Sustainable Development Study – R-1 Zone

Final ■ City of Woodinville ■ February 20, 2007

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Sustainable Development Study – R-1 Zone: Executive Summary

Sustainable Development Study R-1 ■ City of Woodinville ■ February 20, 2007

Sustainable Development Study – R-1 Zone: Executive Summary

Prepared for:

City of Woodinville

Prepared by:

Jones & Stokes
11820 Northup Way, Suite E300
Bellevue, WA 98005
Contact: Lisa Grueter
425/822-1077

And
City of Woodinville Development Services Department

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Attachment A: Environmental Report	City of Woodinville Sustainable Development Project: R-1 Area Environmental Report	Steward & Associates and City of Woodinville
Attachment A: Appendix A	Hydrogeologic Analysis for City Of Woodinville Sustainable Development Program and Preliminary Assessment of Hillside Drainages Infiltration	Golder Associates, Inc.
Attachment A: Appendix B	Lake Leota Analysis for City Of Woodinville Sustainable Development Program	C. Michael Falter, Ph.D
Attachment A: Appendix C	City of Woodinville R-1 Zone Wetland Inventory C-1. Woodinville Additional Wetland Reconnaissance Survey C-2. Woodinville Wetland Survey C-3. Citizen Advisory Panel Supplied Map	C-1 Jones & Stokes C-2. Cooke Scientific C-3. Citizens Advisory Panel
Attachment A: Appendix D	Woodinville Sustainable Development Study	Perteet Inc.
Attachment B: Neighborhood Character in the R-1 Zone Report	Neighborhood Character in the R 1 Zone, City of Woodinville	City of Woodinville Development Services Department
Attachment C: Transportation Report	Transportation, City of Woodinville	City of Woodinville, Development Services Department, Perteet Inc.
Attachment D: Capital Facilities and Utilities Report	Capital Facilities and Utilities in the R-1 Area	City of Woodinville Community Development Services Department
Attachment E: Moratorium Ordinances	Moratorium Ordinances 419, 424, and 427	City of Woodinville
Attachment F: Other Information/Errata	Reserved for added or corrected information by various authors as appropriate	Various Authors

Sustainable Development Study: R-1 Zone Executive Summary

Issue

The City of Woodinville determined that a review of zoning densities needed to occur on lands currently classified as R-1, where the minimum size for new parcels is one unit per acre. Under current Woodinville Municipal codes, the R-1 zone density can be increased to R-4 only upon approval of a rezone. R-1 to R-4 in the Woodinville's Comprehensive Plan is considered Low Density. This document is called the Sustainable Development Study and includes four individual studies: environmental, neighborhood character, transportation, and capital facilities. The study was initiated after a Moratorium was established to limit development until the results of the study were available. The Moratorium is anticipated to end in March 2007.

The residential zones in the city make-up approximately 60% of the city's 3,500 acres, with the R-1 zone encompassing approximately 30% or 1,100 acres. One of seven major neighborhoods, the R-1 neighborhood is located on the northeastern uplands of the city (see Figure ES-1), and is referred to as the Leota and Wellington Neighborhoods. R-4, R-6, R-8, and five multifamily residential designations comprise the remainder of the city's residential area.

Viewed in the abstract, R-1 zoning has been inconsistent with past decisions by the Central Puget Sound Growth Management Hearings Board (Board) regarding minimum urban densities, but recent Court and Board decisions indicate that such densities are not necessarily required in all urban areas as an absolute rule. The Board and related case law guide decisions where densities may be allowed other than those the Board considers "compact urban." In addition, the GMA calls for ensuring "the vitality and character of established residential neighborhoods," and past Board decisions have explicitly authorized lower urban densities when they provide added or necessary protection for critical areas that are **large in scope, complex in structure and function, and of a high rank order.** (These criteria are known as the "*Litowitz* test," following the name of the plaintiff in the case where they were first identified[1].) Factors used in supporting lower densities are the same as those evaluated in this Sustainable Development Study:

- Environmental – what levels of density can the land support and maintain and protect important critical areas?

[1] *Litowitz v. Federal Way*, CPSGMHB Case No. 96-3-005 (July 22, 1996).

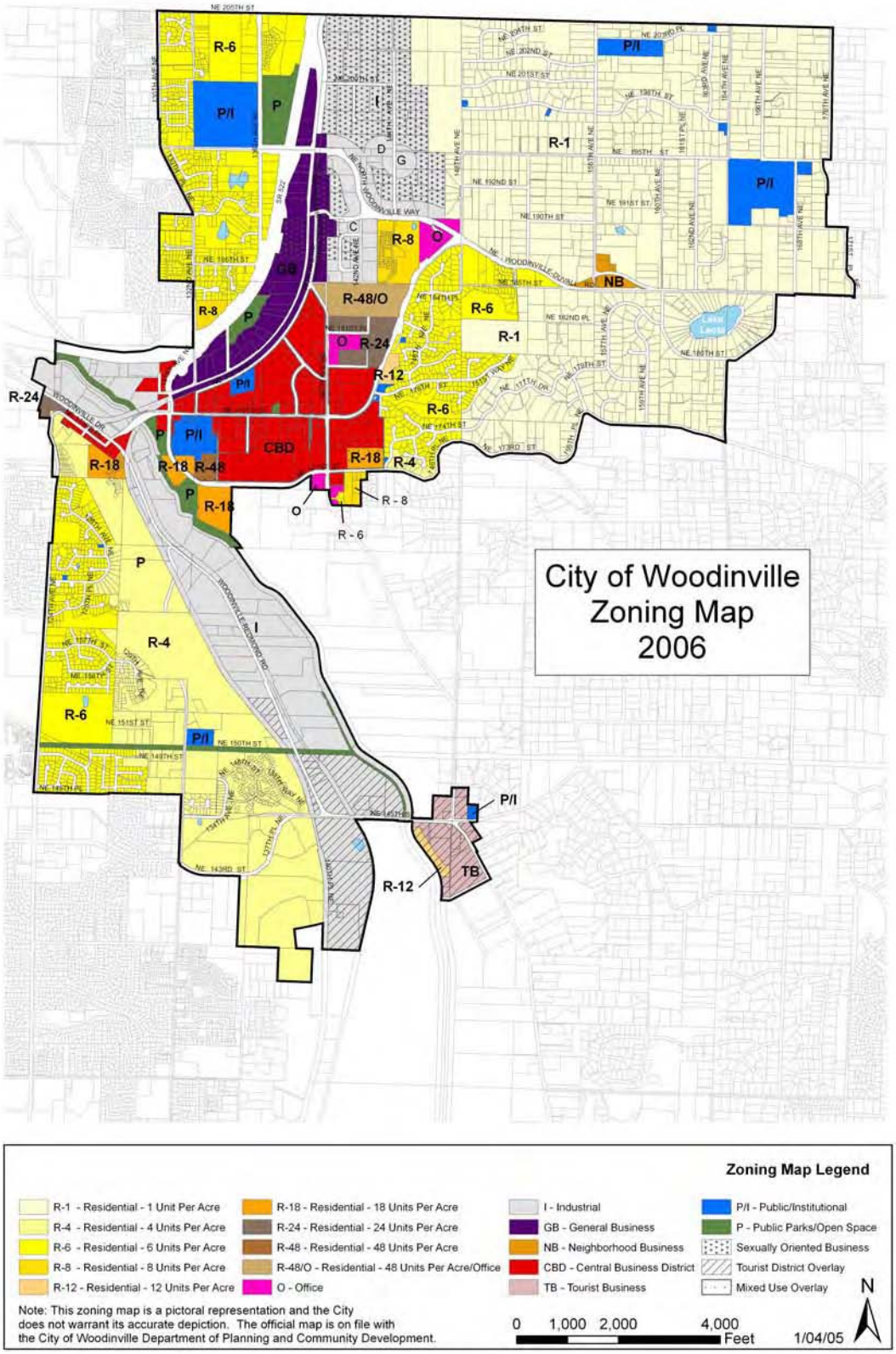

Figure ES-1. Zoning Map

- Neighborhood Character – what areas of the R-1 zoned land have a distinct character that requires recognition through zoning?
- Transportation – how would growth at different densities affect transportation systems?
- Capital Facilities and Services – are infrastructure systems and public services capable of growth at different densities?

In addition to the above, the following are relevant contextual factors that must be evaluated when determining densities and are specifically discussed in the neighborhood character report of this study:

- The percentage of the overall land in the City where lesser densities may be permitted,
- Whether the City is meeting its assigned growth target, the City's overall average density, what density and designations are applied to undeveloped/unplatted areas of the City, and whether, overall, the City's planning record indicates that it is meeting its obligations under the Growth Management Act (GMA).

The Sustainable Development Study examines each individual factor, and then based on a range of these factors, provides zoning alternatives/options for consideration by City decision-makers. Four options are proposed in this study. Policy and code amendments will be prepared supporting the City's preferred option. Such policy and code amendments could include adding environmental, design, road, and capital facility based development standards.

Introduction and Background

The City of Woodinville is one of thirty-nine cities in King County and is adjacent to Snohomish County's boundary. In 2002, the City compared its demographics to King County as a whole and several Eastside and other nearby cities. Compared with Seattle, Mill Creek, Bothell, Kirkland, Redmond, Bellevue, and Issaquah, the City had the largest household size, the most population under age 19, the least growth between 1990 and 2000, and the smallest population. The City, since its inception has promoted the desire to maintain a "Northwest Woodland Character," identifying that desire in numerous places, including its Comprehensive Plan goals, Land Use LU-1, Community Design Goal CD-2, and Environmental Goal ENV-6. Houses in the R-1 zone are mostly homes built in the 1960's through the 1980's on large lots, but in other R-zoned areas they are newer homes on smaller lots.

Growth Management Act Goals

The GMA established 13 goals for the comprehensive planning process. Per RCW 36.70A.020, the following goals are not listed in order of priority and shall be used exclusively for the purpose of guiding the development of comprehensive plans and development regulations:

- **Urban growth.** Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.
- **Reduce sprawl.** Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.
- **Transportation.** Encourage efficient multi-modal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.
- **Housing.** Encourage the availability of affordable housing to all economic segments of the population of this state, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.
- **Economic development.** Encourage economic development throughout the state that is consistent with adopted comprehensive plans; promote economic opportunity for all citizens of this state, especially for unemployed and for disadvantaged persons; promote the retention and expansion of existing businesses and recruitment of new businesses; recognize regional differences impacting economic development opportunities; and encourage growth in areas experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.
- **Property rights.** Private property shall not be taken for public use without just compensation having been made. The property rights of landowners shall be protected from arbitrary and discriminatory actions.
- **Permits.** Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability.
- **Natural resource industries.** Maintain and enhance natural resource-based industries, including productive timber, agricultural and fisheries industries. Encourage the conservation of productive forestlands and productive agricultural lands, and discourage incompatible uses.
- **Open space and recreation.** Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities.
- **Environment.** Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.
- **Citizen participation and coordination.** Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.
- **Public facilities and services.** Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.
- **Historic preservation.** Identify and encourage the preservation of lands, sites and structures that have historical or archaeological significance.

