303(d) list of PCBs for

one location near the north end of Lake Washington. While these locations are not specifically along the Town's shoreline, they are within the same waterbody and can affect the aquatic food chain lake-wide. Thus, discussion of water quality impacts, especially those derived by human causes, is warranted.

4. Shoreline Conditions: The urbanization of the Lake Washington shoreline has resulted in a shoreline generally lacking native vegetation. There are very few sources of woody debris recruitment that remain and these are primarily associated with the only remaining undeveloped shorelines. The result is a lack of habitat structure used for rearing and outside inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits outside inputs of naturally occurring nutrients and food resources.

   Shoreline modifications and nearshore structures around Lake Washington have dramatically altered the lake's aquatic ecosystem. Although some changes in the Lake environment are not completely understood, the effects of physical modifications to shoreline habitats on some aquatic species, particularly Chinook salmon, have been very well studied. Because of their sensitivity to changes in the aquatic ecosystem, anadromous salmonids are commonly used as a biological indicator species for the aquatic health of Lake Washington. There are many indigenous aquatic species inhabiting Lake Washington, but salmonids are one of the most sensitive. Due to their "threatened" status under the ESA, funding and other resources have been made available for the study of Chinook salmon utilizing Lake Washington, which are an important part of the Puget Sound Chinook Salmon Evolutionary Significant Unit (ESU). The life history pattern and habitat requirements of the Chinook salmon reflects the needs of other salmonid and non-salmonid aquatic species indigenous to Lake Washington, and information concerning the Chinook salmon serves as a good proxy for other species in the Lake. Similarly, habitat restoration efforts designed to benefit Chinook or other salmonids will also be beneficial for other native species inhabiting Lake Washington.

   Common modifications to nearshore aquatic habitats around much of Lake Washington include 1) the construction of bulkheads, which result in the structural simplification of shoreline habitats, and 2) the construction of piers, which block sunlight and create large areas of overhead cover within the nearshore littoral zone. These types of

structural modifications to shorelines are now known to benefit non-native predators (like largemouth and smallmouth bass), while reducing the amount of complex aquatic habitat formerly available to salmonids rearing and migrating through Lake Washington (Kahler et al. 2000; Kerwin 2001; Tabor et al. 2006). Adult salmonids tend to utilize deepwater habitats in Lake Washington and structural changes to nearshore habitats typically have a lesser affect on adults than they do on juvenile salmonids. Lake Washington serves as an important rearing area and migration corridor for juvenile salmonids, however, and due to their affinity to nearshore, shallow-water habitats, juvenile salmonids are greatly affected by physical changes at the shoreline.

4.1.4 Anadromous Fish in the Lake Washington Watershed

Adult Chinook salmon migrate from Puget Sound through the Chittenden Locks and into Lake Washington between July and September, continuing on to various tributary streams where they spawn in October and November. Although most Chinook salmon production in the Lake Washington watershed occurs in the Cedar River, the North Lake Washington tributary streams (feeding into the Sammamish River), or at the Issaquah Fish Hatchery, Chinook salmon (as well as coho and sockeye) also use many other, smaller Lake Washington tributary streams such as Kelsey Creek, Juanita Creek, and Thornton Creek. Chinook fry emerge from their redds between January and March, and either rear in their natal stream or emigrate to Lake Washington for a rearing period extending from three to five months. Emigrating through the Chittenden Locks and into Puget Sound between May and August, juvenile Chinook salmon leave the Lake Washington system during their first year (Kerwin 2001; Tabor and Piaskowski 2002). Other anadromous salmonids spawning and/or rearing in the Lake Washington watershed include sockeye salmon, coho salmon, steelhead trout, coastal cutthroat trout, and possibly bull trout.

After emerging from the gravel, Chinook fry from Lake Washington tributaries either emigrate directly to the Lake, or rear to the fingerling stage in their natal stream before entering the Lake (Seiler et al. 2005). This process occurs between February and June. After they enter Lake Washington, juvenile Chinook often congregate near the mouths of tributary streams, and prefer low gradient, shallow-water habitats with small substrates (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). Chinook fry entering Lake Washington early in the emigration period (February and March) are still relatively small, typically do not disperse far from the mouth of their natal stream, and are largely dependent upon shallow-water habitats in the nearshore littoral zone with overhanging vegetation and complex cover (Tabor and Piaskowski 2002; Tabor et al 2004b). The mouths of creeks entering Lake Washington (whether they support salmon spawning or not), as well as undeveloped lakeshore riparian habitats associated

with these confluence areas, attract juvenile Chinook salmon and provide important rearing habitat during this critical life stage (Tabor et al. 2004b; Tabor et al. 2006). Later in the emigration period (May and June), most Chinook juveniles have grown to fingerling size and begin utilizing offshore limnetic areas of the Lake more heavily. As the juvenile Chinook salmon mature to fingerlings and move offshore, their distribution extends throughout Lake Washington.

4.1.5 The Effects of Overwater Shading and Shoreline Armoring

Piers and other overwater structures shade the lake bottom and affect the size, density, and species composition of aquatic plants living directly beneath them (Fresh and Lucchetti 2000). The magnitude of this effect on aquatic macrophytes varies with the size (square footage) of the structure and the amount of sunlight it blocks. Changes in the physical structure of the aquatic plant community affect juvenile salmonids, as well as other indigenous fishes that use this vegetation in the nearshore environment. Spatial heterogeneity in aquatic vegetation increases the amount of edge habitat, improving the quality of foraging habitat available to ambush predators like the bass (Bryan and Scarnecchia 1992; Weaver et al 1997; Kahler et al. 2000). The combined effect of an overwater structure and a dramatic change in aquatic vegetation results in a behavior modification in juvenile salmonids moving through both littoral and limnetic habitats.

Juvenile salmonids migrating parallel to the shoreline will often change course to circumvent large piers or other overwater structures rather than swimming beneath them (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). These behavior modifications disrupt natural patterns of migration and can expose juvenile salmonids to increased levels of predation. Minimizing overwater coverage and associated support structures will benefit salmon fry rearing in the nearshore zone by reducing available predator habitat. It may also benefit older salmon fingerlings during migration out of the lake, by reducing shade levels, thereby reducing migration impacts. Studies related to shading effects from varying types of pier decking indicate that grated decking provides significantly more light to the water surface than traditional decking methods and may lead to improved migratory conditions for juvenile Chinook salmon (Gayaldo and Nelson 2006).

Bulkheads or other types of shoreline armoring affect juvenile salmonids by eliminating shallow-water refuge habitat, or indirectly, by the elimination of shoreline vegetation and in-water woody debris that generally accompanies bulkhead construction. Placing bulkheads waterward of OHWM creates an abrupt, deep-water drop-off at the shoreline while eliminating shallow water

habitat in the nearshore. Lange (1999) found that bank stabilization (i.e., various forms of erosion control structures that we refer to as "bulkheads") was negatively correlated to fish abundance and species richness at all spatial scales investigated. Juvenile Chinook salmon and other small fishes rely on shallow-water habitats in the littoral zone for foraging, refuge, and migration (Collins et al. 1995; Tabor and Piaskowski 2002). Shoreline armoring and bulkheads are also known to result in local reductions to the species diversity and abundance of both the fish community as well as the macroinvertebrate population inhabiting the littoral zone (Schmude et al. 1998; Lange 1999; Jennings et al. 1999).

4.1.6 Predator-Prey Interactions in Lake Washington

Indigenous Lake Washington fish species that prey on juvenile salmonids include cutthroat trout, rainbow trout, coho salmon, northern pikeminnow, five species of sculpin, and lamprey. Non-native predators currently present in the Lake include smallmouth bass, largemouth bass, and yellow perch. Native cutthroat trout populations (adfluvial and anadromous) are strong in Lake Washington, and this species is currently considered the primary predator of juvenile Chinook, sockeye, and coho salmon. Smaller-sized cutthroat trout prey on juvenile salmonid fry inhabiting the littoral zone early in the spring, while larger individuals feed on salmonid fingerlings migrating and rearing in the limnetic zone later in the season (Nowak et al. 2004; Tabor et al 2004a). A small proportion of northern pikeminnow, yellow perch, and smallmouth bass reside in nearshore regions during winter, but the majority moves offshore in the spring as temperatures in nearshore areas warm (Bartoo 1972; Olney 1975; Coutant 1975). The distributions of these fishes overlap primarily with the peak out-migration of Chinook through the littoral zone, whereas the overlap of cutthroat and Chinook distributions is continuous. Sculpins are present in the littoral zone year-round and are also known to eat juvenile Chinook salmon (Tabor et al. 1998; Tabor et al 2004a). In mid-summer, temperatures in the littoral zone become undesirable for juvenile Chinook and coho salmon, and the majority leave the lake or seek cooler temperatures away from the littoral zone, thus segregating themselves from littoral predators, but remaining vulnerable to cutthroat trout and potentially prickly sculpin.

The habitat requirements and behavior patterns of both bass species have been studied extensively throughout their range, including Lakes Washington and Sammamish. A growing body of bass-related research has collectively demonstrated that bass of both species have an affinity for structural elements, and that bass prey on juvenile salmonids in Lake Washington. Smallmouth bass are more abundant in Lake Washington than largemouth bass, but both species are present in the system.

Although smallmouth and largemouth bass are known to prefer natural cover types like brush, logs, aquatic vegetation, or boulders (Stein 1970), these adaptive species readily utilize floating docks and the support piles of piers in the absence of natural cover types. Artificial structures and cover types that promote shade or darkness are frequently favored by yearling bass of both species (Haines and Butler 1969; Bassett 1994). Bass of both species are also known to select low-gradient, shallow-water (0.6-1.5 meters), silty to gravelly habitats near structural features for spawning (Pflug 1981; Heidinger 1975; Allan and Romero 1975), and prefer similar habitat types near cover while foraging or resting (Vogele and Rainwater 1975). Although the habitat preferences of largemouth and smallmouth bass are generally similar, smallmouth bass generally select drop-offs or outcroppings, cover in the form of logs or rocks, and hard substrates without aquatic vegetation (Pflug 1981; Pflug and Pauley 1984), whereas largemouth bass generally prefer softer-bottom substrates and aquatic macrophytes (Coble 1975). These aspects of bass ecology are consistent with observations of bass behavior from across their geographic range (Bryan and Scarnecchia 1992; Kraai et al. 1991; Bassett 1994).

Logs, brush, or other pieces of large wood are rare along developed sections of the Lake Washington shoreline. Piers provide alternative sources of shade, overhead cover, and in-water structure (piles and boatlifts) that attract bass (Fresh et al. 2003). Piers and piles differ from natural cover/structure elements, such as brush piles, primarily in their lack of structural complexity. This difference is critical for prey fish, which rely on structural complexity for avoidance cover in the presence of predators. In developed lakes, piers become the dominant structural features, at the expense of natural complex structures such as woody debris and emergent vegetation (Bryan and Scarnecchia 1992; Poe et al. 1986; Lange 1999). In areas of Lake Washington where smallmouth bass are present, they preferentially select habitats beneath piers and near in-water support pilings (Fresh et al. 2003). Lake Washington smallmouth concentrations tend to be highest around large docks extending over deeper water, equipped with skirting and numerous support piles. Management plans designed to minimize any advantage non-native predators hold over juvenile salmonids in the littoral zone of Lake Washington should also seek to minimize the amount of overwater cover and support structure associated with pier or dock projects along the shoreline.

Shoreline development could potentially increase the rate of predation on juvenile salmonids by several principal means: 1) reducing the amount of refuge habitat available to prey species like juvenile salmonids by modifying the structure of the shoreline; 2) providing concealment structures for ambush predators such as bass and sculpin; 3) providing artificial lighting that allows for around-the-clock foraging by predators; and 4) altering migration routes for smolts and rearing fry. Although many predators that feed on juvenile

salmonids are active, cruising hunters (i.e., other salmonids, piscivorous birds, northern pikeminnow), smallmouth and largemouth bass generally utilize ambush or habituation foraging strategies (Hobson 1979). Fayram and Sibley (2000) determined that smallmouth bass in Lake Washington occupied littoral home ranges that radiated 100 to 200 meters from the focal point and generally did not extend below 8-meter depths. Because of their propensity for ambush foraging and shoreline orientation, bass in Lake Washington benefit from artificial structures placed in the littoral zone, whereas yellow perch are more likely to utilize "non-structural" areas (Paxton and Stevenson 1979). Increased usage of complex cover (e.g., aquatic vegetation, woody debris, substrate interstices, and undercut banks) by prey fishes in the presence of predators, and reduced foraging efficiency of predators due to habitat complexity has been well documented (Wood and Hand 1985; Werner and Hall 1988; Bugert and Bjornn 1991; Tabor and Wurtsbaugh 1991; Persson and Eklov 1995).

Juvenile salmonids, like many other prey species, modify their behavior in the presence of predators by seeking or orienting to complex refuge (Gregory and Levings 1996; Reinhardt and Healey 1997), emigrating from areas with predators (Bugert and Bjornn 1991), aggregating (Tabor and Wurtsbaugh 1991), and moving to different elevations in the water column throughout the day and night (Eggers et al. 1978). Complex habitat features that exclude predators, physically or through risk-aversion can function as prey refuge. Examples of effective prey refuge include complex substrate, aquatic and emergent vegetation, overhanging terrestrial vegetation, undercut banks, and submerged pieces of large wood. Shallow water also functions as a refuge from predation for small fish, especially in the absence of complex habitat features such as woody debris or submerged vegetation.

Historically, Lake Washington's riparian and littoral zones were well vegetated, and interspersed with an abundance of large wood that had fallen along the shoreline (Evermann and Meek 1897; Stein 1970). The lowering of the Lake Washington water level and substantial shoreline development eliminated much of the vegetation and structural complexity historically available to juvenile salmonids rearing and migrating in the nearshore. Management plans seeking to encourage healthy assemblages of native fish should avoid the simplification of shoreline habitat, and the reduction of refuge-habitat for prey species.

Although the magnitude of avian predation in Lake Washington is unknown, piscivorous birds are present and this source of predation must be considered among potential threats to most fish, including juvenile salmonids. Common mergansers are abundant in the spring. Double-crested cormorants are common in Lake Washington, typically perching on the log booms at Union Bay and May Creek rather than on docks and bulkheads. Cormorants also commonly perch on individual piles. Western grebes inhabit enclosed bays (and some marinas), and

forage throughout the lakes on calm days. Gulls are common, perching on log booms and on low docks, and are also known to feed on juvenile salmonids (Ruggerone 1986). In-water structures provide perching platforms for avian predators, from which they can launch feeding forays or dry plumage (Kahler et al. 2000). Incorporating anti-perching devices and grating in the design of overwater piers or related structures would work to minimize any advantage these structures convey to piscivorous birds.

4.2 Analysis of Ecological Functions

Ecological processes and functions of the Town of Yarrow Point's shoreline areas are summarized in Tables 4 through 6. These tables are organized around the Department of Ecology's list of processes and functions for freshwater lakes. The list includes the evaluation of three major process/function groups: 1) hydrologic; 2) vegetation; and 3) habitat. These are further broken down into the following functions which are in turn used to evaluate reach performance:

Lake Functions
1. Hydrologic Functions • Storing water and sediment • Attenuating wave energy • Removing excess nutrients and toxic compounds • Recruitment of large woody debris (LWD) and other organic material
2. Vegetative Functions • Temperature regulation • Water quality improvement • Attenuating wave energy • Sediment removal and bank stabilization • LWD and organic matter recruitment
3. Habitat Functions • Physical space and conditions for life history • Food production and delivery

Assessment of each function is based upon both quantitative data results derived from the GIS inventory information described in Chapter 3, and a qualitative assessment based on aerial photography, field inventory (where possible), and existing assessment information. As described in Chapter 3, the shoreline has been divided into reaches based on ecological function and land use. In the ensuing tables, each reach has been given an overall "rating" for ecological functions based on the available and relevant GIS information and the corresponding quantitative and qualitative evaluation. Rating was completed using a "low" to "high" function scale. The level categories are: Low, Moderate, and High.