Of particular interest in the R-1 study are goals to reduce sprawl, protect the environment, and provide housing choices.

Growth Management and Urban Densities

In 1995, the Central Puget Sound Growth Management Hearings Board established a "general rule" of four net dwelling units per acre as a minimum density for urban areas under the GMA. Calling this standard a "bright line," the Board stated:

> Any residential pattern at that density, or higher, is clearly compact urban development and satisfies the low end of the range required by the Act. Any larger urban lots will be subject to increased scrutiny by the Board to determine if the number, locations, configurations and rationale for such lot sizes complies with the goals and requirements of the Act, and the jurisdiction's ability to meet its obligations to accept any allocated share of County-wide population. Any new residential land use pattern within a UGA [Urban Growth Area] that is less dense is not a compact urban development pattern, constitutes urban sprawl, and is prohibited.

The next year, the Central Board identified the criteria it would use to determine whether environmental factors could justify a lower density in urban areas:

> The Board holds that when environmentally sensitive systems are large in scope (e.g. a watershed or drainage sub-basin), their structure and functions are complex and their rank order value is high, a local government may also choose to afford a higher level of protection by means of land use plan designations lower than 4 du [dwelling units]/acre.

These criteria have come to be known as "the *Litowitz* test," following the name of the plaintiff in the case. The criteria have not changed, nor have they been substantially clarified, under subsequent Growth Board decisions. This leaves many important details somewhat ambiguous. Watersheds and drainage sub-basins can be identified across a wide range of sizes, from a large river system like the Columbia River to an individual wetland or small stream. To some degree, the structure and functions of nearly all natural systems are complex. The meaning of "rank order value" is also unclear and depends on scale. A particular stream or wetland, for example, could rank of high importance within a small jurisdiction or small drainage basin but of much less importance when considered at larger geographic scales. Nevertheless, it is clear that critical areas that are not of high relative value within the larger natural systems in the surrounding vicinity or within an individual jurisdiction would be unlikely to pass the *Litowitz* test.

In a later case, *Fuhriman v. Bothell,* the Board acknowledged "a possible expansion of *Litowitz* analysis," where lower densities might be allowed to protect critical areas that do not, strictly speaking, meet the *Litowitz* test. It noted that critical areas that are linked hydrologically could have "unique geologic or topographical features that would also require the additional level of protection of lower densities in those limited geologically hazardous landscapes." Such areas might, for example, provide sources of cool water for streams and rivers, wildlife habitat, and other ecological

functions. The Board has never explicitly addressed whether it would support reduced densities solely to reduce the public safety threat of geologic hazards, which generally can be addressed through other means (e.g., setbacks, vegetation retention, appropriate stormwater management, and site-specific conditions on development).

Complicating this legal context further, in 2005 the Washington State Supreme Court held that the Growth Boards do not have the legal authority to set "bright line" rules that are not contained within the GMA. And, it suggested that local conditions, such as the existence of private covenants restricting density, could be taken into account by local governments in planning under the GMA. In March 2006, a King County Superior Court judge cited this Supreme Court ruling in voiding a Central Board decision against the City of Normandy Park, where the City had adopted a GMA plan which retained the existing zoning which is generally well below four units per acre. Judge Bruce Hilyer found that, both under the Supreme Court case and under his own independent reading of the GMA, Growth Boards do not have the authority to impose "bright line" rules of their own construction, heightened scrutiny tests, or uniform minimum residential densities. Judge Hilyer emphasized that, under the GMA, deference must be given to a local government's decision regarding appropriate urban densities, based on local circumstances. The fact that the City's plan met its growth allocations and that the City had no UGA appear to have been among key factors in the Normandy Park case.

Several parties have appealed and asked the Supreme Court to accept direct review of Judge Hilyer's decision. Thus, it is not absolutely certain what criteria might be applied to judge the validity of Woodinville's R-1 zoning, should it be challenged to the Central Board or the courts. It is worth noting, however, that the GMA provides for a "broad range of discretion" in local planning. The Act's housing goal explicitly promotes "a variety of residential densities and housing types, and encourage[s] preservation of existing housing stock." (RCW 36.70A.020(4)) The Act also calls for housing elements in local Comprehensive Plans that ensure "the vitality and character of established residential neighborhoods" (RCW 36.70A.070(2)).

While there may be less certainty about urban and rural densities, the GMA goals that must be balanced remain. By reviewing a range of important planning issues – environmental, neighborhood character, transportation, and capital facilities – the City intends to achieve a balance of GMA goals appropriate to local conditions in Woodinville.

Growth Targets

In addition to meeting GMA goals, the City must plan for its fair share of population growth in accordance with GMA provisions. Under the King County population allocation process performed under the GMA, the City of Woodinville is required to provide up to 1,869 new housing units by the year 2022. In an extensive public process, the City has strategically evaluated where and how it could locate its population growth with the goal of preserving its woodland community character. The City did this through creation of a Central Business District zone for the downtown, which allows a base density of 36 units per acre, up to a maximum of 48 units per acre. With development standards that

encourage high density housing and transit- oriented design, the City's buildable land analysis shows that the City has sufficient capacity under its current zoning to accommodate at least 1,947 new housing units, 78 more than are needed to meet its 2022 population allocation (see Attachment B for more information). Therefore, during review of the R-1 zone, the primary concern is protecting critical areas without concern for the City's ability to meet its growth forecast.

Public Participation

Another GMA goal involves ensuring public participation. To that end, a citizen's advisory panel was appointed. In addition, the Planning Commission conducted meetings. *As of February 20, 2007*, the following meetings have been conducted:

CAP Meetings

- July 12, 2006: Discussion of Issues & Scope of Work; Develop Tentative Meeting Schedule
- July 19, 2006: Introduction of Subject Experts; Technical Expert Presentations; Stormwater, Hydrogeology, Limnology, Other
- August 2, 2006: Legal Issues; Technical Experts Continued; Data Needs; Critical Areas Definitions; Goals Discussion
- August 23, 2006: Goals Discussion; Data Needs; Critical Areas; Neighborhood Character
- September 6, 2006: Discussion Of One Sentence Purpose of Being a Member; Continuation of Goals Discussion
- September 14, 2006: Continuation Of Goals Discussion
- September 19, 2006: Continuation of Goals Discussion
- October 12, 2006: Environmental Studies Presentation, Consultants; Miscellaneous; Continuation of Goals Development; Transportation Issues Mailed
- November 15, 2006: Draft Environmental Report Presentation; CAP Final Goals and Policies Recommendation
- December 27, 2006: Draft Environmental Report Status; Housing-Neighborhood Character Study; Comp. Plan & Regulatory Amendment Strategies
- January 3, 2007: Draft Environmental Report Status; Housing-Neighborhood Character Study; Comp. Plan & Regulatory Amendment Strategies
- January 10, 2007: Open House Sustainable Development
- January 18, 2007: Open House Sustainable Development: ·Schedule Of Sustainable Development Project: Housing-Neighborhood Character Study: Other Reports of Project
- January 24, 2007: Review Draft Sustainable Development Report with Consultants
- January 30, 2007: Review Draft Sustainable Development Report

Planning Commission Meetings

- June 7, 2006: Appointment of CAP Members
- August 16, 2006: Status Report On Environmental Studies
- September 20, 2006: Status Report On Sustainable Development
- November 15, 2006: Joint Meeting With CAP & Consultants Re: Environmental Report
- January 3, 2007: Comprehensive Plan, Zoning Code And Regulatory Amendment Proposal Discussion
- January 18, 2007: Open House Sustainable Development
- January 24, 2007: Joint Meeting with CAP and Consultants; Review Draft Sustainable Development Report
- January 31, 2007: Public Hearing
- February 14, 2007: Public Hearing and Deliberation

The City Council is conducting additional public meetings and hearings through March 2007. Please see www.ci.woodinville.wa.us for more information.

Analysis

Table ES-1 outlines the reports prepared and used for this Study. Each report is summarized below and in Table ES-2. In addition, each report is provided as an attachment to this Executive Summary.

Table ES-1. Report Preparation Matrix

Attachment	Report Name	Prepared By:
Attachment A: Environmental Report	City of Woodinville Sustainable Development Project: R-1 Area Environmental Report	Steward & Associates and City of Woodinville
Attachment A: Appendix A	Hydrogeologic Analysis for City Of Woodinville Sustainable Development Program and Preliminary Assessment of Hillside Drainages Infiltration	Golder Associates, Inc.
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Attachment C: Transportation Report	Transportation, City of Woodinville	City of Woodinville Public Works Perteet Inc.
Attachment D: Capital Facilities and Utilities Report	Capital Facilities and Utilities in the R-1 Area	City of Woodinville Development Services Department
Attachment E: Moratorium Ordinances	Moratorium Ordinances 419, 424, and 427	City of Woodinville
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Environmental

Two critical areas in the R-1 zone appear to meet the *Litowitz* test that allows for lower densities in urban areas to protect large scope, complex and high rank order critical areas – Cold Creek and Lake Leota. These two critical areas are linked: the Lake Leota basin is the primary headwaters for Cold Creek. The outlet stream of Lake Leota is, in fact, Cold Creek, but for the majority of time the lake does not flow out through this stream, but instead discharges into groundwater, which reaches Cold Creek through seeps and springs to the east of the R-1 zone. Cold Creek's unusual reliance on groundwater is why it provides a steady flow of cold, clean water to the Bear Creek system downstream. Bear Creek is a large producer of naturally spawned salmon for a stream its size in western Washington, and, according to the Environmental Report, Cold Creek plays a very important role in that. The Lake Leota basin comprises approximately 40% of the entire R-1 zone (see Figure ES-2 for a map of drainage basins in the R-1 zone).

The Environmental Report (Attachment A) recommends that the **Lake Leota basin** is best suited for lower densities that preserve and protect Lake Leota and Cold Creek. For the most part, R-1 is expected to produce the best results. The report also mentions a number of other recommendations for the lake's protection, including stormwater and channel improvements upstream, continuance of the current no-engine rule for boats, best management practices for lakeside property owners and others in the wider lake basin, improvements in monitoring, and changes in how the lake's outlet is controlled. For the long-term, the Environmental Report recommends a lake management plan.