4.2.1 Reach 1 Results

Reach 1 is depicted in Exhibit 3 below. It extends from the eastern limits of the Wetherill Nature Preserve in Cozy Cove north around the main peninsula and terminates at the western boundary of Morningside Park. It specifically includes all shoreline residential lots within Town limits, except for the long, narrow residential parcel east of Morningside Park. This reach includes approximately 7,601 linear feet of shoreline and 32.15 total acres of shoreline jurisdiction. Aerial oblique photographs of the reach from 2007 provided by Ecology are included in Appendix C, and show land use, cover, and general shoreline condition.

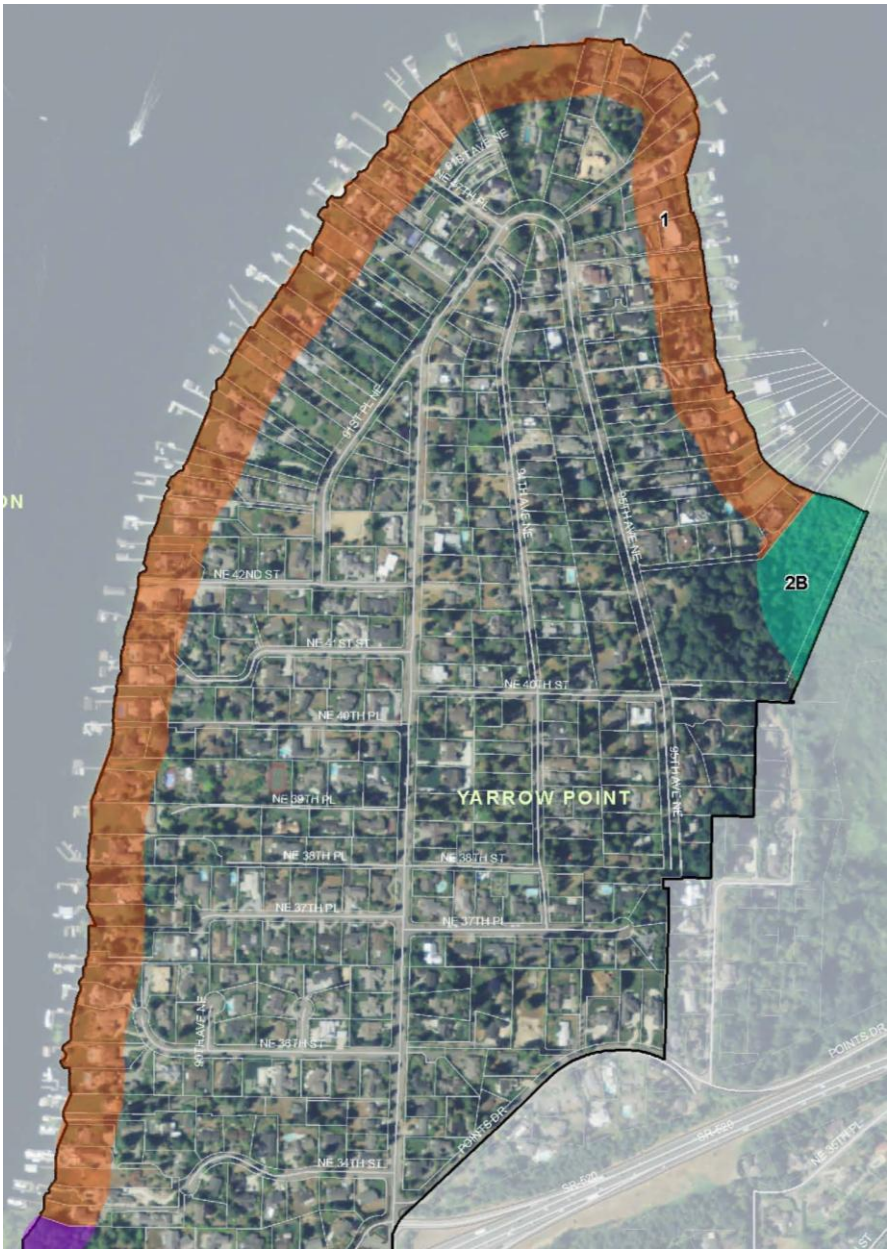

Exhibit 3. Overview photo of Reach 1.

Table 4. Function Summary of Town of Yarrow Point Reach 1

Shoreline Processes and Functions Occurring within Reach 1	Alterations and Assessment of Functions	Recommendations for Protection and Restoration
Ecosystem process: Water movement (wave energy); sediment movement (inputs, deposition and loss); shoreline erosion; movement of woody debris; organic inputs from shoreline. **Shoreline functions:** Water quantity – no significant discharges of surface waters Water quality – temperature regulation performed by some riparian vegetation, nutrient removal (denitrification), sediment transport, and toxicant removal. Habitat - consists of shoreline habitats. Specifically, this area contains habitat structure and complexity for plants, diatoms, fishes, birds, mammals and anadromous fish species, and terrestrial plants and animals.	This long reach contains both west and east facing single-family residential lots situated along the main peninsula of Yarrow Point. The area within shoreline jurisdiction contains a total of 103 lots. With the exception of one lot located at the northern tip of the peninsula and owned by the Yarrow Point Beach Club, all lots are developed with single-family residences. Residential setbacks within this reach vary dramatically as lot depths range from approximately 150 feet to over 400 feet. Therefore, some homes are situated far back from the lake while others are located much closer to the shoreline. Taking this into consideration, existing primary structure setbacks on the developed lots average 121 feet from the shore, with a median of 97 feet. Residences on Yarrow Point commonly have large altered areas waterward of the primary structure: decks, patios, pools, etc. The average and median setback to those major improvements is 90 and 65 feet, respectively. 27.6% of this reach is considered impervious. According to a national data set that interpreted aerial photos at a 30-meter scale, approximately 22.5% of the reach is covered in vegetation (various types of forest, grass, wetlands [map error], and shrubs). This data has limited reliability. Site visits and current aerial photo analysis show that most of the shoreline area close to the OHWM is occupied by lawns with scattered trees at the water's edge. Most shrub and tree vegetation is located perpendicular to the water along property lines (see Appendix C). 86.9% of the shoreline is armored with concrete, rock or wooden bulkheads, preventing the movement of sediments within the shoreline environment and altering the nearshore aquatic habitat (see Section 4.1.5 for detailed effects information). This reach also has 82 piers, providing a total of 4.13 acres of overwater cover (see Sections 4.1.5 and 4.1.6 for detailed effects information). **Overall rating for shoreline ecological functions:** **Low/Moderate**	1. Evaluate existing SMP setback strategy and results to confirm whether continuation of that basic approach will satisfy no net loss requirements, protect immediate shoreline functions, prevent further loss of vegetation, and eliminate the need for new shoreline armoring. 2. Evaluate whether additional limitations on placement of accessory structures (e.g., pools and decks) in the setback is necessary to meet no net loss requirements. Recommendations for restoration: 1. Revegetate the shoreline where possible. 2. If lots were to redevelop in the future, removal and restoration of shoreline armoring should be investigated.

4.2.2 Reach 2A – Wetherill Nature Preserve Results

Reach 2A is depicted in Exhibit 4 below. It encompasses the entire shoreline of the Wetherill Nature Preserve located within Town limits. The Wetherill Nature Preserve Board oversees the maintenance and protection of the Preserve. This reach includes approximately 94 linear feet of shoreline and a total of 3.49 acres of shoreline jurisdiction. Aerial oblique photographs of the reach from 2007 provided by Ecology are included in Appendix C, and show land use, cover, and general shoreline condition.

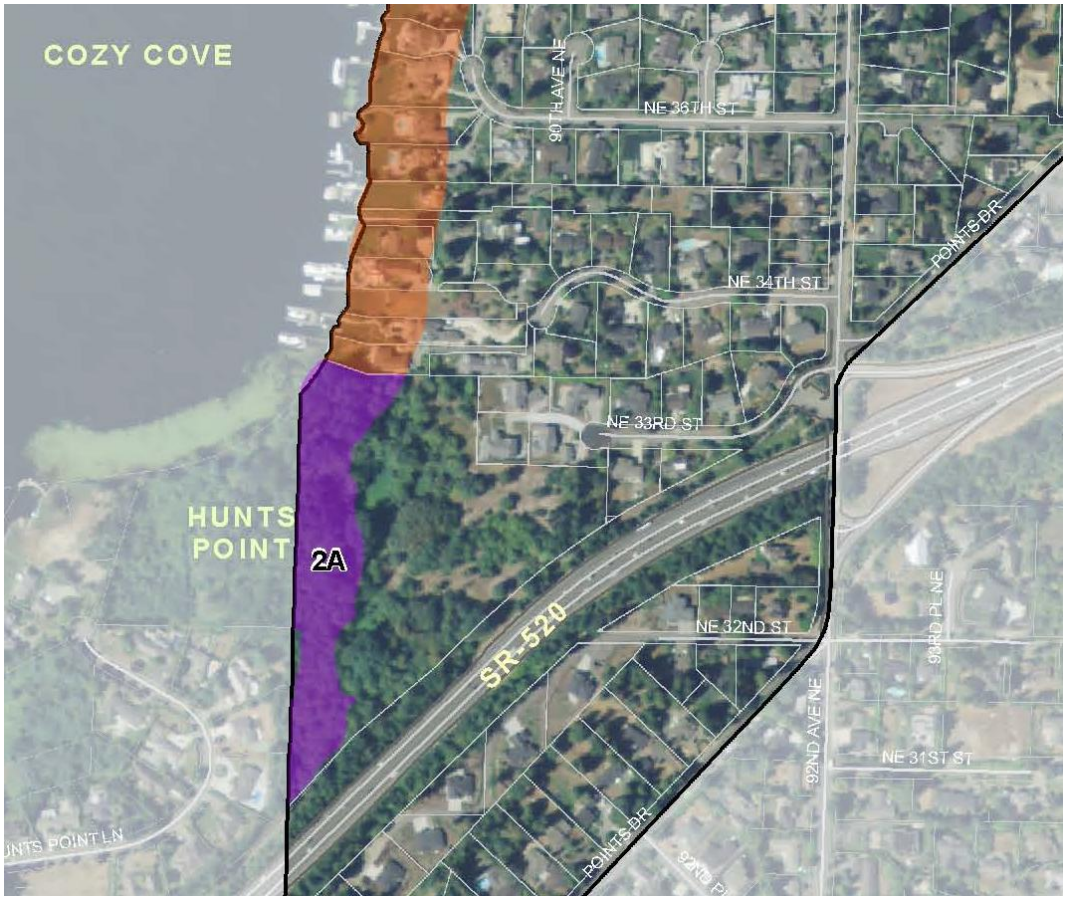

Exhibit 4. Overview photo of Reach 2A.

Table 5. Function Summary of Yarrow Point Reach 2A

Shoreline Processes and Functions Occurring within Reach 2A	Alterations and Assessment of Functions	Recommendations for Protection and Restoration
Ecosystem process: Water movement (wave energy); sediment movement (inputs, deposition and loss); shoreline erosion;	This reach includes the Wetherill Nature Preserve and areas of adjacent wetland. The Wetherill Nature Preserve is the Town's least	Recommendations for protection: 1. One of the most important measures

Shoreline Processes and Functions Occurring within Reach 2A	Alterations and Assessment of Functions	Recommendations for Protection and Restoration
movement of woody debris; organic inputs from shoreline. **Shoreline functions:** Water quantity – no significant discharges of surface waters Water quality – temperature regulation performed by some riparian vegetation, nutrient removal (denitrification), sediment transport, and toxicant removal. Habitat - consists of shoreline habitats. Specifically, this area contains habitat structure and complexity for plants, diatoms, fishes, birds, mammals and anadromous fish species, and terrestrial plants and animals.	altered shoreline. The shoreline is comprised of emergent, scrub-shrub and forested wetland vegetation. Most of the shoreline is in a completely natural state with no shoreline armoring. Trails meander through Wetherill Nature Preserve providing physical and visual access to the lake. **Overall rating for shoreline ecological functions: High**	to protect this area is to establish an environment designation that will prevent future alteration to shoreline processes. Recommendations for restoration: 1. Explore opportunities for revegetation in areas lacking native vegetation.

4.2.3 Reach 2B – Morningside Park Results

Reach 2B is depicted in Exhibit 5 below. It encompasses the entire shoreline of Morningside Park located within Town limits, as well as one narrow, privately owned, undeveloped parcel. This reach includes approximately 207 linear feet of shoreline and 3.32 acres of shoreline jurisdiction. Aerial oblique photographs of the reach from 2007 provided by Ecology are included in Appendix C, and show land use, cover, and general shoreline condition.

Morningside Park includes areas of wetland associated with the adjacent Yarrow Bay wetland complex. The Yarrow Bay wetlands are mapped as priority wetlands by WDFW (2006). Priority wetlands are those wetlands that have "[c]omparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, [and] high vulnerability to habitat alteration" (http://wdfw.wa.gov/hab/phshabs.htm). Vegetation within the wetland complex includes palustrine forest, scrub-shrub, and emergent wetland vegetation classes. The wetlands provide excellent habitat for birds (songbirds, raptors, waterfowl), amphibians, mammals and even reptiles. Bald eagles and ospreys regularly perch in trees adjacent to Yarrow Bay, and forage in the Bay. Although a bald eagle nest is mapped in the Yarrow Bay Wetlands, it was last active in 1999 and the nesting pair relocated to Hunts Point. However, a mapped great blue heron nesting colony is still active.

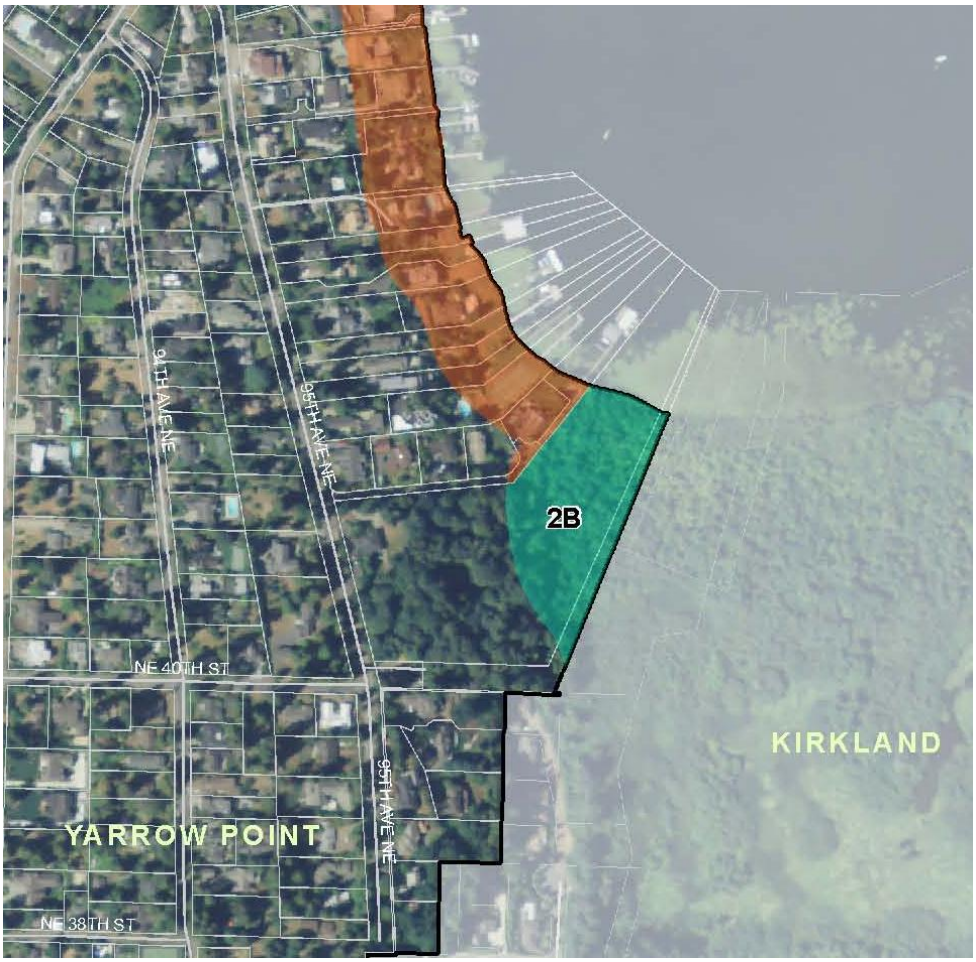

Exhibit 5. Overview photo of Reach 2B.