In the **School Basin**, which drains directly to Cold Creek and is immediately east of the Lake Leota Basin, the Environmental Report recommends extensive use of low-impact development regulations (LID) and improved mapping of streams and wetlands, to help protect the creek. The basin does not require the need for R-1 densities.

In the **Upper Woodin Creek Basin** in the southwestern portion of the R-1 zone, the Environmental Report identifies geologic hazard areas that require specific engineering and geotechnical protection. In addition and where appropriate, careful use of LID (which, if inappropriately constructed, could destabilize hazard areas) could provide beneficial effects. In the **Golf Course Basin,** and **the Hillside Drainages Basin**, which ultimately flow to Little Bear Creek, and in the Upper Woodin Creek Basin, the Environmental Report recommends tightlining stormwater in fuse-welded pipe (e.g. HDPE pipe) near geologic hazards to below areas of instability. The Environmental Report also includes a hydrogeologic modeling of a worst-case scenario to determine how the geologic hazards in both of these areas may be affected by stormwater infiltration and what setback would be required if the worst case actually existed. Such infiltration might provide benefits to Lake Leota but could increase potential threats to these hazards. The southwest portion of the Upper Woodin Creek basin has complex, steep terrain that would best be served by lesser density, but the upper flatter portion of the basin could allow for greater density. (See Figure ES-3 for a topography map based on LIDAR imaging; note that the red boundary identifies the areas of 15% slopes or greater.)

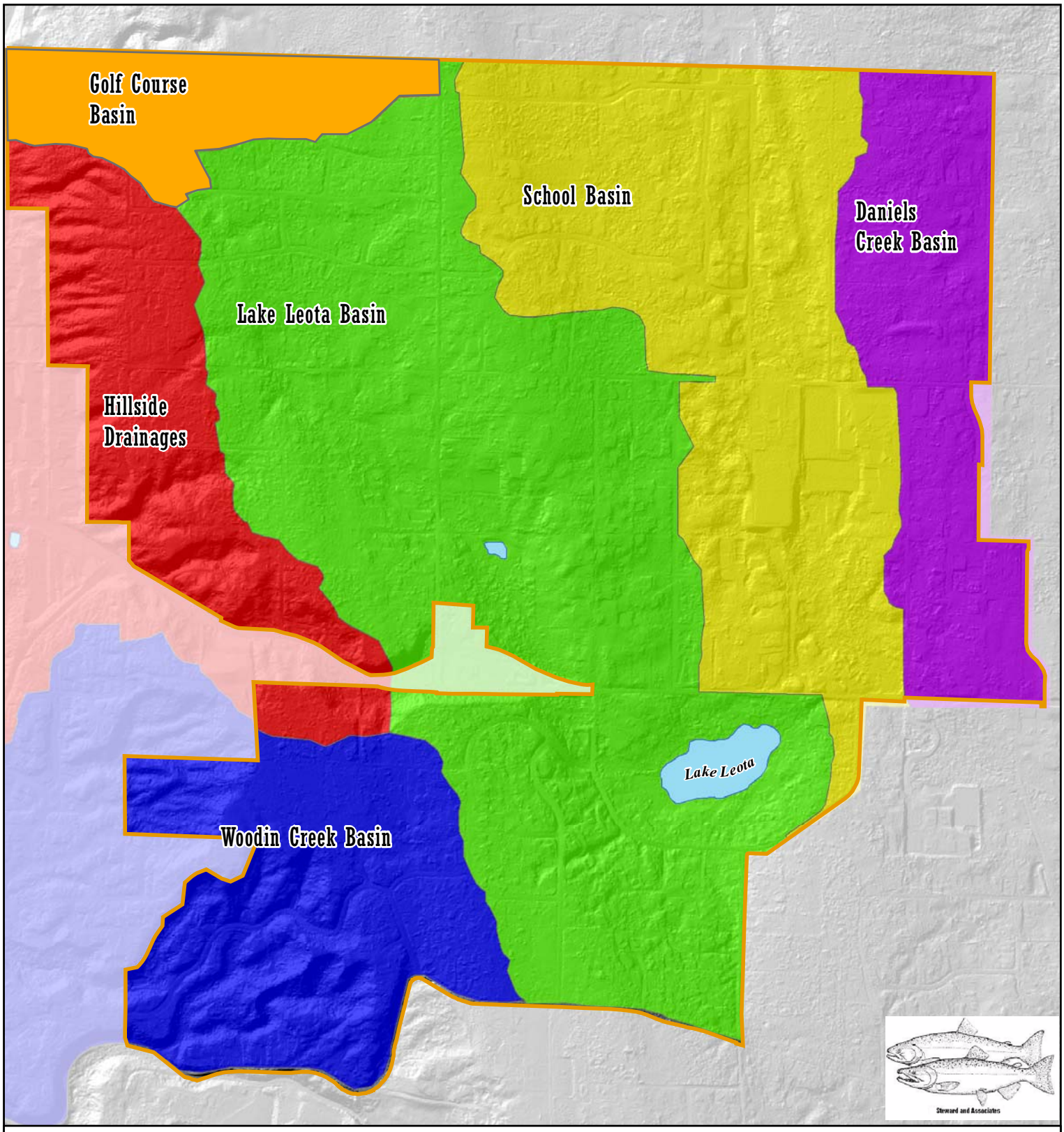

Figure ES-2. Woodinville Drainage Areas

Drainage areas

- Hillside Drainages
- School Basin
- Daniels Creek Basin
- Woodin Creek Basin
- Lake Leota Basin
- Golf Course Basin

- R-1 boundary
- Waterbodies

0 0.5 Miles

N W E S

1:13,500

City of Woodinville

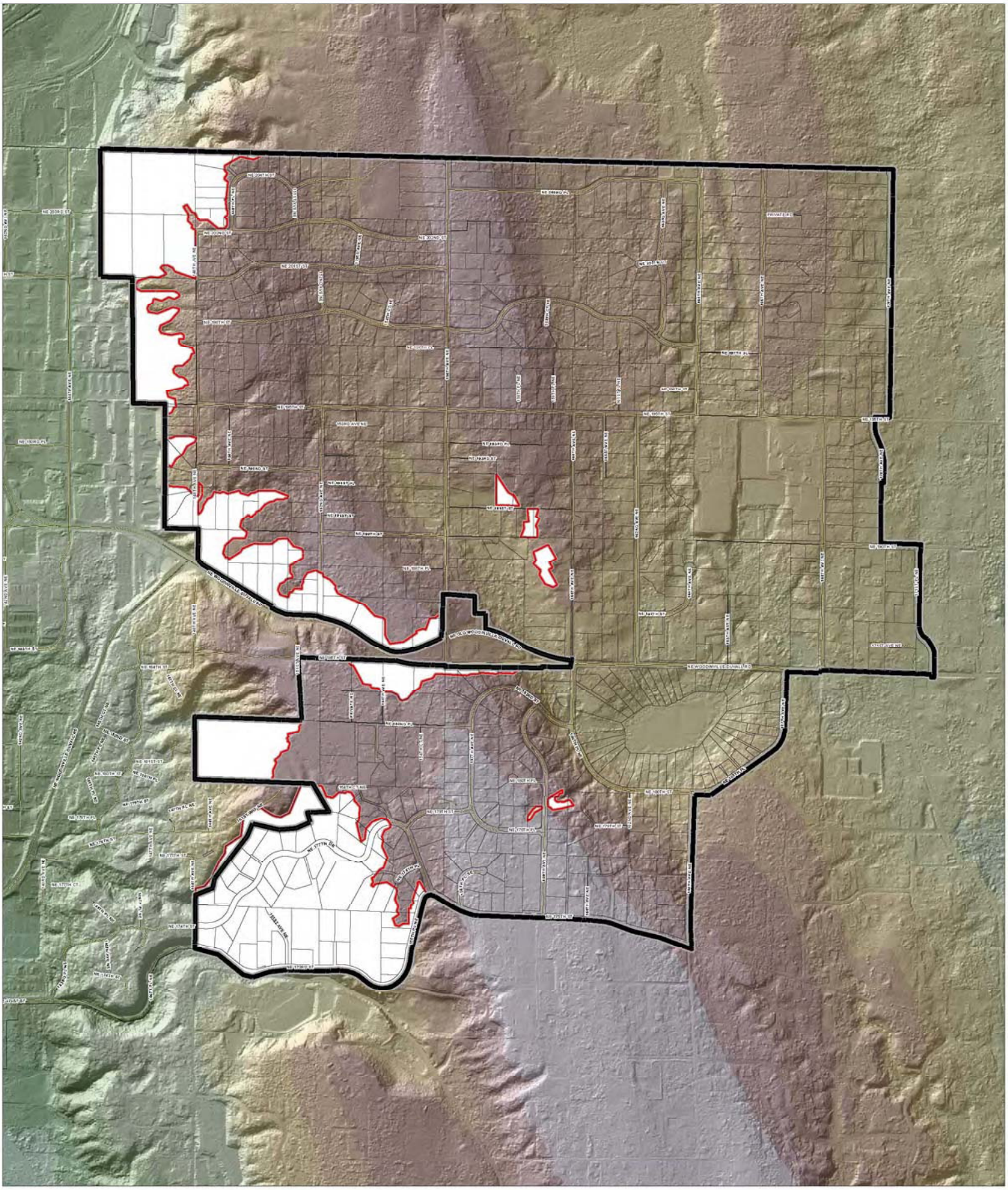

Figure ES-3. 2004 Topography of the City of Woodinville, Revision 2

Lidar Source: King County

Identifies Slopes Greater than 15% in R-1 Study Area

Based on environmental factors, the conclusions of this study differ for different areas of the R-1 zone, primarily because of complex patterns of surface water drainage and groundwater flow and the special needs to protect Leota Basin and Cold Creek that cannot be accomplished by the standard requirements of the city's Critical Areas Ordinance. The data collected for this study has been used to determine a broader planning level analysis that identifies whether or not different zoning densities could improve the protection of important critical areas in the city. Taking into account that individual developments are required to protect on-site critical areas such as streams, wetlands, steep slopes, aquifer recharge areas, and others by complying with the Woodinville Municipal Code, Critical Areas Ordinance, Chapter 21.24, the conclusions of this study determined that Lake Leota and Cold Creek required additional protection through decreased densities. In summary, the Environmental Report finds that one particular basin encompassing much of the R-1 zone area, the Lake Leota Basin, meets the CPSGMHB *Litowitz* criteria allowing for additional environmental protection through zoning densities. Other implementing development regulation measures are recommended in other basins to protect environmental quality.