Table 6. Function Summary of Yarrow Point Reach 2B.

Shoreline Processes and Functions Occurring within Reach 2B	Alterations and Assessment of Functions	Recommendations for Protection and Restoration
Ecosystem process: Water movement (wave energy); sediment movement (inputs, deposition and loss); shoreline erosion; movement of woody debris; organic inputs from shoreline. **Shoreline functions:** Water quantity – no significant discharges of surface waters Water quality – temperature regulation performed by some riparian vegetation, nutrient removal (denitrification), sediment transport, and toxicant removal. Habitat - consists of shoreline habitats. Specifically, this area contains habitat	This reach is almost entirely part of Morningside Park, one of the Town's two least altered shorelines. The shoreline is comprised of emergent, scrub-shrub and forested wetland vegetation. Most of the shoreline is in a completely natural state with no shoreline armoring. The shoreline is not directly accessible by trail, although views of the lake can be found from within the Park. **Overall rating for shoreline ecological functions: High**	Recommendations for protection: 1. One of the most important measures to protect this area is to establish an environment designation that will prevent future alteration to shoreline processes. Recommendations for restoration: 1. Explore opportunities for revegetation in areas lacking native vegetation.

Shoreline Processes and Functions Occurring within Reach 2B	Alterations and Assessment of Functions	Recommendations for Protection and Restoration
structure and complexity for plants, diatoms, fishes, birds, mammals and anadromous fish species, and terrestrial plants and animals.		

5 LAND USE ANALYSIS AND IMPLICATIONS

WAC 173-26-201(3)(d)(2) requires a shoreline use analysis to estimate the future demand for shoreline space and to identify future use conflicts. The Town does not anticipate future use conflicts, as the area is entirely developed and no changes in land use patterns are projected or desired by local residents in and outside of shoreline jurisdiction.

5.1 Residential Development

The Town of Yarrow Point is fully developed as a residential community and home to approximately 1,000 citizens. With the exception of the Town Hall, Morningside Park, the Wetherill Nature Preserve, and two private residential tracts, each property is developed with a single-family residence. Occasionally, a residential lot may become vacant, as an older home is removed and a newer, larger home is planned and eventually constructed. Many residential lots have private waterfront, including individual or shared piers.

There are two residential zoning designations in the Town, with only the R-15 zone represented within the shoreline jurisdiction. The zone requires a minimum lot size of 15,000 square feet. While Yarrow Point has the potential for subdivision of additional lots within shoreline jurisdiction, it is unlikely that the Town will see an increase in lots along the water's edge. This is due to the nature of lot configuration within the Town. Residential lots along the shoreline are typically narrow parcels with 50 to 70 feet of frontage along Lake Washington. With the exception of the large parcel at the tip of Yarrow Point, all other lakefront parcels have been developed. Any increase in the number of residential properties would occur upland from the existing lakefront lots, with limited potential for new waterfront structures.

5.2 SR 520

State Route 520 passes through the southern portion of Yarrow Point and is adjacent to the Wetherill Nature Preserve, but outside of shoreline jurisdiction.

5.3 Utilities

The City of Bellevue operates a sanitary sewer line within Lake Washington. Its location varies between (approximately) twenty feet offshore to twenty feet landward of the OHWM. The line requires occasional maintenance, including placement of gravel atop the line to protect any exposed pipe areas. A study is currently underway by the City of Bellevue Utilities Department to evaluate the condition of the sewer line, with the goal of 1) identifying any sections requiring immediate repair or replacement, and 2) developing a management plan for the next several decades of sewer capital improvements.

Development review of shoreline projects and replacement residences in Yarrow Point includes utility locates in order to protect the existing system.

5.4 Wetherill Nature Preserve

As more fully described in Section 6 below, the Wetherill Nature Preserve provides sixteen acres of passive recreational space for the public, including its undeveloped, natural shoreline area.

5.5 Shoreline Designations

The Department of Ecology, in accordance with WAC 173-26-211, has directed that shoreline areas be classified as one of six specific shoreline designations, based on the existing land use patterns, the biological and physical character of the shoreline, and the goals of the community as expressed through the Comprehensive Plan. The six suggested designations include Natural, Rural Conservancy (not suited for incorporated areas), Aquatic, High Intensity, Urban Conservancy, and Shoreline Residential, with the following purposes:

Natural Environment: to protect those shoreline areas that are relatively free of human influence or include intact or minimally degraded shoreline functions intolerant of human use. These systems require that only very low intensity uses be allowed in order to maintain the ecological functions and ecosystem-wide processes. Consistent with the policies of the designation, local government should include planning for restoration of degraded shorelines within this environment.

Aquatic Environment: to protect, restore, and manage the unique characteristics and resources of the areas waterward of the OHWM.

High Intensity Environment: to provide for high-intensity water-oriented commercial, transportation, and industrial uses while protecting existing ecological functions and restoring ecological functions in areas that have been previously degraded.

Urban Conservancy Environment: to protect and restore ecological functions of open space, flood plain and other sensitive lands where they exist in urban and developed settings, while allowing a variety of compatible uses.

Shoreline Residential Environment: to accommodate residential development and appurtenant structures that are consistent with this chapter. An additional purpose is to provide appropriate public access and recreational uses.

The designations appropriate for Yarrow Point include Shoreline Residential for Reach 1 and Urban Conservancy/Natural for Reaches 2A and 2B. In addition, all areas waterward of the OHWM are considered part of the Aquatic environment.

6 PUBLIC ACCESS ANALYSIS AND IMPLICATIONS

WAC 173-26-201(3)(d)(v) requires that each jurisdiction developing a Shoreline Master Program identify public access needs and opportunities within its jurisdiction and explore actions to enhance shoreline recreation facilities.

Public access to the shoreline of Yarrow Point may be found in several locations:

Wetherill Nature Preserve: The 16-acre Preserve, on land that was donated to the Towns of Hunts Point and Yarrow Point in 1988, offers approximately 2,000 linear feet of hiking trails in Yarrow Point and access to an additional 1,200 linear feet of trail in Hunts Point. The trails meander through undisturbed shoreline areas, home to numerous plant and animal species, and reach the lake edge at two points, one each in Hunts Point and Yarrow Point. These points provide excellent views of the water and each have a bench. Trails within the Preserve are designated for pedestrian use only. Access to the Preserve is through the "Points Loop Trail," a local facility that connects the Points' communities of Hunts Point, Yarrow Point, Clyde Hill, and Medina.

The Wetherill deed states "the property is conveyed to the public in perpetuity, and that it shall never be used for a purpose other than as a nature preserve and a place of retreat for the education and benefit of members of the general public." Further, the deed directs that "No boat moorage facilities, piers, or pilings should be installed along the waterfront, and access from the water to the property should be discouraged."

The Wetherill Nature Preserve is managed by a Board composed of residents of Yarrow Point and Hunts Point. Yearly projects, which rely upon volunteer efforts, may include invasive plant eradication, construction and installation of

habitat boxes for bats, planting of native species, trail maintenance, and the creation and installation of educational signage. The Preserve will continue to provide a natural shoreline experience for the public.

Morningside Park: This 8.5-acre park, located on the eastern shore of the Yarrow Point Peninsula and adjacent to the Yarrow Bay Wetlands, is undeveloped, with the exception of the Town Hall, constructed in 1992. The Park is more fully described in Section 4.2.3.

Road End Swimming Beach at NE 47th Street: The street end of NE 47th Street originally proved ferry service as part of the "mosquito fleet." The 10,000 square foot area provides a swimming beach and pier, and is used throughout the year by Town residents.

NE 42nd Street Access: The western terminus of NE 42nd Street provides a hand-carried boat launch area, as well as park benches.

Other: Additional public recreational opportunities may be found within the public parks and swimming beaches of the neighboring communities of Medina, Kirkland, and Bellevue. In addition, boat launch and boat rental facilities are available in nearby Kirkland and Bellevue.

7 SHORELINE MANAGEMENT RECOMMENDATIONS

The following are recommended actions for translating inventory and characterization findings into the draft SMP policies, regulations, environment designation boundaries, and restoration strategies for areas within the shoreline jurisdiction. In addition to the recommendations included below derived from analysis in Chapters 1 through 6, the Town's current regulations, such as the existing Shoreline Master Program, will be reviewed for adequacy under the Shoreline Master Program Guidelines requirements. Where existing regulations fulfill either the recommendations provided below or a standard in the Shoreline Management Act or Shoreline Master Program Guidelines, the existing language or concepts would be considered for incorporation into the updated SMP.

The following recommendations are not suggested SMP language.

7.1 Shoreline Master Program

7.1.1 Shoreline Environment Designation Provisions

- The current environment designations include Residential and Conservancy. It is recommended that the Town utilize Ecology's environment designations as appropriate.

- Consider the Shoreline Residential designation for all areas currently zoned and/or developed for single-family residential uses. These areas constitute 82 percent of the shoreline area.

- Consider the Urban Conservancy or a similar locally equivalent designation for all active parks (public and private), street ends, and shoreline recreation lots. These areas constitute 2 percent of shoreline jurisdiction. This designation would reflect the continued management priorities of providing water-related shoreline access at these sites. Alternatively, the private parks and shoreline recreation lots could be designated Shoreline Residential if greater flexibility for future use is desired.

- Consider the Natural designation for all passive parks and open spaces dominated by wetlands. These areas constitute approximately 16 percent of shoreline jurisdiction.

7.1.2 General Policies and Regulations

Critical Areas

- Develop critical areas regulations meeting Ecology requirements as outlined in the Shoreline Master Program Guidelines for incorporation into the SMP.

Shorelines of Statewide Significance

- Lake Washington is a Shoreline of Statewide Significance and the SMP should incorporate the priorities of RCW 90.58.020 in the SMP policies.

- Corridors for migrating listed salmon species, habitat restoration and water quality improvements are in the broader statewide interest. The Town should give priority to these shoreline functions to be consistent with policies for Shorelines of Statewide Significance.

- In managing the shoreline area, the Town of Yarrow Point shall evaluate regulations that:

- Preserve the natural character of the shoreline to the extent possible;
- Seek long term over short term benefits to the shoreline area;
- Protect resources and ecology of the shoreline area; and,
- Increase public access and recreational opportunities along the shoreline.

Public Access

- The Town of Yarrow Point shall continue to provide opportunities for public access through the Wetherill Nature Preserve trail system, Morningside Park, the NE 47th Street Road End Beach, and the NE 42nd Street boat launch area.

Vegetation Conservation

- As noted, presence of native vegetation along the boundary between the land and the lake is very limited. Conservation of existing native vegetation during land development and ongoing use is critical to maintaining the ecological processes and natural functions of shoreline areas. For existing development, vegetation conservation provisions should be crafted to emphasize retention of existing native vegetation and existing non-native trees where present, as well as encourage, through policies and/or regulation, establishment of native riparian vegetation.

- Include provisions which encourage the protection and enhancement of the ecological functions of the shoreline, while still providing public recreation opportunities to the lake.

- Incentives should be provided for the retention and planting of native vegetation, particularly in areas designated as Shoreline Residential. Incentives could include additional flexibility with building setbacks from the shoreline and impervious surface coverage.

- Consider establishing tree conservation standards, with higher tree replacement requirements for tree removal in the shoreline setback area.

Water Quality, Storm Water, and Nonpoint Pollution

- The Town currently reviews all development applications for compliance with the latest King County/Ecology stormwater management manual. The SMP should include appropriate regulatory references to the manual, requirements for use of appropriate materials in and over the water, and consideration of policies and/or regulations limiting upland use of chemical (pesticides/herbicides).

7.1.3 Shoreline Modification Provisions

Shoreline Stabilization

- Ensure "replacement" and "repair" definitions and standards are consistent with WAC 173-26-231(3)(a). Repair activities should be defined to include a replacement threshold so that applicants and staff will know when "replacement" requirements need to be met.

- Explore a range of solutions to reduce the amount of bulkheads and shoreline armoring over time along the shoreline. Consistent with requirements of the Shoreline Master Program Guidelines, alternative methods to protect shorelines from erosion using native vegetation, strategically placed logs and boulders, and other materials should be investigated. Consider incorporating incentives into the SMP to encourage removal or "softening" of hardened shorelines where local conditions allow.

- Where new shoreline stabilization structures are permitted, consider requiring the planting of riparian vegetation along all or a portion of the shoreline immediately landward of the OHWM as mitigation. Also, where possible, the installation of a gravel/cobble beach fill waterward of the OHWM should be required.

Piers and Docks

- Provide clear dimensional and other standards for new piers and replacement/modified piers. Use of the Corps' Regional General Permit (or upcoming Programmatic Biological Evaluation) standards as a starting point for new and replacement pier regulations should be considered.

- Consider standards that address incorporating materials such as grated decking for dock and pier replacements/modifications that may be proposed in the future along the shoreline.

- Require replacement of nearshore decking with grated decking equivalent in size to the additional surface coverage associated with pier addition.

- Consider restrictions on new covered moorage structures. Boatlifts and canopies should be allowed as alternatives.

Fill

- As directed by the Shoreline Master Program Guidelines, provide appropriate limitations on placement of fill in shoreline areas, including

areas waterward of the ordinary high water mark. Fill should be limited to shoreline restoration projects.

- Restoration fills should be encouraged, including improvements to shoreline habitats, material to anchor large woody debris placements, and as needed to implement shoreline restoration.

Breakwaters, Jetties, Groins and Weirs

- Regulations should be developed consistent with the State's Shoreline Master Program Guidelines, and consideration given to prohibiting some or all of these modifications.

Dredging and Dredge Material Disposal

- The State's Shoreline Master Program Guidelines are fairly detailed with regard to establishing the framework and details of dredging regulations. The need for dredging in the Town is likely fairly limited. Allowed dredging should be limited to shoreline restoration projects.

Shoreline Habitat and Natural Systems Enhancement Projects

- To the maximum extent feasible, the SMP should include provisions and incentives to encourage restoration projects, particularly in areas identified as having low function. Emphasize that certain fills can be an important component of some restoration projects, particularly for Lake Washington armoring improvements.

- Provide incentives for shoreline homeowners to remove bulkheads and restore shoreline conditions using native vegetation and other natural shoreline features that can serve as effective prey refuge.

7.1.4 Shoreline Uses

Boating Facilities

- Develop appropriate standards for community and public-access related overwater structures. No commercial marinas or facilities are anticipated in Yarrow Point. This need appears to be met by facilities in the adjacent community of Kirkland.

Recreational Development

- Incorporate policies and regulations which support the operation of existing and development of future recreational opportunities within the shoreline area. This should include opportunities for increased disabled access.

- There are no public or private boat ramps in shoreline jurisdiction. This need appears to be met by facilities in the adjacent community of Kirkland.

- Explore developing or improving boat launch facilities for small, non-motorized craft at public access points.

Residential Development

- Evaluate existing SMP setback strategy and results to confirm whether continuation of that basic approach will satisfy no net loss requirements, protecting immediate shoreline functions, preventing further loss of vegetation, and eliminating the need for new shoreline armoring.

- Evaluate whether additional limitations on placement of accessory structures (e.g., pools and decks) in the setback is necessary to meet no net loss requirements.

- The current average and median setbacks from the OHWM for existing primary structures is 121 and 97 feet, respectively. However, a look at the existing setback for major improvements associated with and located waterward of the house indicates an average and median setback of 90 and 65 feet, respectively. On 28 percent of the parcels, the primary structure is located more than 150 feet from the OHWM on 28 percent of the parcels, and greater than 100 feet on 49 percent of the parcels. Approximately 10 percent of the parcels have a primary structure setback of less than 50 feet. The current setback requirement is 50 feet.

- Consider providing incentives to achieve shoreline rehabilitation and enhancement.

- Include a policy regarding education of waterfront homeowners about the use of fertilizers and chemicals and encourage natural lawn care and landscaping methods to reduce chemical output into surrounding shorelines.

- Where feasible based on topography and soils, encourage low impact development techniques that reduce impervious surface areas and increase use of eco-friendly stormwater detention/transmission.

Nonconformance

- Continue to evaluate all nonconforming shoreline and residential maintenance or remodeling projects for compliance with zoning thresholds for replacement of nonconforming structures.

Transportation and Parking

- Transportation and parking facilities are not prominent features in the Town's shoreline jurisdiction and the potential for development of new facilities or expansion of existing facilities is almost non-existent. However, some basic regulations should still be included.

- Continue to target private roads, driveways and parking areas for improvements to stormwater facilities during significant additions or redevelopment.

Utilities

- Create regulations that differentiate between primary (or major) utilities and those minor utilities intended to provide local service connections. Additional restrictions should be placed on primary (or major) utilities such as trunk sewer lines, transmission lines, etc.

- Include provisions for utility repairs and maintenance in shoreline jurisdiction, particularly for in-water utility work. The entire Town has sewer lines that parallel the shoreline waterward and landward of the OHWM, with small lines extending landward to connect the single-family homes.

- Stormwater regulations and capital facility projects should emphasize maintaining and improving the water quality of discharges to Lake Washington.

7.2 Restoration Plan

7.2.1 Introduction

The Shoreline Restoration Plan must address the following six subjects (WAC 173-26-201(2)(f)(i-vi)) and incorporated findings from this analysis report:

(i) Identify degraded areas, impaired ecological functions, and sites with potential for ecological restoration;

(ii) Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;

(iii) Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;

(iv) Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies including identifying prospective funding sources for those projects and programs;

(v) Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and

(vi) Provide for mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

The Restoration Plan will "include goals, policies and actions for restoration of impaired shoreline ecological functions. These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program." The Restoration Plan will mesh potential projects identified in this report with additional projects, regional or Town-wide efforts, and programs of the Town, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline. Topics will include, among others, the Town's stormwater management and planning activities, comprehensive and parks planning activities, and SR 520 plans. These and any other projects will be discussed in greater detail in the Shoreline Restoration Plan.

7.2.2 WRIA 8

The Town was one of 27 members of the WRIA 8 Forum, which participated in financing and developing the *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan*. The *Chinook Salmon Conservation Plan* includes the Town of Yarrow Point's Resolution No. 267, ratifying the plan, dated 12 July 2005. The following is a list of general objectives for Lake Washington that are part of the WRIA 8 Action Start-List.

Reduce predation to outmigrating juvenile Chinook by: reducing bank hardening, restoring overhanging riparian vegetation, replacing bulkhead and rip-rap with sandy beaches with gentle slopes, and use of mesh dock surfaces and/or community docks.

- Encourage salmon friendly shoreline design during new construction or redevelopment by offering incentives and regulatory flexibility to improve bulkhead and dock design and revegetate shorelines.

- Increase enforcement and address nonconforming structures over long run by requiring that major redevelopment projects meet current standards.

- Discourage construction of new bulkheads; offer incentives (e.g., provide expertise, expedite permitting) for voluntary removal of bulkheads, beach improvement, riparian revegetation.

- Support joint effort by NOAA Fisheries and other agencies to develop dock/pier specifications to streamline federal/state/local permitting; encourage similar effort for bulkhead specifications.

- Promote value of light-permeable docks, smaller piling sizes, and community docks to both salmon and landowners through direct mailings to lakeshore landowners or registered boat owners sent with property tax notice or boat registration tab renewal.

- Offer financial incentives for community docks in terms of reduced permit fees, loan fees/percentage rates, taxes, and permitting time, in addition to construction cost savings.

- Develop workshop series specifically for lakeshore property owners on lakeside living: natural yard care, alternatives to vertical wall bulkheads, fish friendly dock design, best management practices for aquatic weed control, porous paving, and environmentally friendly methods of maintaining boats, docks, and decks.

Protect and restore water quality in tributaries and along shoreline. Restore coho runs in smaller tributaries as control mechanism to reduce the cutthroat population. Reconnect and enhance small creek mouths as juvenile rearing areas.

- Address water quality and high flow impacts from creeks and shoreline development through NPDES Phase 1 and Phase 2 permit updates, consistent with Washington Department of Ecology's 2001 Stormwater Management Manual, including low impact development techniques, on-site stormwater detention for new and redeveloped projects, and control of point sources that discharge directly into the lakes.

- Encourage low impact development through regulations, incentives, education/training, and demonstration projects.

- Protect and restore water quality and other ecological functions in tributaries to reduce effects of urbanization and reduce conditions which encourage cutthroat. Protect and restore forest cover, riparian buffers, wetlands, and creek mouths by revising and enforcing critical areas ordinances and Shoreline Master Programs, incentives, and flexible development tools.

- Promote through design competitions and media coverage the use of "rain gardens" and other low impact development practices that mimic natural hydrology.

Many of the planning-level items listed above should be considered part of Chapter 7, Shoreline Management Recommendations. Other items will be addressed in greater detail in the Shoreline Restoration Plan.

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9 List of Acronyms and Abbreviations

Corps.....U.S. Army Corps of Engineers

Ecology .....Washington Department of Ecology

GMA.....Growth Management Act

HPA.....Hydraulic Project Approval

LUC ..... Land Use Code

LWD .....Large Woody Debris

NOAA Fisheries .....National Marine Fisheries Service

NRCS.....Natural Resources Conservation Service

PAHs .....polycyclic aromatic hydrocarbons

PCBs .....polychlorinated biphenyls

PHS.....Priority Habitats and Species

SMA.....Shoreline Management Act

SMP .....Shoreline Master Program

USFWS .....U.S. Fish and Wildlife Service

WDFW .....Washington Department of Fish and Wildlife

APPENDIX A

Assessment of Shoreline Jurisdiction

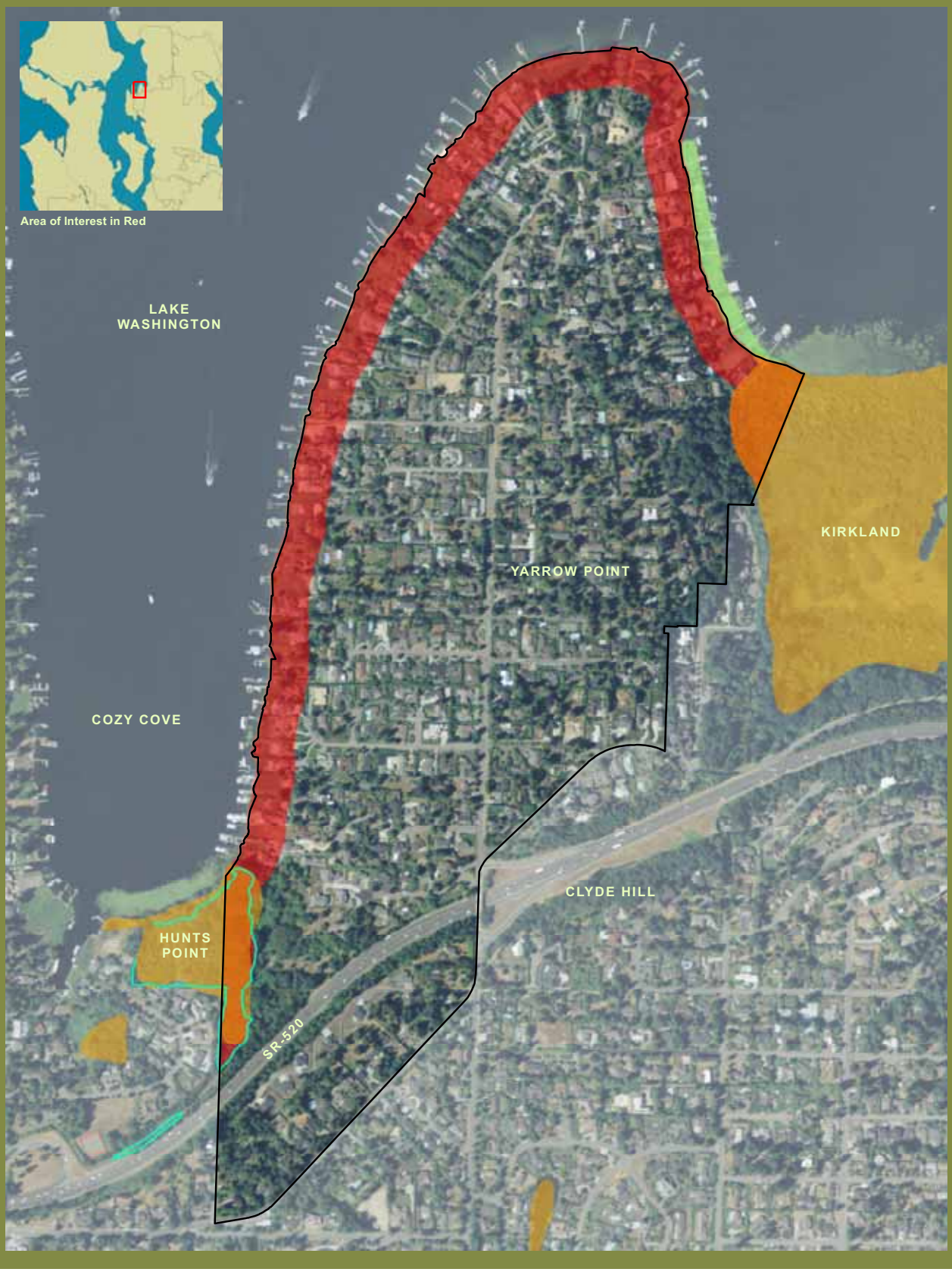
APPENDIX B

Inventory and Analysis Map Folio

Yarrow Point

MINIMUM SHORELINE JURISDICTION

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

All elements depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

- Delineated Wetland Boundary*
- NWI Wetlands**
- Aquatic Bed Wetlands***
- Shoreline Jurisdiction
- Town Boundary

** Wetland identified in Shannon & Wilson Inc., 2002.*
*** A wetland is mapped in error by NWI and is corrected to reflect current conditions.*
**** Aquatic bed wetlands that are not contiguous with wetlands landward of the OHWM do not require a buffer.*

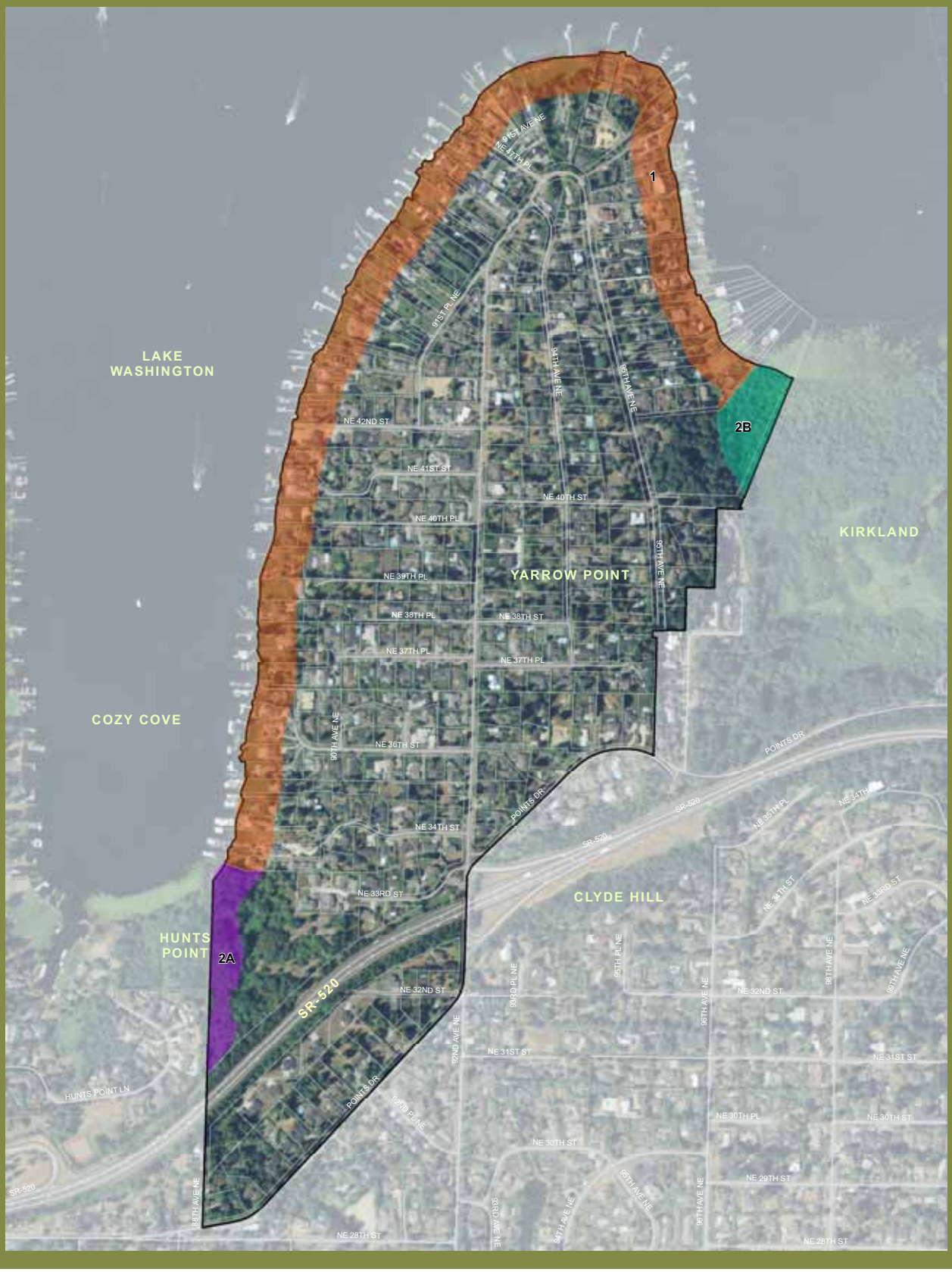
0 250 500
Feet

Data: King County, FWS NWI, TWC. July, 2010.