Neighborhood Character

Based on urban design principles, 12 theoretical neighborhoods were identified and evaluated for distinct neighborhood characteristics in the "Neighborhood Character in the R-1 Zone Report" found in Attachment B. These conceptual neighborhoods are identified on Figure ES-4 and below:

- **Northwest Wellington.** The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns, and streets that together crisply define neighborhood boundaries.
- **Southwest Wellington.** Accessibility and lot configuration largely define this neighborhood. External access is limited, which makes for an enclave-like place. The wooded setting adds immensely to a sense of place.
- **North Wellington.** With few exceptions, this neighborhood is defined by its location in a physiographic plain and by the degree of road connectivity. External accessibility also defines boundaries and encloses the neighborhood.
- **Central Wellington.** There is only one major access into this neighborhood, NE 195th Street. Other minor roads connect from different directions and are closed off or dead end. Central Wellington is somewhat more defined by adjacent neighborhoods than it is unto itself.
- **South Wellington.** This area is commonly accessed off of 156th Avenue NE. It contains many unimproved or private roads that are the result of short plat activity. Its boundaries, similar to those of Central Wellington, are easily defined by adjacent neighborhoods.
- **Northeast Wellington.** This is a neighborhood defined primarily by the constricted nature of access. There is only one way in and one way out via 168th Avenue NE. It is further isolated by school property occupying the major portion of its southern extremity.

City of Woodinville

Sustainable Development Project

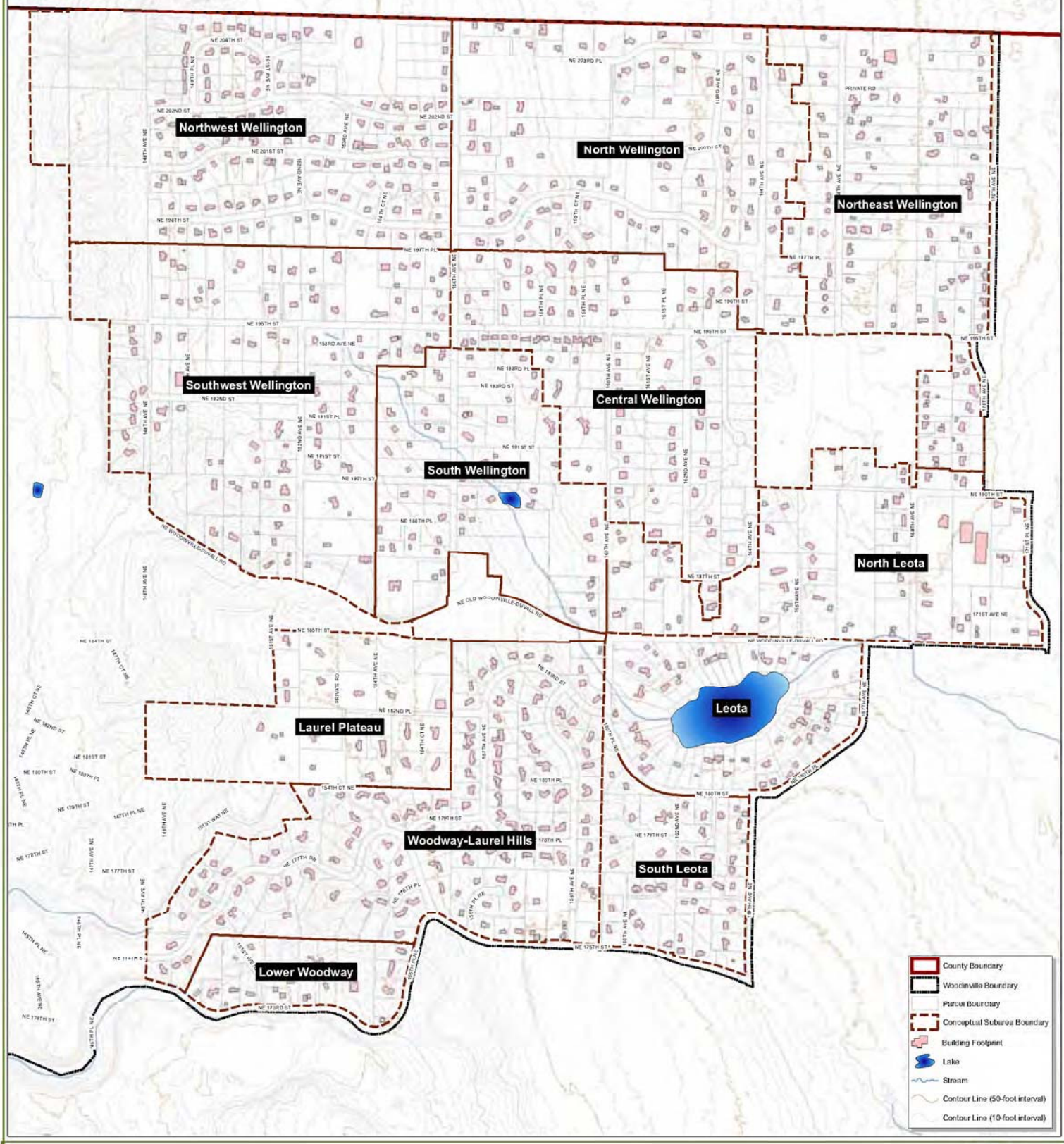

Figure ES-4. Conceptual Subareas

0 500 1,000
Feet

- **North Leota.** North Leota is characterized by its adjacency to Woodinville-Duvall Road and by its broad range of lot sizes. There is no connectivity in any sense of the term, but this neighborhood occupies the greatest extent of the Leota outwash plain niche.
- **Leota.** This neighborhood is the best defined in the study area. Common views, common access, lot configuration enclosure, and wooded nature make this one of Woodinville's most distinct places.
- **South Leota.** This is a well-defined neighborhood, all on an even grade, facing northeast, shaded in the afternoon, wooded slope. Political boundaries and transportation network provide strong elements to boundary definition.
- **Laurel Plateau.** Terrace-flat topography defines this neighborhood. Steep slopes and formal subdivision boundaries confine this area into one neighborhood.
- **Woodway-Laurel Hills.** This neighborhood predominantly consists of two formal subdivisions that have similar street networks and topography. Ridge and slope topography characterize its common physiographic niche, and its richly manicured landscape amidst tall woods creates a common definitive sense of place.
- **Lower Woodway.** This neighborhood located in the southwest fringe of the study area has common access off of NE 173rd Street. Steep slopes are common throughout. Its identity is defined by its adjacency to its neighbor and by its isolation because of topography and access limitations.

Each neighborhood was evaluated by methods of character identification that included visual surveys and overlay mapping iterations of human-made, physical, and environmental phenomena. See the Neighborhood Character Report (Attachment B) for details. This analysis was performed with the intent of identifying neighborhood character and validating its importance as a vital element in certain neighborhoods of Woodinville.

Based on the evaluation, the Neighborhood Character report identifies five neighborhoods with distinctive character that could be diminished if redevelopment occurred within them at different than existing densities, whether lower or higher:

- Northwest Wellington
- Southwest Wellington
- North Wellington
- Leota
- Woodway-Laurel Hills

These five neighborhoods were recommended to receive "neighborhood character recognition" through maintaining existing common density in the neighborhood. The neighborhood analysis concluded that neighborhood character has an important place along with environment, transportation, and capital facilities in the Woodinville R-1 Area.

Transportation

The R-1 study area was reviewed for transportation conditions; please see Attachment C. Results show the majority of the roadways within the R-1 zone were developed under King County prior to the City's incorporation. With the exception of newer roads constructed under the City's design requirements, the local streets in the R-1 zone do not meet the City's road cross-section standards. Under the Fire Department Access standard, requiring a minimum paved width of 20 feet, only a few short sections of roadways do not meet this standard.

Future road improvements, for the arterial and collector classified roads, have been identified in the City's long-range capital improvements program (CIP) and will be systematically reviewed and considered for improvements. It is likely improvements will be performed in several phases along each of these classifications of roadways and as need dictates and development warrants. On local streets, these are likely to occur under special projects (such as a special district for sidewalks) or under development mitigation.

The 156th Avenue NE corridor in the R-1 area was used to review operational projections for LOS at public road intersections. Using a very conservative traffic circulation model (with 50% of the existing R-1 zone redeveloping at a higher density, an annual growth of 2.5%, and assuming no road improvements) the analysis identified two intersections that would exceed the City's adopted LOS E by 2028. At both locations, the LOS could be brought back into compliance with widening improvements within the existing public right-of-way. The analysis assumptions included the Institute of Transportation Engineers (ITE) Trip Generation manual, 7th edition. It is an international guideline used by traffic engineers and other professionals who are responsible for meeting mobility and safety needs.

For vehicle capacity, both the City's "Low-Density" and "High-Density" road standards, provide the same vehicle trip capacity. If additional capacity were needed, due to physical restrictions within the roadway (such as the need to address a narrow road section), adequate right-of-way currently exists to allow for any needed improvement to address deficiencies.

Several local streets, and one minor arterial, have been identified with vertical sight distance conditions. These instances are under review by the City for possible mitigation measures. Road grades within the entire R-1 zone are all within the City's acceptable standards (under 15%).

Pedestrian and bike facilities are very limited within the entire R-1 zone area. Only Woodinville-Duvall Road has designated shared pedestrian and bike facilities along both sides of the roadway. Most of the developments following incorporation of the City (in 1993) do provide pedestrian facilities. However, these make up a very small portion of the R-1 zone. Of the remaining streets, it is estimated that less than 20% have any type of pedestrian facility and travel by non-motorized means must utilize the edge of the pavement or shoulder area.

In summary, transportation conditions can be mitigated under different densities, and transportation is not a distinguishing factor in the R-1 study. However, one area in the southwest portion of the Upper

Woodin Creek Basin, with particularly difficult terrain for transportation improvements, may be a candidate for less density (pers. com. Mick Monken, Public Works Director, January 19, 2007).

Capital Facilities

A range of capital facilities and services are evaluated in the Capital Facilities report (see Attachment D). Results are similar for all R-1 zoned areas for police and fire services, schools, and water services. Differences are found in relation to sewer services as described below.