Yarrow Point

ANALYSIS REACHES

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

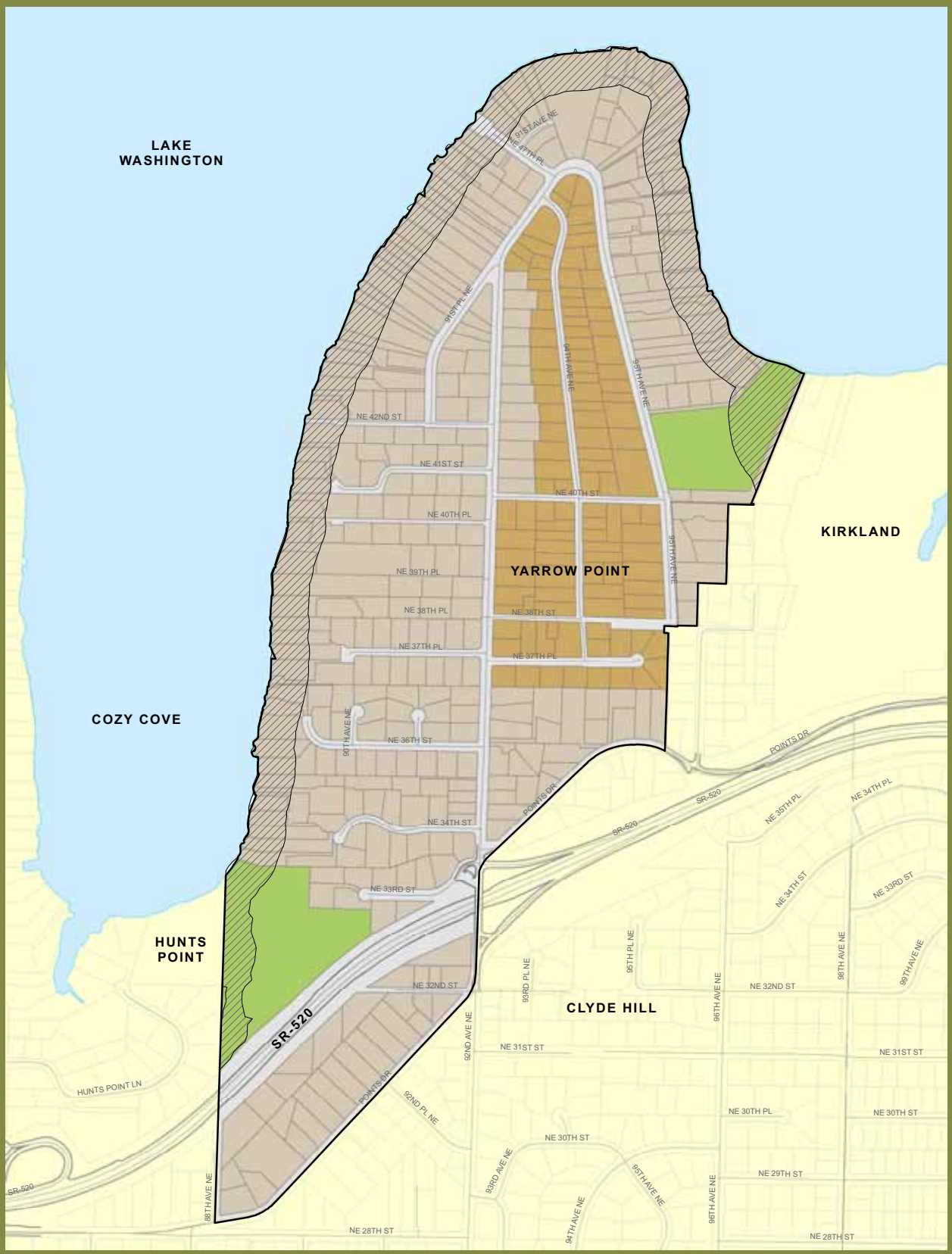
- Reach 1
- Reach 2A
- Reach 2B
- Town Boundary

0 250 500
Feet

Data:King County, TWC. February, 2010.

ZONING

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

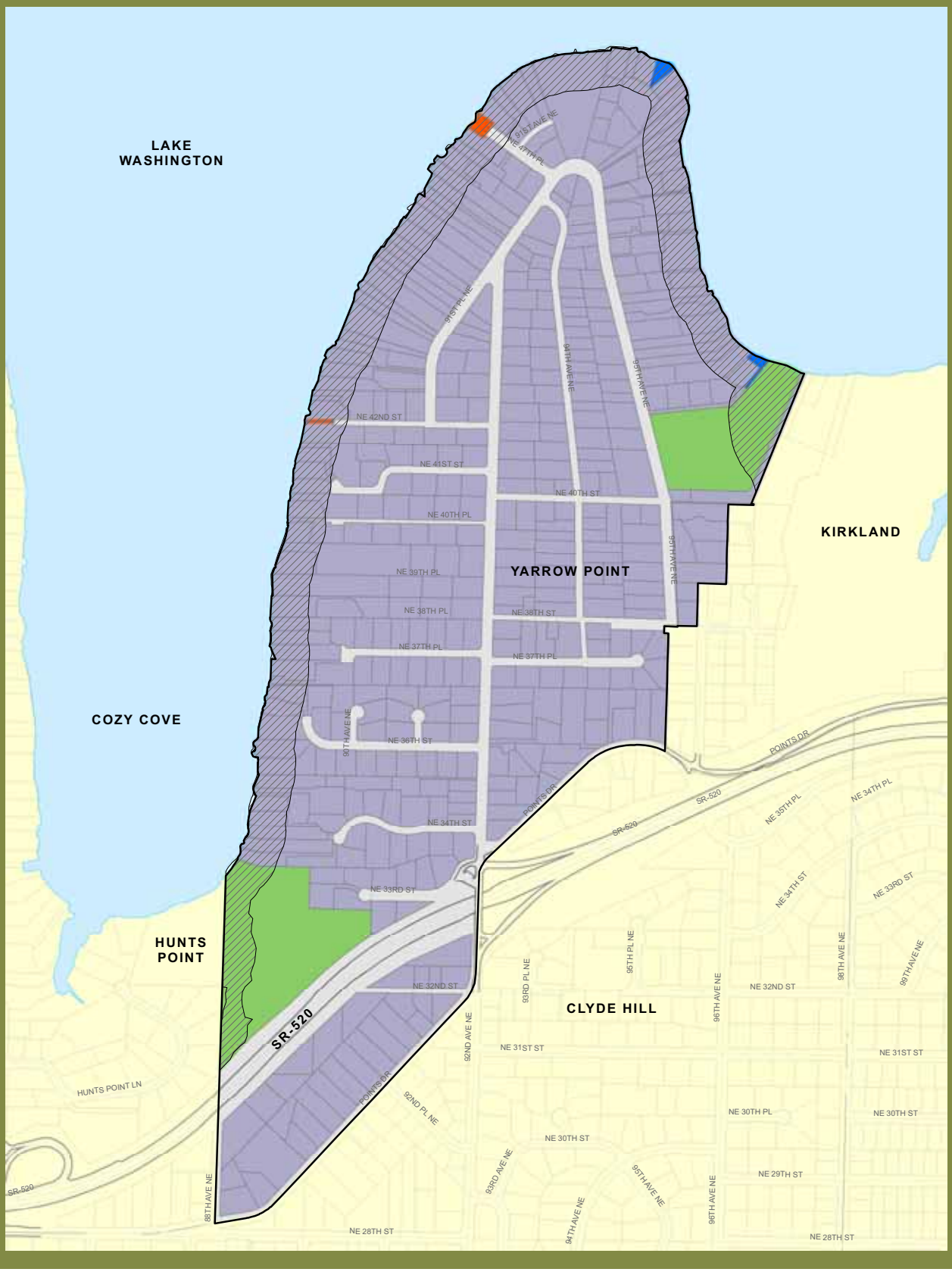
- R12, Single Family Residential, 12,000 SF+
- R15, Single Family Residential, 15,000 SF+
- Public Uses
- City Boundary
- Proposed Shoreline Jurisdiction

0 250 500
Feet

Data: King County, TWC, NW GEO Graphics. February, 2010.

LAND USE

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

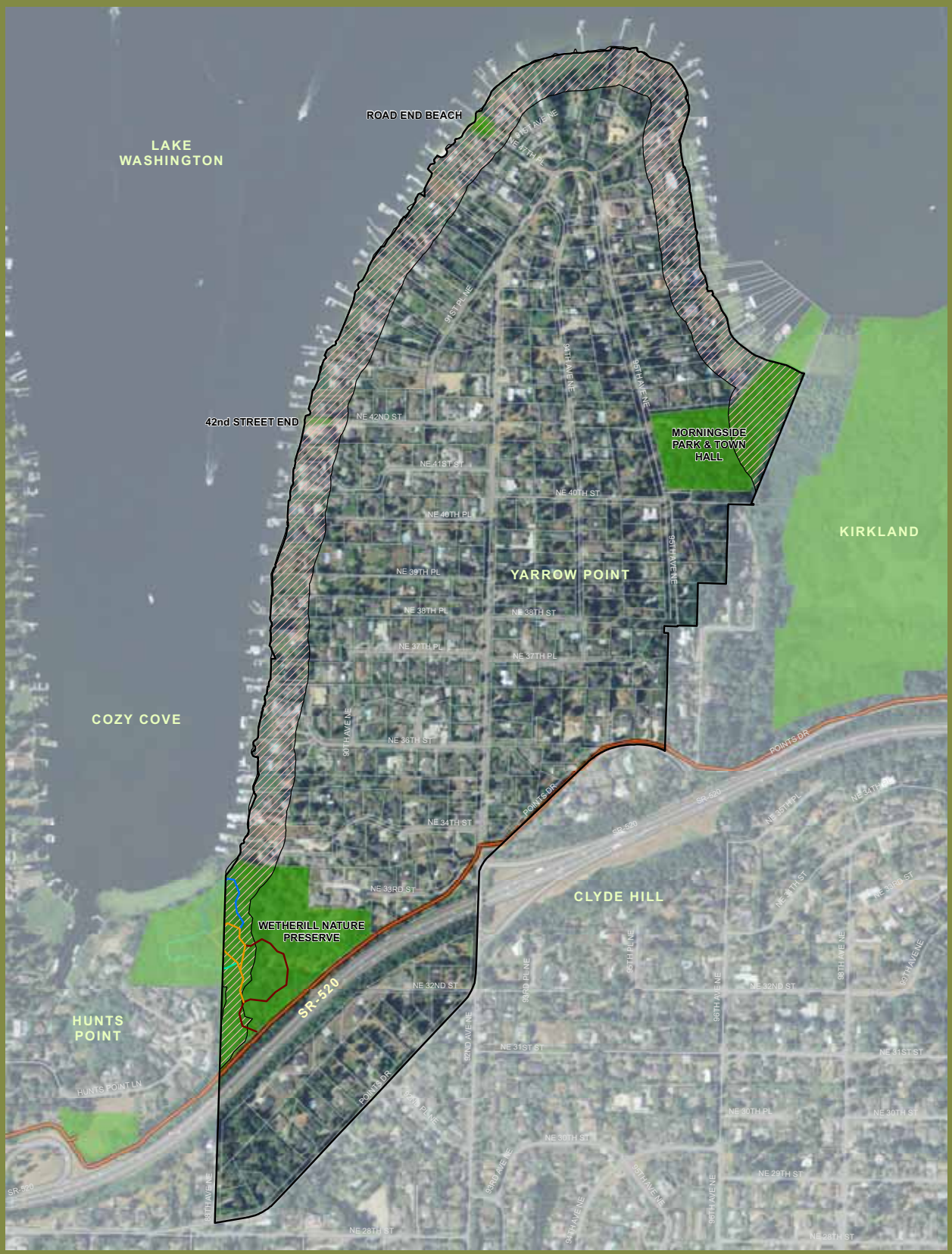
- Public Access to Lake
- Public Parks
- Private Recreation Lot
- Residential
- Proposed Shoreline Jurisdiction
- Town Boundary

0 250 500
Feet

Data: King County,TWC, NW GEO Graphics. February, 2010.

PUBLIC ACCESS AREAS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

- Points Loop Trail
- Lake Trail
- Marsh Trail
- Upland Trail
- Woodland Trail
- Parks
- Town Boundary
- Proposed Shoreline Jurisdiction

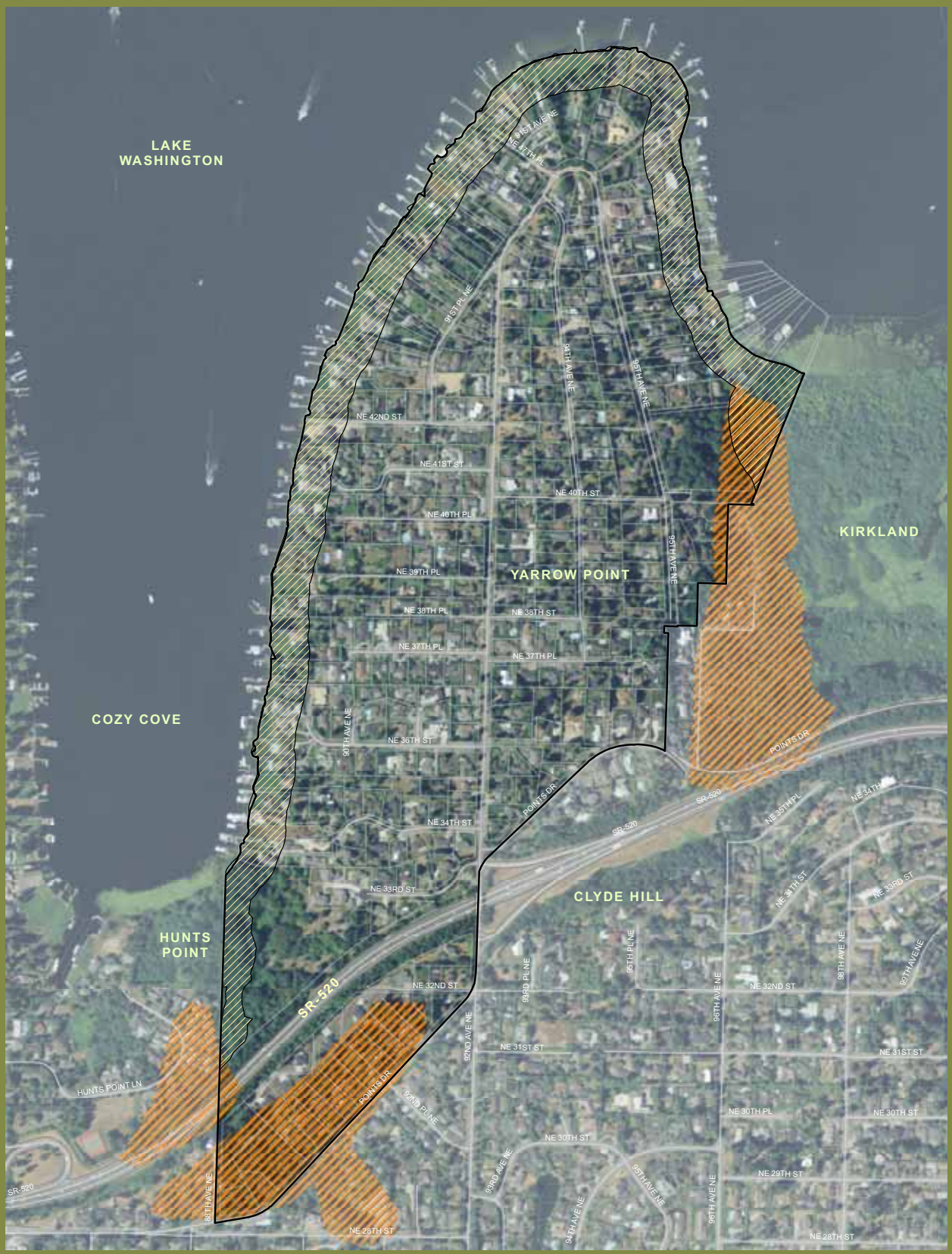
0 250 500
Feet

Data:King County,TWC, Town of Yarrow Point. June, 2010.

Yarrow Point

EROSION HAZARD AREAS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

All element depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

- Erosion Hazard Areas
- Proposed Shoreline Jurisdiction
- City Boundary

0 250 500
Feet

Data: King County, TWC. February, 2010.

LISTED WATERBODIES

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM

THE WATERSHED COMPANY

All elements depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

- Water Quality Listed Areas
- Proposed Shoreline Jurisdiction
- Town Boundary

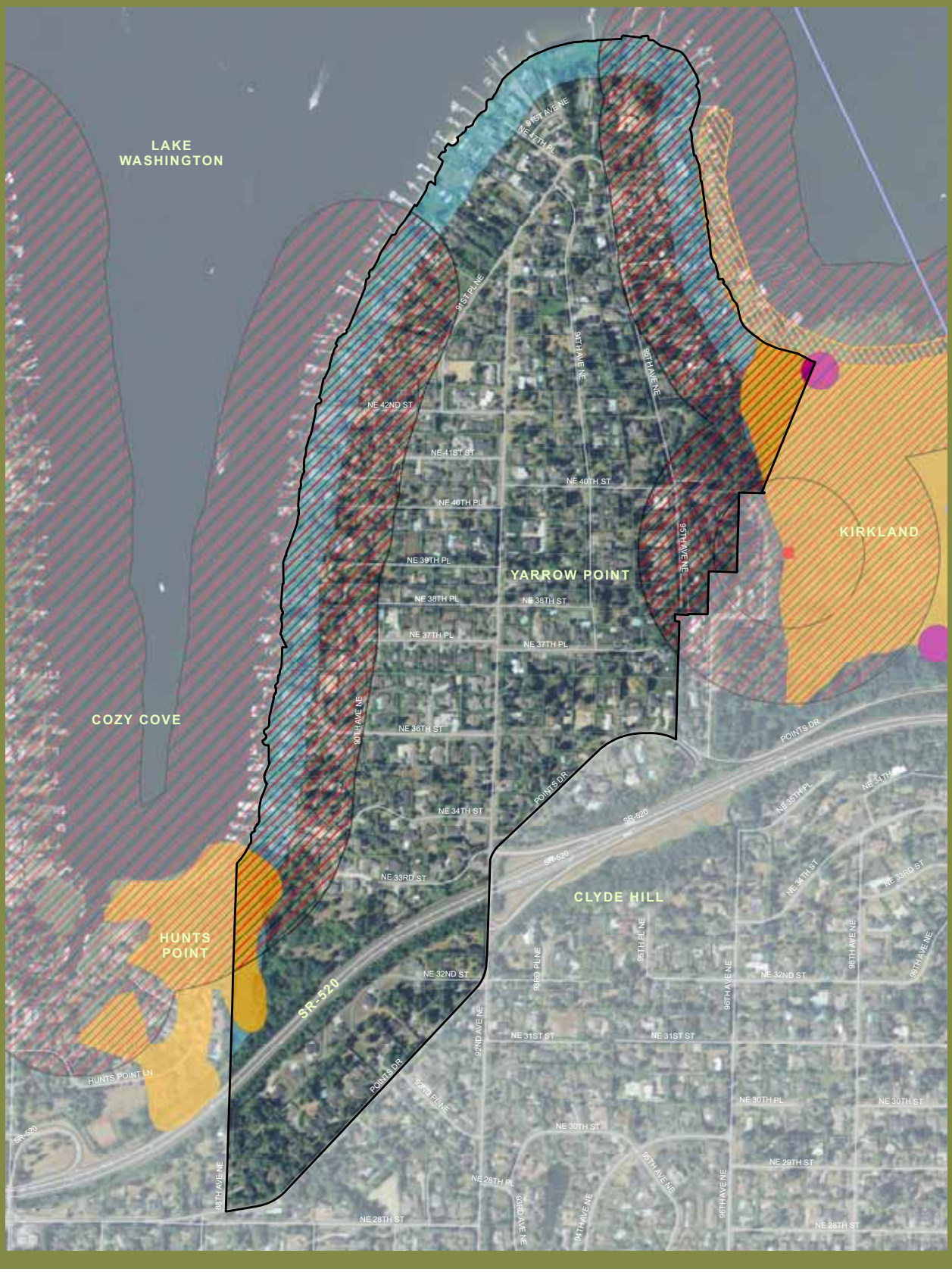
0 250 500
Feet

Data: King County, WA DOE, TWC. February, 2010.

Yarrow Point

WDFW PRIORITY HABITATS & SPECIES

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

- Coast Resident Cutthroat
- Bald Eagle Nest
- Bald Eagle Buffer*
- Great Blue Heron
- Priority Wetland**
- Aquatic Bed Component of Priority Wetland***
- Proposed Shoreline Jurisdiction
- Town Boundary

** Buffers of bald eagle nests, communal roosts, and shorelines that fall within a half-mile of nests.*
*** Feature is either no longer present and/or may be mapped erroneously by WDFW.*
****Aquatic bed wetlands that are not contiguous with wetlands landward of the OHWM do not require a buffer.*

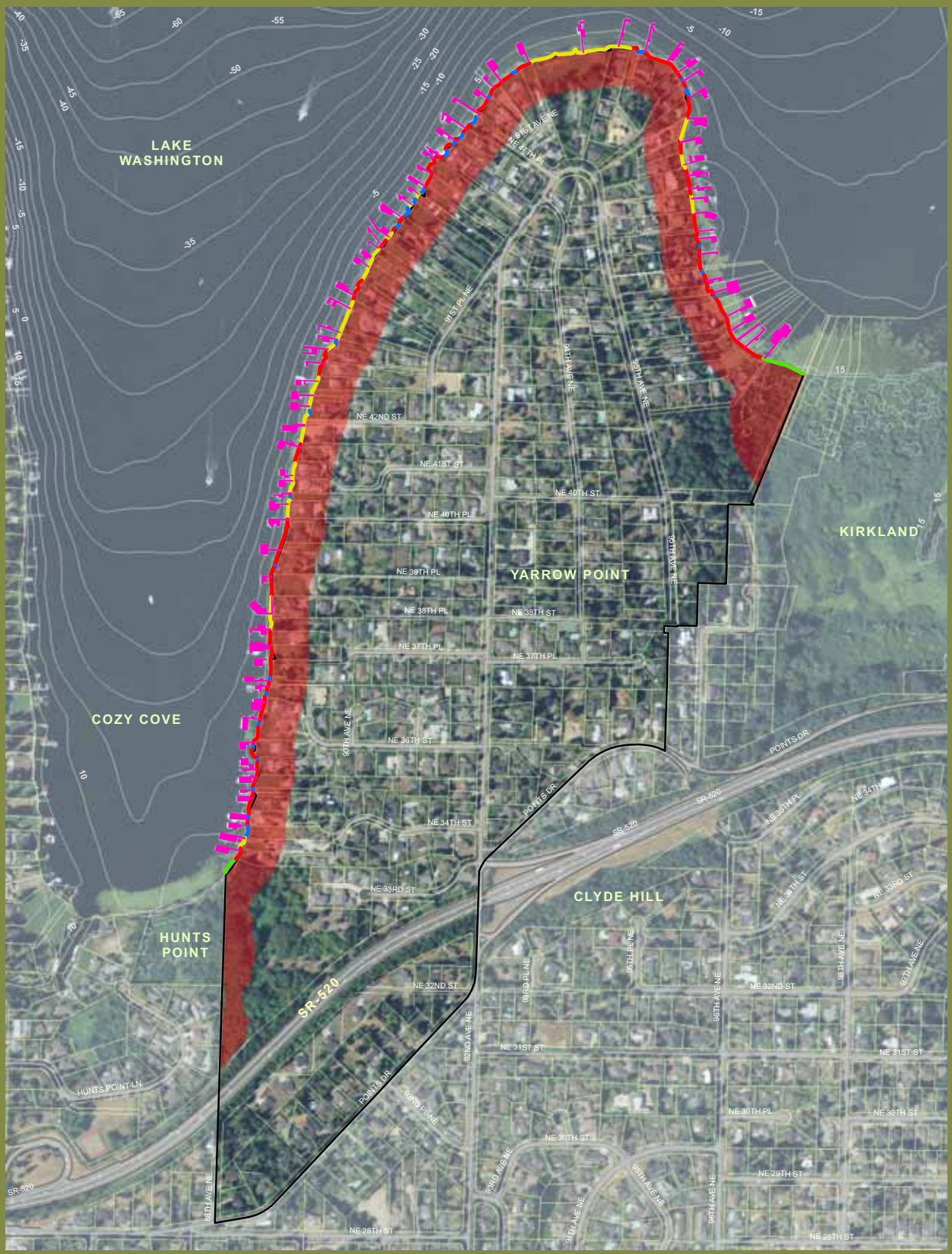
0 250 500
Feet

Data: King County, WDFW, TWC. July, 2010.

Yarrow Point

SHORELINE MODIFICATIONS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

- Overwater Structures
- Town Boundary
- Proposed Shoreline Jurisdiction

ARMORING TYPES

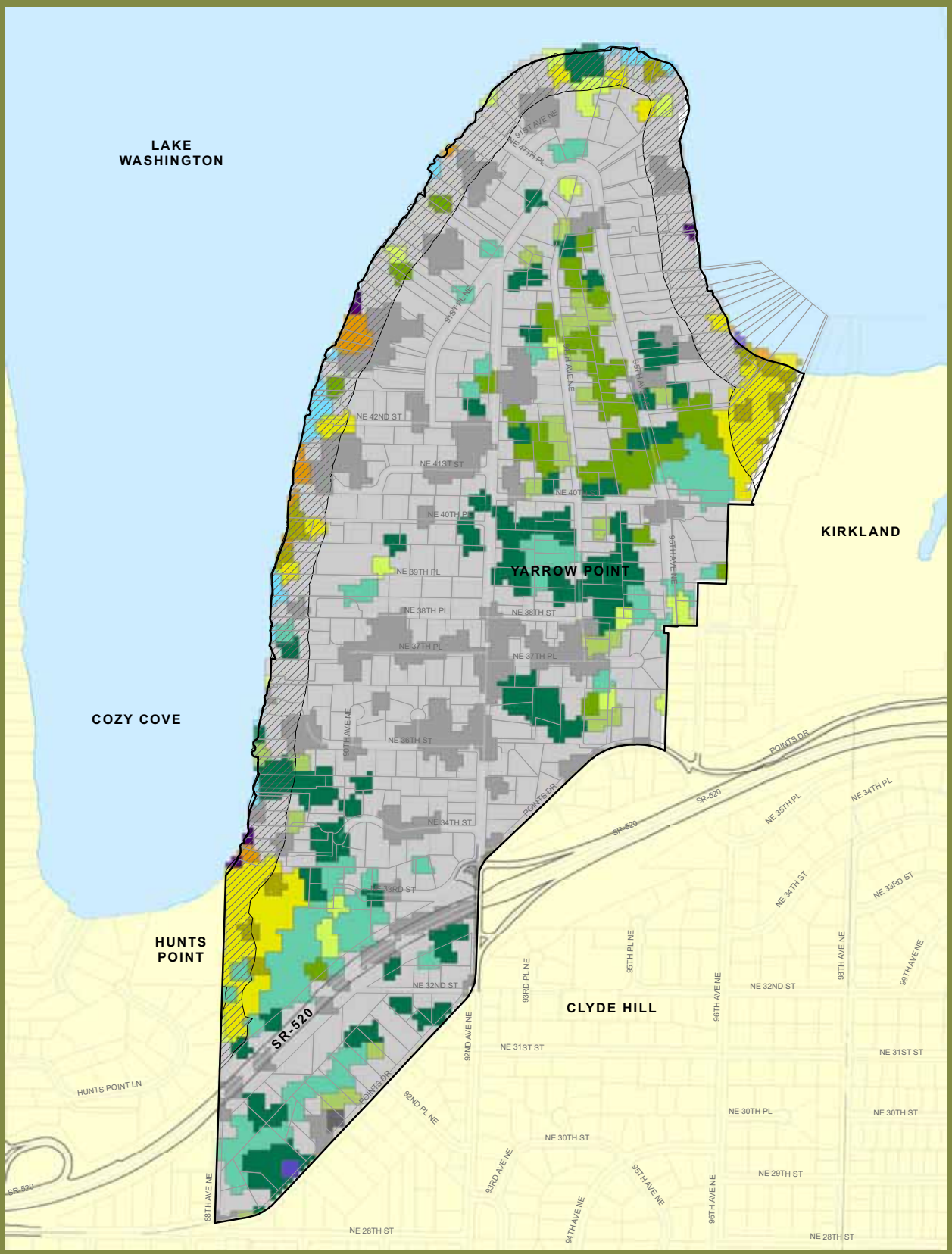
- Boulder
- Concrete
- Semi-Natural
- Natural

0 250 500 Feet

Data: King County, DNR, TWC. October 22, 2010.