- **Police and Fire Services.** Projected increases in housing units due to zoning ranging from R-1 to R-4 would not affect response time for the police and fire service providers. Population and housing increases may require additional personnel and facilities (vehicles), but response time is not expected by increases in density, unless access is restricted.
- **Schools.** Student populations are currently in the decline and an excess capacity exists in the R-1 area; therefore, increasing density would not create an effect on schools.
- **Water.** Increases in R-1 area zoning to R-4 over buildable parcels, would result in an increase in demand for 4,312 gallons per day in the entire study area, considered by Water District officials to have no major impact to the current capacity of supply or facilities.
- **Sewer.** The western portion of the R-1 zone has gravity access to the existing sewer facilities and is physically better suited for R-4 zoning. The eastern area of the basin is more difficult to serve due to severe grade changes that would involve pump stations and major expenses. The Capital Facilities report indicates that the eastern portion is better suited for lower densities only as it relates to sewer until such time as sewer facility economics becomes feasible. Figure ES-5 identifies the "break" between the areas more easily sewered than those areas less easily sewered at the present time.

Overlay of All Study Topics

Based on each individual study topic, the following results were found:

- **Environmental:** Two critical areas in the R-1 zone appear to meet the *Litowitz* test that allows for lower densities in urban areas to protect large scope, complex and high rank order critical areas – Cold Creek and Lake Leota. These two critical areas are linked: the Lake Leota basin is the primary headwaters for Cold Creek. Applying these environmental study results alone, this would mean that R-1 zoning is an appropriate application in the Lake Leota Basin in addition to existing critical areas regulations. Other implementing development regulation measures are recommended in other basins to protect environmental quality. The Lake Leota basin appears on Figure ES-2 in green shading, and is also identified in Figure ES-6. A zoning option that focuses on the environmental results alone is presented later in this report – Figure ES-8 illustrates R-1 zoning for the Lake Leota Basin. See Attachment A for more information.

City of Woodinville

Sustainable Development Project

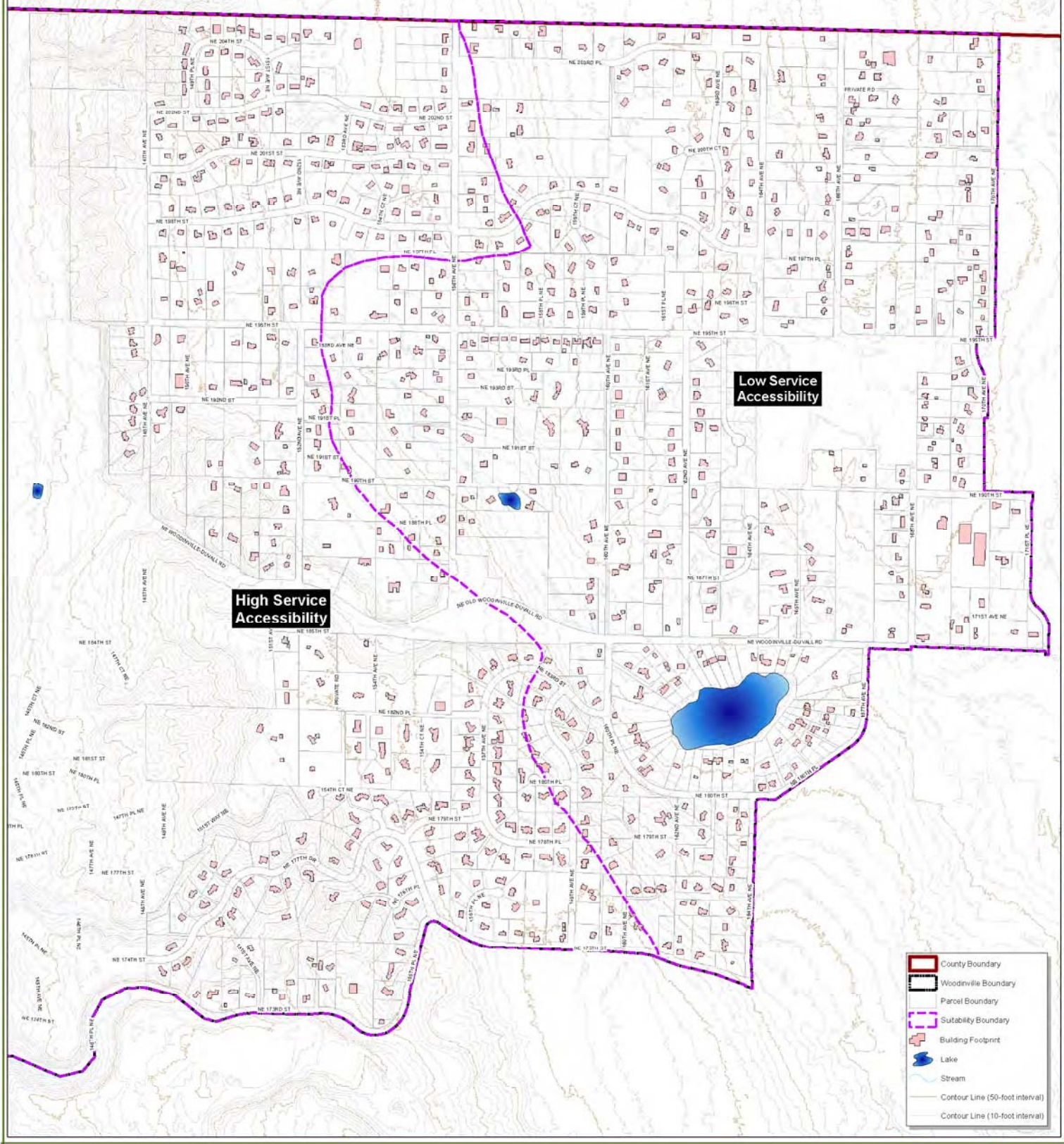

Figure ES-5

Sewer Service Accessibility

- **Neighborhood Character:** Based on the evaluation, the Neighborhood Character report identifies five neighborhoods with distinctive character that could be diminished if redevelopment occurred within them at different than existing densities, whether lower or higher: Northwest Wellington; Southwest Wellington; North Wellington; Leota; and Woodway-Laurel Hills. These five neighborhoods were recommended to receive "neighborhood character recognition" through maintaining existing common density in the neighborhood. These neighborhoods are identified on Figure ES-4 as well as highlighted on Figure ES-6. If considering the Neighborhood Character analysis by itself, the densities that would help maintain existing common density patterns vary in the five neighborhoods from R-1, R-2 and R-3. See Attachment B, Figure 19, for more information.
- **Transportation:** Transportation conditions can be mitigated under different densities, and transportation is not a distinguishing factor in the R-1 study. However, one area in the southwest portion of the Upper Woodin Creek Basin, with particularly difficult terrain for transportation improvements, may be a candidate for less density. Figure ES-6 illustrates the portion of the Upper Woodin Creek Basin where the slope system would likely inhibit more transportation improvements.
- **Capital Facilities:** Generally, public safety (police and fire services), school services, and water services can accommodate additional growth under R-1 or R-4 densities. The western portion of the R-1 zone has gravity access to the existing sewer facilities and is physically better suited for R-4 zoning. The eastern area of the basin is more difficult to serve due to severe grade changes that would involve pump stations and major expenses. The Capital Facilities report indicates that the eastern portion is better suited for lower densities only as it relates to sewer until such time as sewer facility economics becomes feasible. Figure ES-5 identifies the "break" between the areas more easily sewered than those areas less easily sewered at the present time. Figure ES-6 also shows sewer accessibility in conjunction with the other environmental, neighborhood, and transportation conclusions.

Figure ES-6 presents an overlay map showing environmental basins, neighborhood subareas identified as having high character, an area where future transportation improvements would be more difficult due to complex steep slopes, and areas where sewer service is more or less accessible. The zoning options presented below emphasize one or more of the four topics – environmental, neighborhood character, transportation, and capital facilities.

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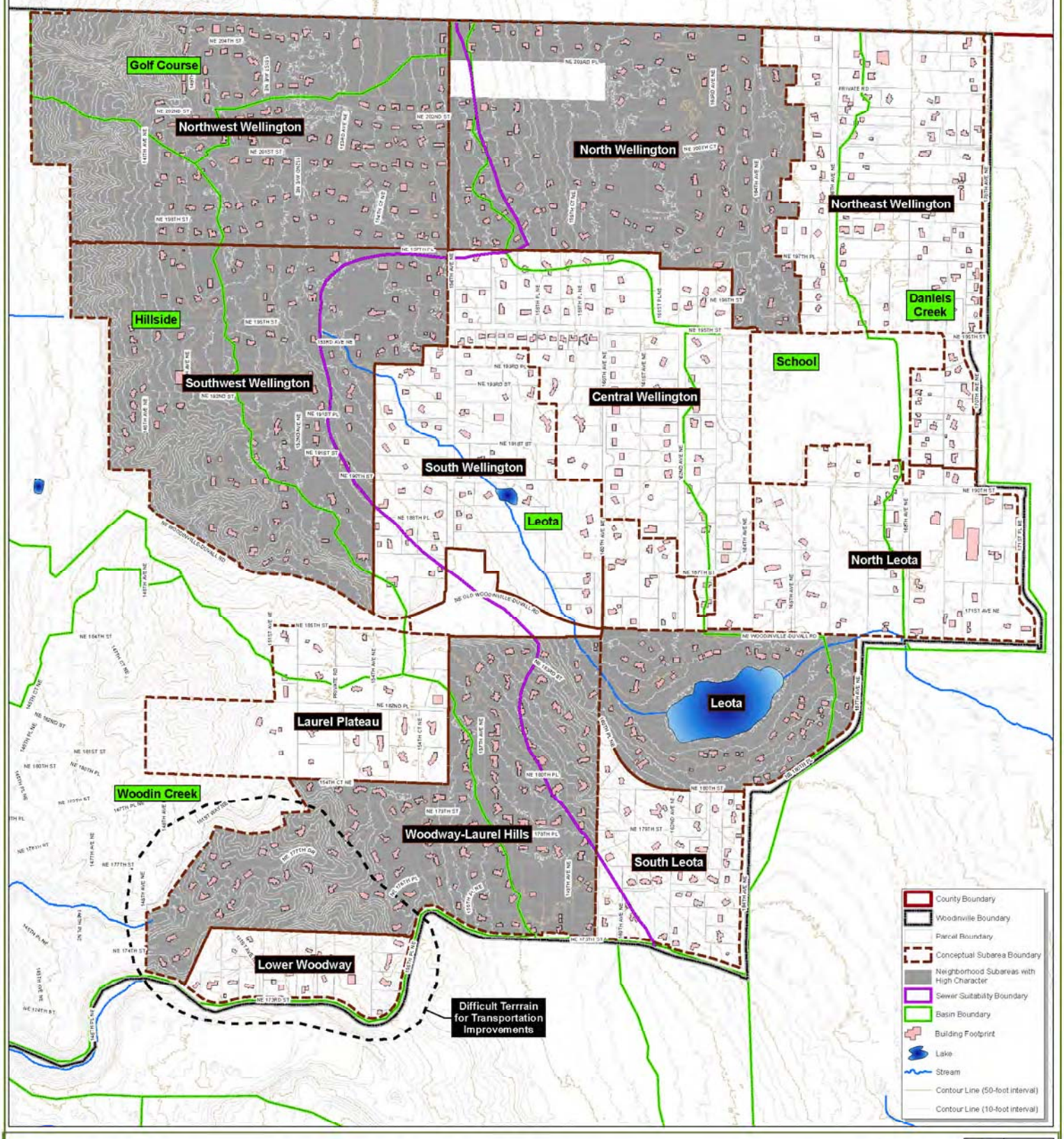