VEGETATION

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

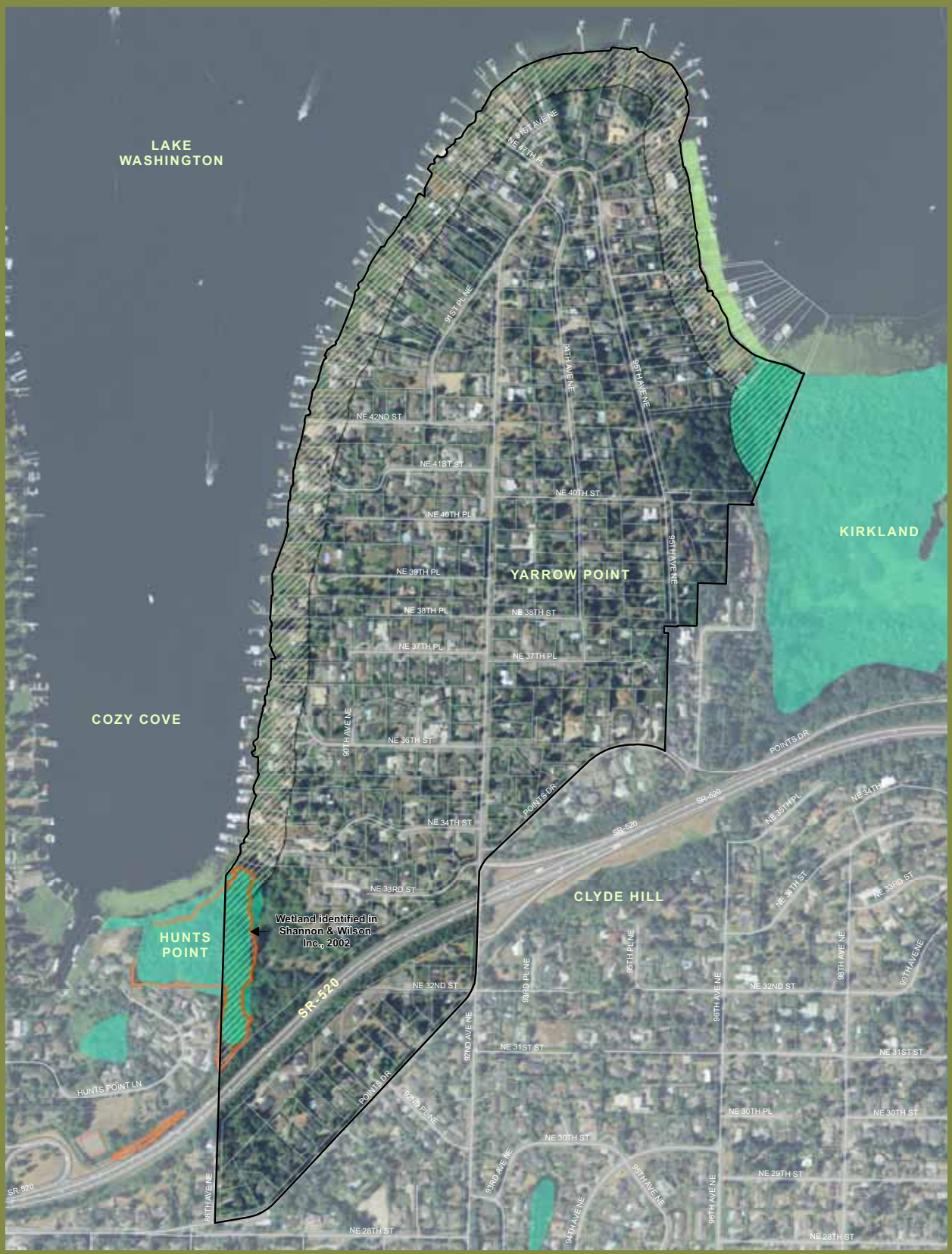
- High Intensity Developed
- Medium Intensity Developed
- Low Intensity Developed
- Developed Open Space
- Evergreen Forest
- Deciduous Forest
- Mixed Forest
- Grassland
- Scrub/Shrub
- Palustrine Forested Wetland
- Palustrine Scrub/Shrub Wetland
- Palustrine Emergent Wetland
- Unconsolidated Shore
- Water
- City Boundary
- Proposed Shoreline Jurisdiction

0 250 500
Feet

Data: King County, NOAA CCAP, TWC, February, 2010.

WETLANDS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

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MAP LEGEND

- NWI Wetlands*
- Aquatic Bed Wetlands**
- Other Wetlands
- Proposed Shoreline Jurisdiction
- Town Boundary

** A wetland is mapped in error by NWI and is corrected to reflect current conditions.*
*** Aquatic bed wetlands that are not contiguous with wetlands landward of the OHWM do not require a buffer.*

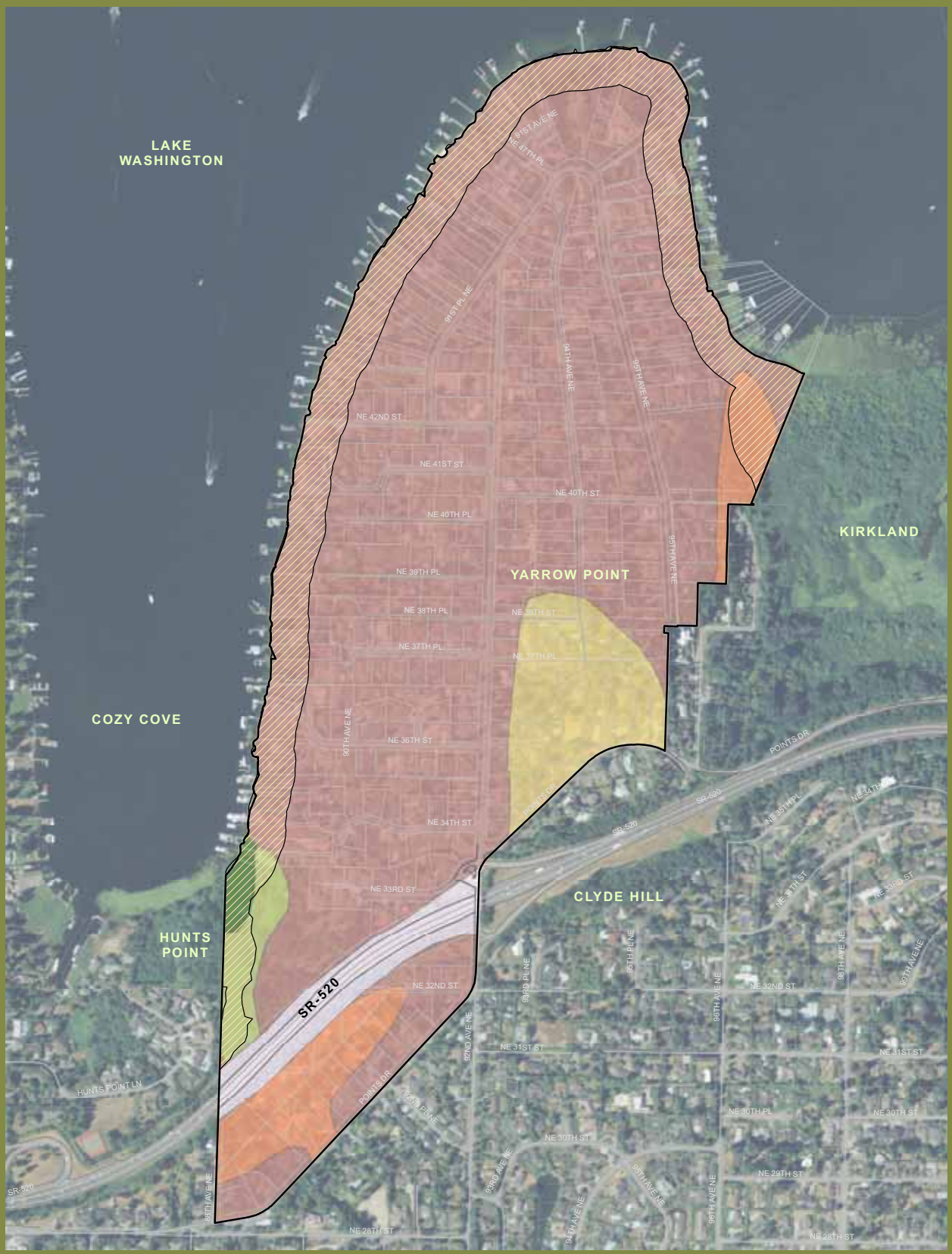
0 250 500
Feet

Data:King County, FWS NWI, TWC. July, 2010.

Yarrow Point

NRCS SSURGO SOILS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



All element depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

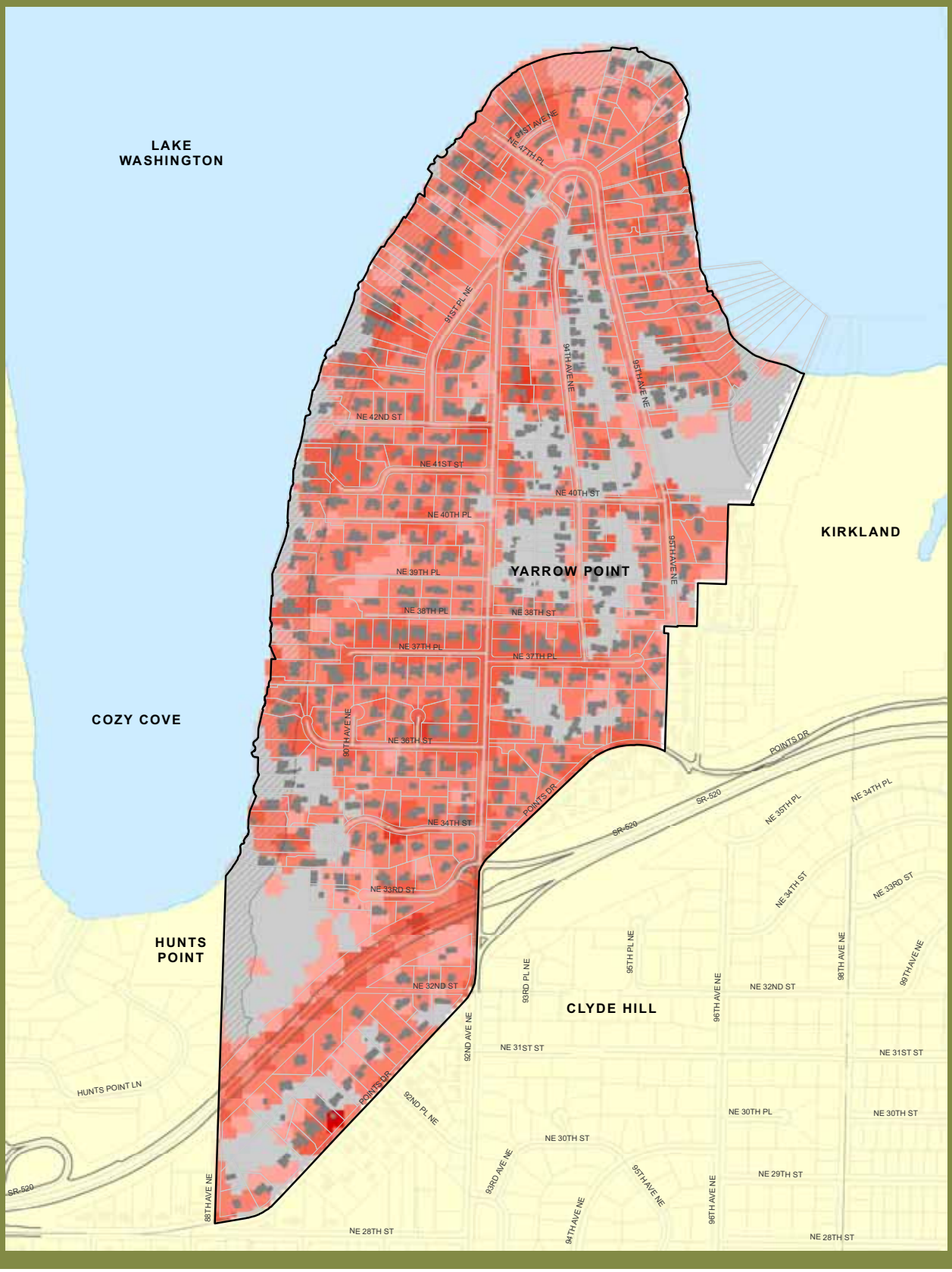
- Alderwood gravelly sandy loam,0-6%
- Alderwood gravelly sandy loam,6-15%
- Alderwood gravelly sandy loam,15-30%
- Bellingham silt loam
- Seattle muck
- Urban Land
- City Boundary
- Proposed Shoreline Jurisdiction

0 250 500
Feet

Data:King County,TWC NRCS SSURGO. February, 2010.

IMPERVIOUS SURFACES

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

All elements on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

Impervious Surfaces*
City Boundary
Proposed Shoreline Jurisdiction

Percent Impervious
0
0 - 20
20.1 - 45
45.1 - 65
65.1 - 85
85.1 - 100

** This impervious surface data is provided by NW Geo Graphics as an approximate only.*

0 250 500
Feet

Data: King County, USGS, NW GEO Graphics,TWC, February, 2010.

UTILITIES

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM

THE WATERSHED COMPANY

All elements depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

MAP LEGEND

- Storm Drain
- Storm Drain Pipe
- City of Bellevue Sanitary Sewer
- Proposed Shoreline Jurisdiction
- Town Boundary

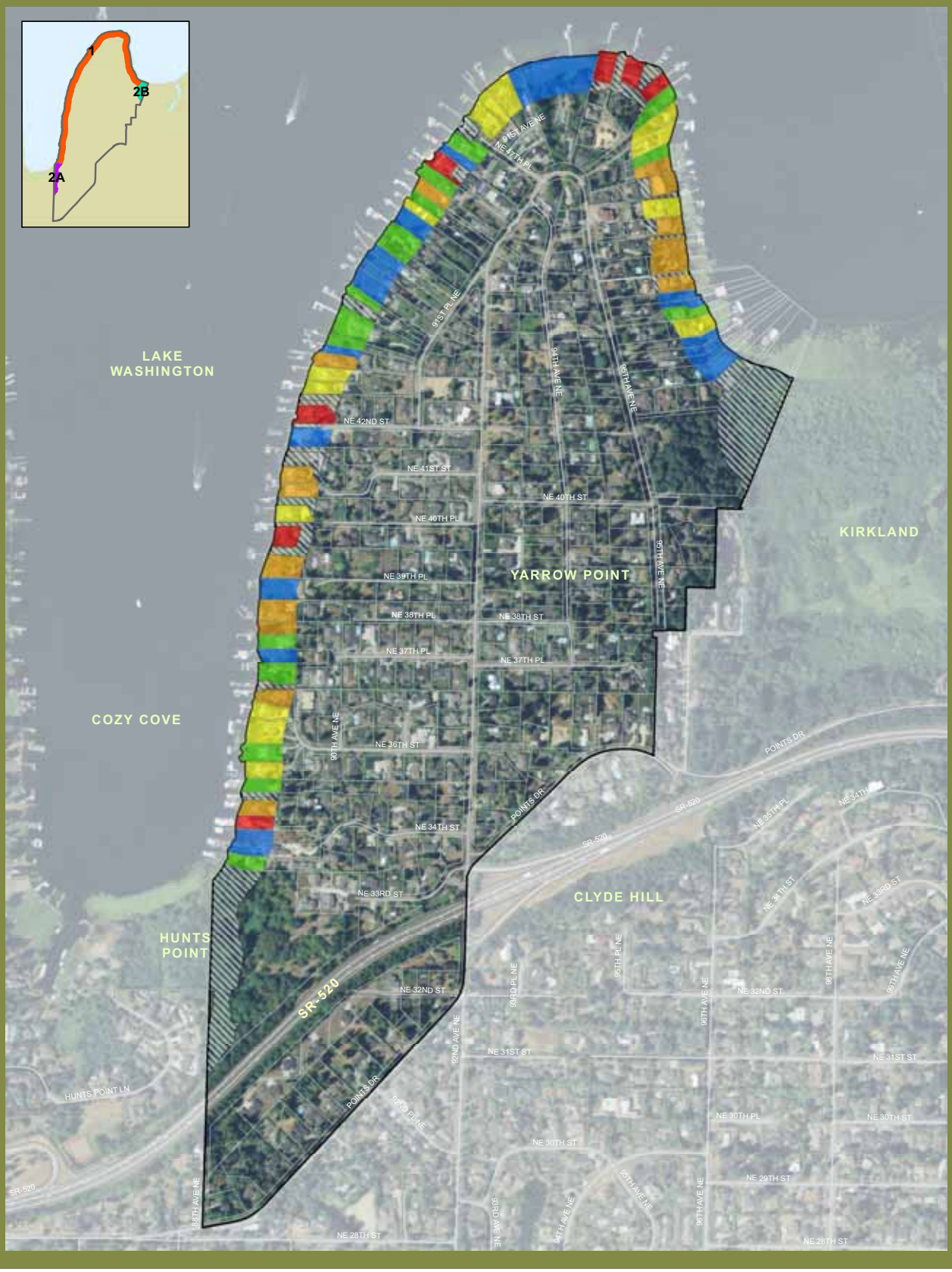
0 250 500
Feet

Data:King County, Town of Yarrow Point, City of Bellevue, TWC. July, 2010.