Figure ES-6. Composite Basin, Neighborhood Subarea, Transportation and Sewer Suitability Map

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Feet

Table ES-2. Sustainable Development Report Summary Matrix

Location/Boundary	Environmental	Neighborhood Character	Transportation	Capital Facilities	Summary
Lake Leota Basin	Conclusions: ▪ R-1 zoning provides substantial, long-term environmental benefits not solely achieved by requirements of the Critical Areas Ordinance. ▪ Even if increased density is necessary to provide sewer service, there would be a net environmental benefit directly surrounding the lake. ▪ Require Low-Impact Development (LID) as part of stormwater regulations throughout basin. LID performs best at lower densities. Technical Findings: ▪ Lake Leota and Cold Creek meet *Litowitz* criteria; lake is part of Cold Creek headwaters which flows to Bear Creek, high spawning tributary in Western Washington. ▪ Lake is at risk of accelerating eutrophication; which would worsen with increased development density. ▪ Lake is growing shallower, becoming more polluted. ▪ Trends pose long-term risks to Cold Creek, Bear Creek system. ▪ Goal: minimize eroded sediments from stormwater entering lake. ▪ Reducing net nutrient inputs by replacing septic systems directly adjacent/around lake with sewer would probably be positive even if accompanied by other impacts on water quality from increased density. ▪ Septic systems should be upgraded to increase nutrient removal. ▪ Limited Steep Slopes – per mapping ▪ Wildlife – no protected species documented, many birds and mammals exist in an urban setting.	Contains all or part of the following conceptual neighborhood sub-areas: ▪ Northwest Wellington ◄ ▪ Southwest Wellington ◄ ▪ North Wellington ◄ ▪ Central Wellington ▪ South Wellington ▪ Leota ◄ ▪ South Leota ▪ Woodway-Laurel Hills ◄ ◄= identified for neighborhood character recognition through zoning measures A description of the sub-areas follows: ▪ Northwest Wellington: The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns, and streets that together crisply define neighborhood boundaries. ▪ Southwest Wellington: Accessibility and lot configuration largely define this neighborhood. External access is limited, which makes for an enclave-like place. The wooded setting adds immensely to a sense of place. ▪ North Wellington: With few exceptions, this neighborhood is defined by its location in a physiographic plain and by the degree of road connectivity. External accessibility also defines boundaries and encloses the neighborhood. ▪ Central Wellington: There is only one major access into this neighborhood, NE 195th Street. Other minor roads connect from different directions and are closed off or dead ends. Central Wellington is somewhat more defined by adjacent neighborhoods than it is unto itself. ▪ South Wellington: This area is commonly accessed off of 156th Avenue NE. It contains many unimproved or private roads that are the result of short plat activity. Its boundaries, similar to those of Central Wellington, are easily defined by adjacent neighborhoods. ▪ Leota: This neighborhood is the best defined in the study area. Common views, common access, lot configuration enclosure, and wooded nature make this one of Woodinville's most distinct places. ▪ South Leota: This is a well-defined neighborhood, all on a hillside grade, facing northeast, shaded in the afternoon, wooded slope. Political boundaries and transportation network provide strong elements to boundary definition. ▪ Woodway-Laurel Hills: This neighborhood predominantly consists of two formal subdivisions that have similar street networks and topography. Ridge and slope topography characterize its common physiographic niche, and its richly manicured landscape amidst tall woods creates a common definitive sense of place.	▪ **North of NE Woodinville-Duvall Road (System A):** Roads have asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The layout is typically long block sections with some gentle curves. Only a very small portion of streets in this area have curb and gutter or sidewalk sections. Internal circulation is possible in the northwesterly and northeasterly neighborhoods. Some vertical sight distance conditions have been identified in this area in the northwesterly neighborhoods. ▪ **South of NE Woodinville-Duvall Road (System C):** The general characteristics of these roads are asphalt pavement with some areas of paved shoulders along one side and a mixture of open ditch or open shoulder drainage. No streets were identified in this area to have curb and gutter of sidewalk sections. Internal circulation is fair. No sight distance concerns have been identified in this area. ▪ **Intersection Levels of Service 156th Ave NE:** 156th Avenue NE at NE 198th Street and NE 195th Street would exceed adopted levels of service. However, it is likely that the LOS can be improved by the addition of turn lanes on both the arterial and local roadways and/or by the installation of a traffic control device such as a 4 way stop. Both NE 195th and NE 198th have sufficient right-of-way to allow for the lane widening.	▪ The western edge of the Lake Leota Basin has gravity access to the existing sewer facilities and may be physically suitable for R-4 zoning. ▪ The eastern area of the basin is more difficult to sewer due its location, which would involve pump stations and major expense. The eastern portion should remain at R-1, until such time as sewer facility economics become feasible.	▪ R-1 zoning appropriate for environmental protection, and meets *Litowitz* test. ▪ Five neighborhoods have high commonality and are recommended for neighborhood character recognition; the dominant density in these neighborhoods would be kept consistent. ▪ Transportation system would be somewhat impacted with higher density, but can be mitigated. Neutral issue for zoning. ▪ Western edge of basin has greater ability to be sewered at R-4 densities due to gravity flow.

Location/Boundary	Environmental	Neighborhood Character	Transportation	Capital Facilities	Summary
School Basin	Conclusions: ▪ R-1 zoning benefits Cold Creek, but with minimal effect on its most important attributes; maintaining low density in this part of R-1 Zone is not as important as in Lake Leota Basin. ▪ R-4 could have negative impact without LID. ▪ Emphasis in this area is requiring LID through stormwater performance standards for new development. This provides greatest benefit at lower densities but, ironically, they may be more important at higher densities, where the potential impacts to downstream resources would be greater without such extra effort. Technical Findings: ▪ Surface water from basin drains to Cold Creek; provides relatively small contribution to Cold Creek flows. ▪ Groundwater drains west, bypassing Cold Creek. ▪ Stormwater impacts have little effect on contribution of cold, steady summer flows downstream. ▪ Cold Creek remains important system to protect in its own right, supporting five salmon species. ▪ Limited Steep Slopes – per mapping ▪ Wildlife – no protected species documented, many birds and mammals exist in an urban setting.	Contains all or part of the following conceptual neighborhood sub-areas: ▪ North Wellington ◄ ▪ Northeast Wellington ▪ Central Wellington ▪ North Leota ◄= identified for neighborhood character recognition through zoning measures A description of the sub-areas follows: ▪ North Wellington: With few exceptions, this neighborhood is defined by its location in a physiographic plain and by the degree of road connectivity. External accessibility also defines boundaries and encloses the neighborhood. ▪ Northeast Wellington: This is a neighborhood defined primarily by the constricted nature of access. There is only one way in and one way out via 168th Avenue NE. It is further isolated by school property occupying the major portion of its southern extremity. ▪ Central Wellington: There is only one major access into this neighborhood, NE 195th Street. Other minor roads connect from different directions and are closed off or dead ends. Central Wellington is somewhat more defined by adjacent neighborhoods than it is unto itself. ▪ North Leota: North Leota is characterized by its adjacency to Woodinville-Duvall Road and by its broad range of lot sizes. There is no connectivity in any sense of the term, but this neighborhood occupies the greatest extent of the Leota outwash plain niche.	▪ **North of NE Woodinville-Duvall Road (System A):** Roads have asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The layout is typically long block sections with some gentle curves. Only a very small portion of streets in this area has curb and gutter or sidewalk sections. Internal circulation is possible in the northeasterly neighborhoods including part of the School Basin area.	▪ The basin is more difficult to sewer due to its location, which would involve pump stations at major expense.	▪ R-4 possible with environmental mitigation such as stormwater management. ▪ R-2 appropriate for neighborhood character recognition in North Wellington; a range of R densities (2 to 4) identified in other sub-areas. ▪ Lesser transportation network exists, but standards in place for development will address growth at any level including R-4. Neutral issue for zoning. ▪ Grade change and associated sewer cost limit higher densities at this time.
Daniels Creek Basin	Conclusions: ▪ R-1 zoning provides minor benefits to Daniels Creek, minimal benefits to Bear Creek system. ▪ LID would provide some benefit, but lower priority than elsewhere. Technical Findings: ▪ Surface water from area is small part of Daniels Creek basin; groundwater drains to west. ▪ Cottage Lake attenuates impact of Daniels Creek Basin on rest of Bear Creek system. ▪ Limited Steep Slopes – per mapping ▪ Wildlife – no protected species documented, many birds and mammals exist in an urban setting.	Contains all or part of the following conceptual neighborhood sub-areas: ▪ Northeast Wellington ▪ North Leota ◄= identified for neighborhood character recognition through zoning measures A description of the sub-areas follows: ▪ Northeast Wellington: This is a neighborhood defined primarily by the constricted nature of access. There is only one way in and one way out via 168th Avenue NE. It is further isolated by school property occupying the major portion of its southern extremity. ▪ North Leota: North Leota is characterized by its adjacency to Woodinville-Duvall Road and by its broad range of lot sizes. There is no connectivity in any sense of the term, but this neighborhood occupies the greatest extent of the Leota outwash plain niche.	▪ **North of NE Woodinville-Duvall Road, East of 164th Avenue NE (System B):** The general characteristics of these roads are asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The layout is typically long straight aligned block sections. Only a very small portion of streets in this area has curb and gutter or sidewalk sections. Internal circulation is possible but is poor as there is only one route possible in all cases without having to enter onto a major arterial. One vertical sight distance concern has been identified in this area.	▪ The basin is more difficult to sewer due to its location, which would involve pump stations at major expense. The area should remain at R-1, until such time as sewer facility economics becomes feasible.	▪ R-4 possible with environmental mitigation. ▪ No conceptual neighborhood sub-areas identified for neighborhood character recognition; R-4 density possible. ▪ More limited access options, but internal circulation possible including R-4. Neutral issue for zoning. ▪ Grade change and associated sewer cost limit higher densities at this time.