Yarrow Point

SHORELINE PRIMARY STRUCTURE SETBACKS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

All elements depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

SHORELINE SETBACKS

<50'	101'-150'
51'-75'	150+
76'-100'	N/A

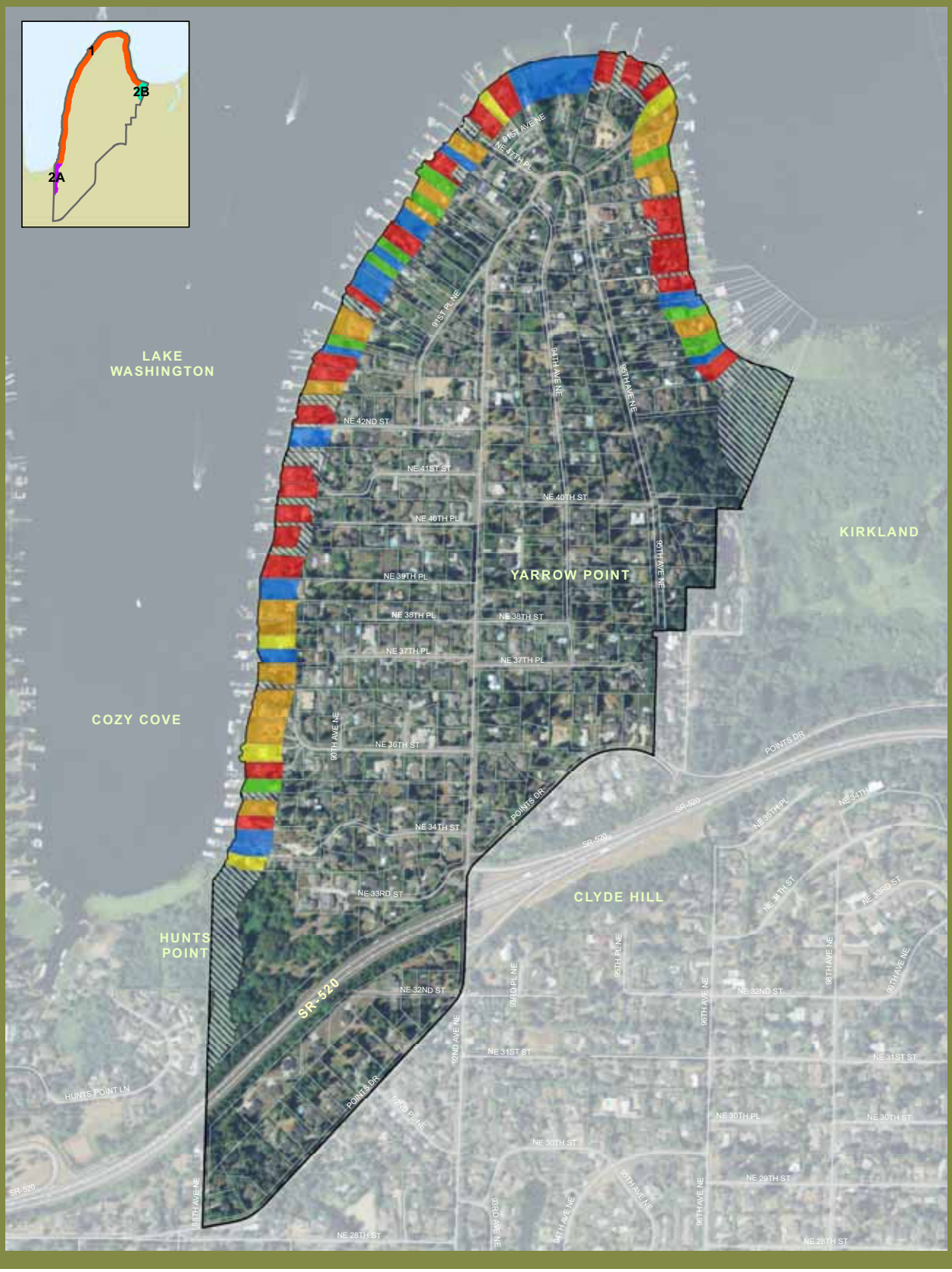
0 250 500
Feet

Data: TWC, King County GIS. June, 2010.

Yarrow Point

SHORELINE IMPROVEMENT SETBACKS

TOWN OF YARROW POINT SHORELINE MASTER PROGRAM



THE WATERSHED COMPANY

All elements depicted on this map are approximate. They have not been formally delineated or surveyed and are intended for planning purposes only. Additional site-specific evaluation may be needed to confirm/verify information shown on this map.

SHORELINE SETBACKS

- <50'
- 51'-75'
- 76'-100'
- 101'-150'
- 150+
- N/A

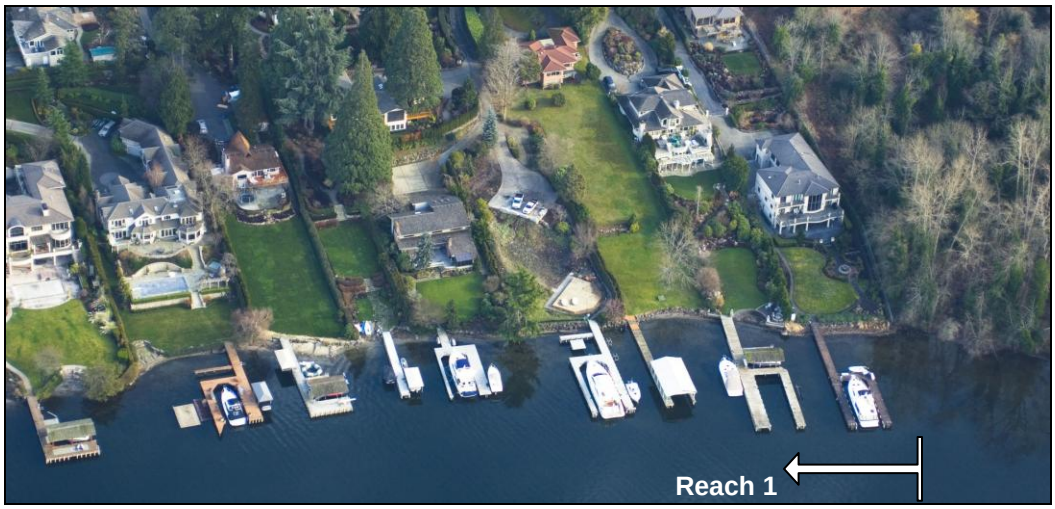
0 250 500
Feet

Data: TWC, King County GIS. June, 2010.

APPENDIX C

Ecology's Oblique Aerial Photographs of Yarrow Point Shoreline by Reach

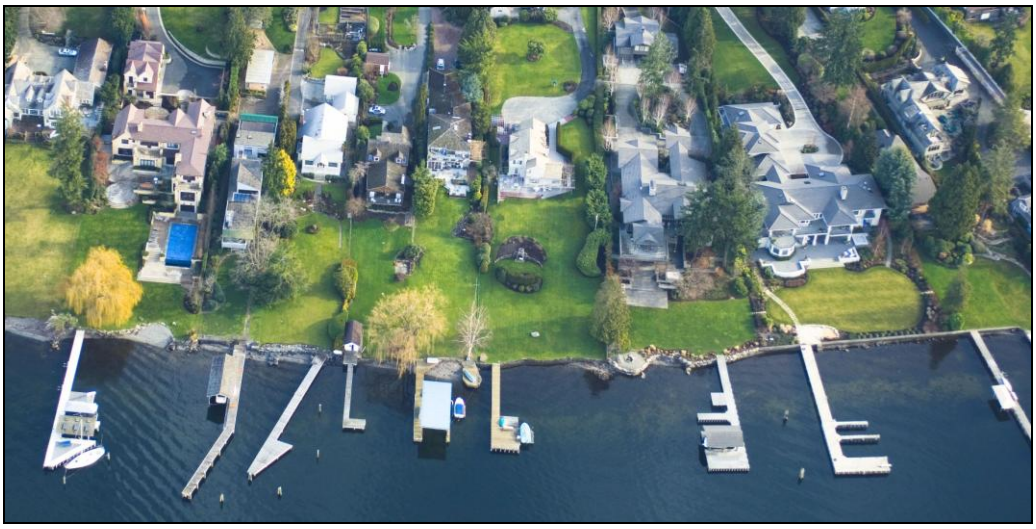
Aerial oblique photographs were taken in 2007



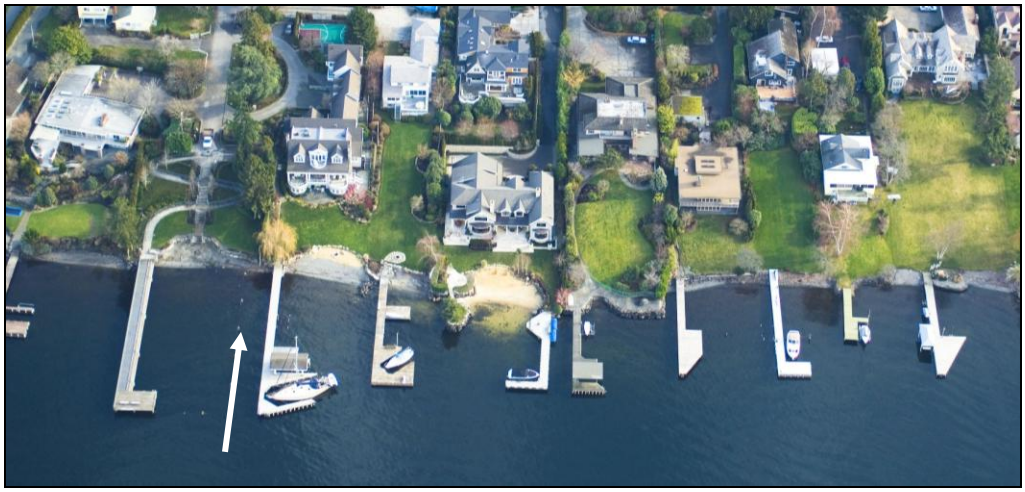
Westernmost extent of Reach 1 – Cozy Cove.

Reach 1 – Cozy Cove.

Reach 1 – NE 42nd Street Shoreline Street End.



Reach 1 – Cozy Cove.

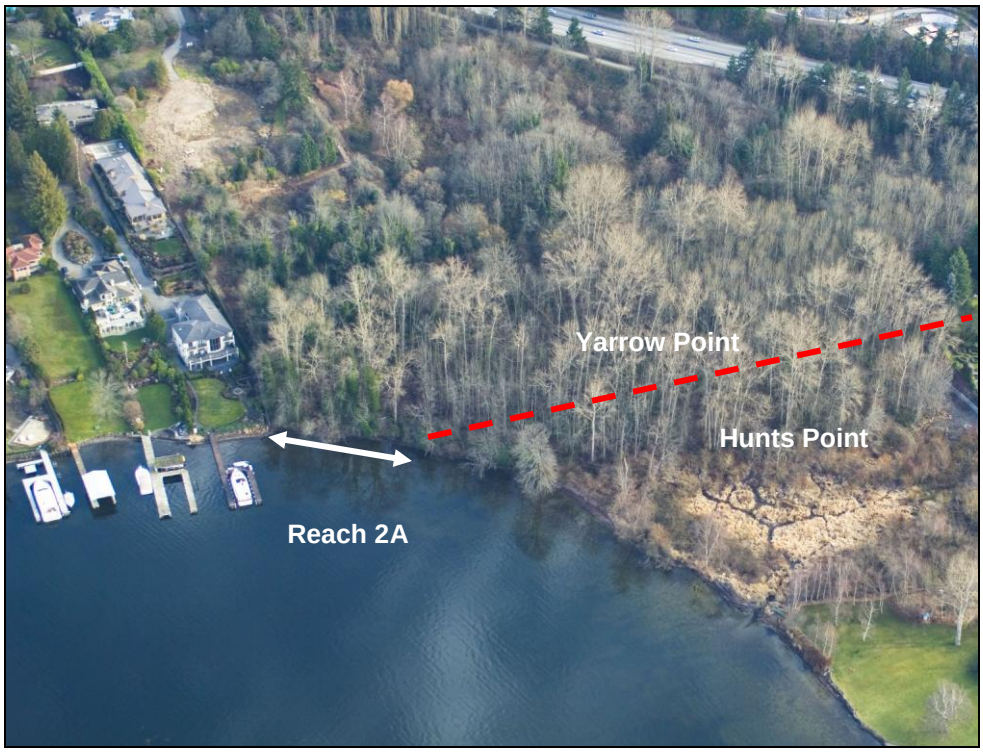


Reach 1 – Road End Beach at NE 47th Street.

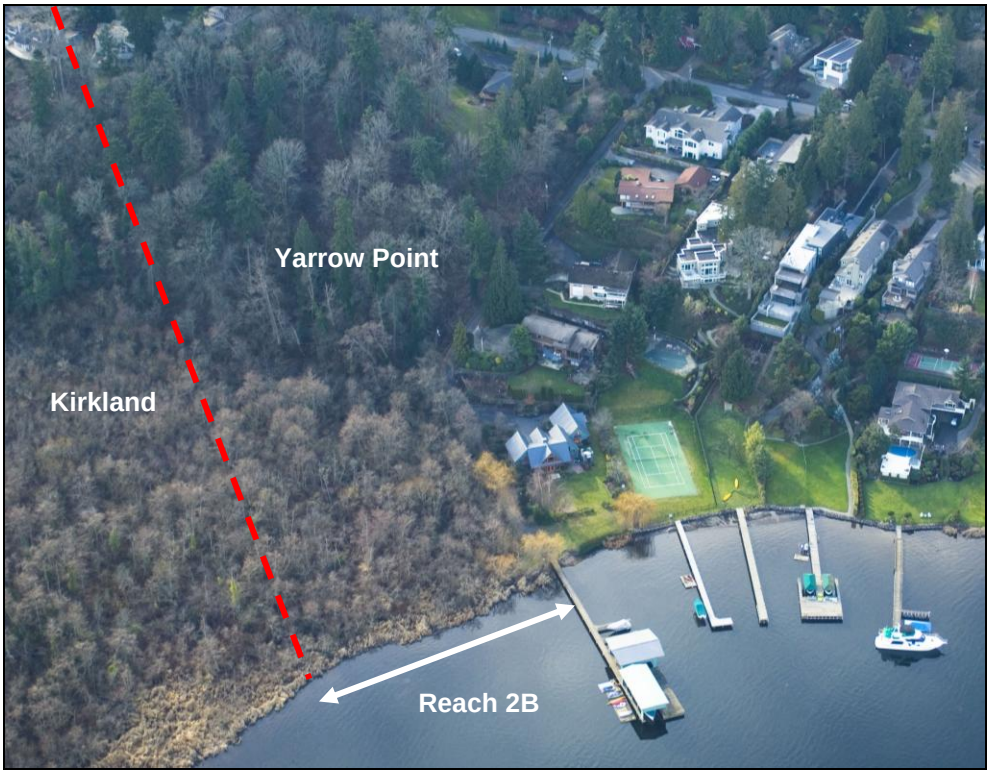
Reach 1 – Tip of Yarrow Point.

Reach 1 – Yarrow Bay.

Easternmost extent of Reach 1 – Yarrow Bay.



Reach 2A – Wetherill Nature Preserve.



Reach 2B – Morningside Park.