Location/Boundary	Environmental	Neighborhood Character	Transportation	Capital Facilities	Summary
Upper Woodin Creek Basin	Conclusions: ▪ R-1 zoning provides some protection to geologic hazards, minor benefits to Woodin Creek. ▪ Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of stormwater. ▪ Infiltration near slopes would threaten geologic hazard areas. ▪ Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination. ▪ LID would provide some downstream benefit to Woodin Creek, but infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. Technical Findings: ▪ Woodin Creek probably does not meet *Litowitz* criteria, especially above fish blockages. ▪ R-1 area is relatively small part of basin. ▪ Native Growth Protection Easements (NGPEs) provide valuable protection that remains regardless of zoning. ▪ Geologic hazards are common and significant. ▪ HDPE fuse-welded tightlines and tanks or vaults, not ponds, should be adequate to protect slopes from adjacent stormwater. ▪ Groundwater surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards; infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. ▪ Large underdeveloped parcel may have geologic hazards and wetland, is headwaters of North Tributary. ▪ Wildlife – no protected species documented, many birds and mammals exist in an urban setting.	Contains all or part of the following conceptual neighborhood sub-areas: ▪ Laurel Plateau ▪ Woodway-Laurel Hills ◄ ▪ Lower Woodway ◄ = identified for neighborhood character recognition through zoning measures A description of the sub-areas follows: ▪ Laurel Plateau: Terrace-flat topography defines this neighborhood. Steep slopes and formal subdivision boundaries confine this area into one neighborhood. ▪ Woodway-Laurel Hills: This neighborhood predominantly consists of two formal subdivisions that have similar street networks and topography. Ridge and slope topography characterize its common physiographic niche, and its richly manicured landscape amidst tall woods creates a common definitive sense of place. ▪ Lower Woodway: This neighborhood located in the southwest fringe of the study area has common access off of NE 173rd Street. Steep slopes are common throughout. Its identity is defined by its adjacency to its neighbor and by its isolation because of topography and access limitations.	▪ **South of NE Woodinville-Duvall Road (System C):** The general characteristics of these roads are asphalt pavement with some areas of paved shoulders along one side and a mixture of open ditch or open shoulder drainage. The terrain has gentle to moderate (hill slope) grade changes. Some grades in this section appear to be at the 15% grade slope standard. The layout is typically long block sections with gentle to moderate curve sections. No streets were identified in this area to have curb and gutter of sidewalk sections. Internal circulation is fair. No sight distance concerns have been identified in this area. ▪ **Southwest portion of basin:** One area in the southwest portion of the Upper Woodin Creek Basin, with particularly difficult terrain for transportation improvements, may be a candidate for less density due to sloped terrain adjacent to the roadway making it less feasible to be improved.	▪ The basin has gravity access to the existing sewer facilities and may be physically suitable for R-4 zoning.	▪ R-4 possible with environmental mitigation. ▪ R-2 appropriate for neighborhood character recognition in Woodway-Laurel Hills; up to R-4 possible in other sub-areas. ▪ Except in southwest part of basin, lesser transportation network exists, but standards in place for development will address growth at any level including R-4. The southwest portion of basin, with particularly difficult terrain for transportation improvements, may be a candidate for less density. ▪ Basin has greater ability to be sewered at R-4 densities.
Hillside Drainages	Conclusions: ▪ R-1 zoning provides some protection to geologic hazards, minor benefits to Little Bear Creek. ▪ Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of stormwater. ▪ Infiltration near slopes would threaten geologic hazard areas. ▪ Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination. ▪ LID would provide some downstream benefit to Little Bear Creek, but infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city; ▪ Other forms of LID still encouraged. Technical Findings: ▪ Hillside Drainages are relatively small part of Little Bear Creek basin flows. ▪ HDPE tightlines would be adequate to protect slopes from adjacent stormwater. ▪ Groundwater or perched water surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards. ▪ Along the northwestern portion of the basin, a large undeveloped	Contains all or part of the following conceptual neighborhood sub-areas: ▪ Northwest Wellington ◄ ▪ Southwest Wellington ◄ ◄ = identified for neighborhood character recognition through zoning measures. A description of the sub-areas follows: ▪ Northwest Wellington: The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns, and streets that together crisply define neighborhood boundaries. ▪ Southwest Wellington: Accessibility and lot configuration largely define this neighborhood. External access is limited, which makes for an enclave-like place. The wooded setting adds immensely to a sense of place.	▪ **North of NE Woodinville-Duvall Road (System A):** Roads have asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The layout is typically long block sections with some gentle curves. Only a very small portion of streets in this area has curb and gutter or sidewalk sections. Internal circulation is possible in the northwesterly neighborhoods. Some vertical sight distance conditions have been identified in this area in the northwesterly neighborhoods	▪ Majority has gravity access to the existing sewer system facilities and may be physically suitable for R-4 zoning.	▪ R-4 possible with environmental mitigation. ▪ R-1 and R-2 appropriate for neighborhood character recognition in Northwest and Southwest Wellington. ▪ Lesser transportation network exists, but standards in place for development will address growth at any level including R-4. Neutral issue for zoning. ▪ Basin has greater ability to be sewered at R-4 densities.

Location/Boundary	Environmental	Neighborhood Character	Transportation	Capital Facilities	Summary
	forested hillslope runs north-south, connecting to a large vegetated area in the adjacent golf course to the north and an industrial area below. Although there are no documented protected species (threatened, endangered) in this area, the area provides a place for urban species to forage, nest, drink and move into adjacent open areas. Pileated woodpeckers are a "State Candidate" species without specific or designated protection, and are not expected to be impacted by future development. The industrial area and highway, limit the ability to support wildlife species that are not tolerant of substantial human disturbance.				
Golf Course Basin	Conclusions: ▪ R-1 zoning provides some protection to geologic hazards, minor benefits to Little Bear Creek, helps minimize erosion in Golf Course Creek; ▪ Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of stormwater; ▪ Infiltration near slopes would threaten geologic hazard areas; ▪ Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination; ▪ LID, especially in headwaters of basin, could provide significant benefits to Golf Course creek; infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. Technical Findings ▪ Golf Course Basin is relatively small part of Little Bear Creek basin flows. ▪ HDPE tightlines would be adequate to protect slopes from adjacent stormwater. ▪ Groundwater or perched water surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards. ▪ Golf Course creek may be perennial, provides important source of water for wildlife in area. ▪ Golf Course creek carries high sediment load from eroding ravine, which could be exacerbated by development in headwaters area without stormwater management focused on minimizing erosive discharges.	Contains all or part of the following conceptual neighborhood sub-areas: ▪ Northwest Wellington ◄ ◄ = identified for neighborhood character recognition through zoning measures. A description of the sub-areas follows: ▪ Northwest Wellington: The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns, and streets that together crisply define neighborhood boundaries.	▪ **North of NE Woodinville-Duvall Road (System A):** Roads have asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The layout is typically long block sections with some gentle curves. Only a very small portion of streets in this area has curb and gutter or sidewalk sections. Internal circulation is possible in the northwesterly neighborhoods. Some vertical sight distance conditions have been identified in this area in the northwesterly neighborhoods	▪ Area has gravity access to the existing sewer system facilities and may be physically suitable for R-4 zoning.	▪ R-4 possible with environmental mitigation. ▪ R-1 and R-2 appropriate for neighborhood character recognition in Northwest and Southwest Wellington. ▪ Lesser transportation network exists, but standards in place for development will address growth at any level including R-4. Neutral issue for zoning. ▪ Basin has greater ability to be sewered at R-4 densities.

Location/Boundary	Environmental	Neighborhood Character	Transportation	Capital Facilities	Summary
Multiple Basins	▪ No wetlands in the R-1 zone are of a high rank order; few, if any, could be argued to be large in scope or complex in structure and function. ▪ No stream within the R-1 zone beside Cold Creek is of a high rank order. Woodin Creek, while arguably large in scope (at least within the City's jurisdiction) and complex in structure and function, does not support fish in the R-1 zone and supports very few spawning salmon downstream. ▪ Increased density in the R-1 zone would likely have only small impacts on all affected streams beside Cold Creek. These impacts could be further minimized by appropriate stormwater management and mitigation. The portions of the R-1 zone that drain to these other streams (including Little Bear Creek, Woodin Creek, and Daniels Creek—an upper tributary of the Bear Creek system) is small relative to their overall basins. Moreover, existing NGPEs in the upper basin of the stream most potentially impacted, Woodin Creek, would significantly reduce potential downstream impacts. ▪ Protection of geologically hazardous areas in and adjacent to the R-1 zone depends primarily on proper development practices and stormwater management, not maintenance of R-1 zoning. ▪ To the extent that critical aquifer recharge areas within the R-1 zone are threatened by contamination, the greatest current threat is from inadequate or poorly maintained septic systems. This threat would increase with more dense development on septic systems, but would decrease or be eliminated by development accompanied by sewers serving new and existing development.\ ▪ Wildlife – no protected species documented, many birds and mammals exist in an urban setting.		▪ The majority of the roadways within the R-1 zone were developed under King County development standards prior to the City's incorporation. With the exception of newer roads constructed under the City's design requirements, the local streets in the R-1 zone do not meet the City's road cross-section standards. ▪ Under the Fire Department Access standard, requiring a minimum paved width of 20 feet, only a few short sections of roadways do not meet this standard. ▪ Future road improvements, for the arterial and collector classified roads, have been identified in the City's long range Capital Improvement Program and will be systematically reviewed and considered for improvements. ▪ On local streets, improvements are likely to occur under special projects (such as a special district for sidewalks) or under development mitigation. ▪ Two intersections on 156th Street would exceed the City's adopted LOS E by 2028 assuming R-4 development levels (conservative estimates). At both locations, the LOS can be brought back into compliance with widening improvements within the existing public right-of-way. ▪ In regard to vehicle capacity, both the City's "Low Density" and "High Density" road cross-section standard provide the same vehicle trip capacity. If additional capacity were needed, due to physical restrictions within the roadway, such as the need to address a narrow road section, adequate right-of-way current exists to allow for any needed improvement to address any deficiencies. ▪ Several local streets, and one minor arterial have been identified with vertical sight distance condition. These are currently being taken under review by the City for possible mitigation measures. ▪ Road grades within the entire R-1 zone are all within the City's acceptable standards (under 15%). ▪ Pedestrian and bike facilities are very limited within the entire R-1 zone area. Only Woodinville-Duvall Road has designated shared pedestrian and bike facilities along both sides of the roadway. Most of the developments following incorporation of the City (in 1993) do provide pedestrian facilities. However, these make up a very small portion of the R-1 zone. Of the remaining streets, it is estimate that less than 20% have any type of pedestrian facility and travel by non-motorize means must use the edge of the pavement or shoulder area.	▪ Police and Fire Services: projected increases in housing units due to zoning changes from R-1 to R-4 would not affect response time for the department. Population and housing increases may require additional personnel and facilities (vehicles), but response time is not usually affected by increases in density, unless access is restricted. ▪ Schools: Suitability for R-4, due, in part, to minor projections in student population that may result from R-4 density increases in the R-1 area, and due to the District's ability to charge impact fees. ▪ Water: Increases in R-1 area zoning to R-4 over buildable parcels, would result in an increase in demand for 4,312 gallons per day in the entire study area, considered by Water District officials to have no major impact to the current capacity of supply or facilities.	

Density Options

Based on the environmental, neighborhood character, transportation, and capital facilities reports, a range of zoning options for the R-1 study area were prepared for Planning Commission, City Council, and public review:

- R-1 Only – Retains existing R-1 zoning for entire study area without the option for R-4 (or could have option R1(a): No Action with allowance for rezone to R-4);
- R- *Litowitz* (Based on current Growth Management Hearings Board Decisions) – Retain R-1 zoning only for the Lake Leota Basin. R-4 zoning surrounding Leota drainage basin;
- R- Multiple Factors – Combination of R-1, R-2 and R-4 zoning based upon the combination of the *Litowitz* test, neighborhood character analysis to ensure the vitality and character of existing residential areas, transportation and capital facilities; and
- R-4 Only – R-4 zoning for the entire study area.

Figures 7 through 10 present the options. A summary of the effects of each option is provided in Table ES-3. Each option considers the four study topics differently as described in the table.

After a Planning Commission public hearing on January 31 and February 14, 2007, the Planning Commission recommended that R-1 be retained in the study area and that development regulations be considered regarding infill development, including but not limited to, density transfers to downtown, and shadow platting to ensure the ability to develop to greater densities in the future if warranted. The City Council will consider the Planning Commission recommendations together with the above options at public meetings and a hearing as well.

City of Woodinville

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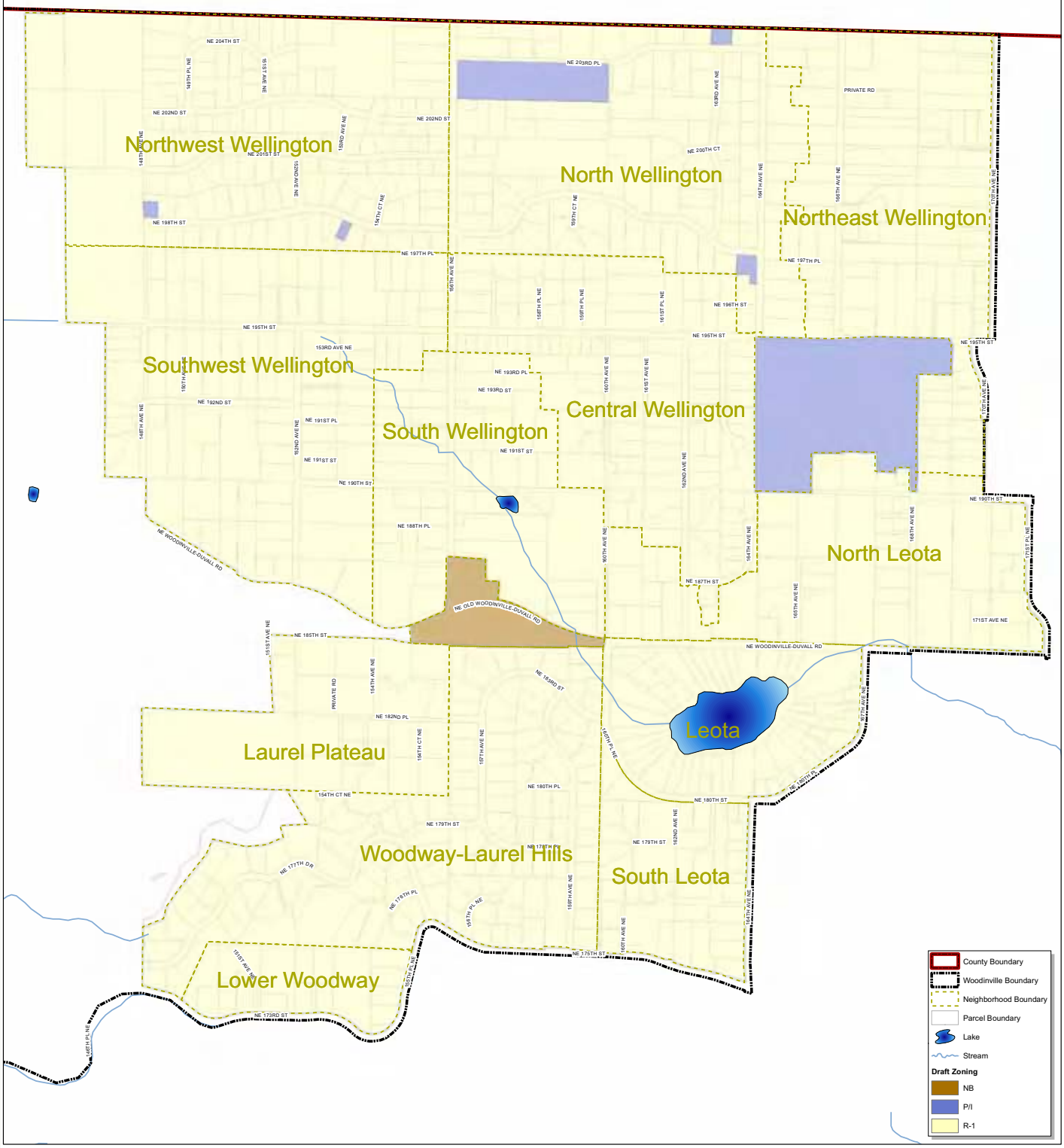

Figure ES-7. Zoning Option 1
All R-1

0 500 1,000
Feet

City of Woodinville
17301 - 133rd Ave NE
Woodinville, WA 98072
www.woodinville.wa.us
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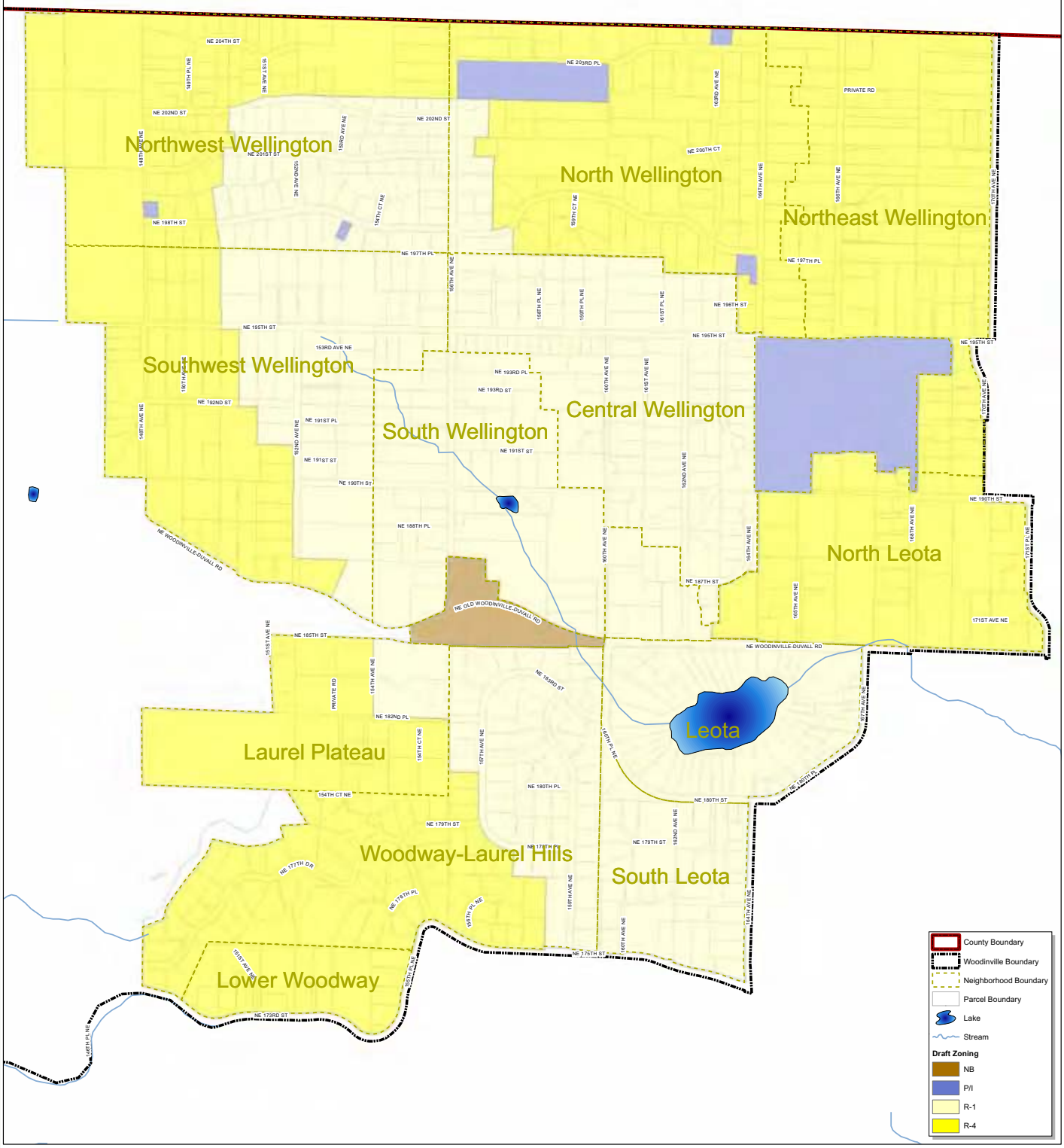

Figure ES-8. Zoning Option 2
R-Litowitz

0 500 1,000
Feet

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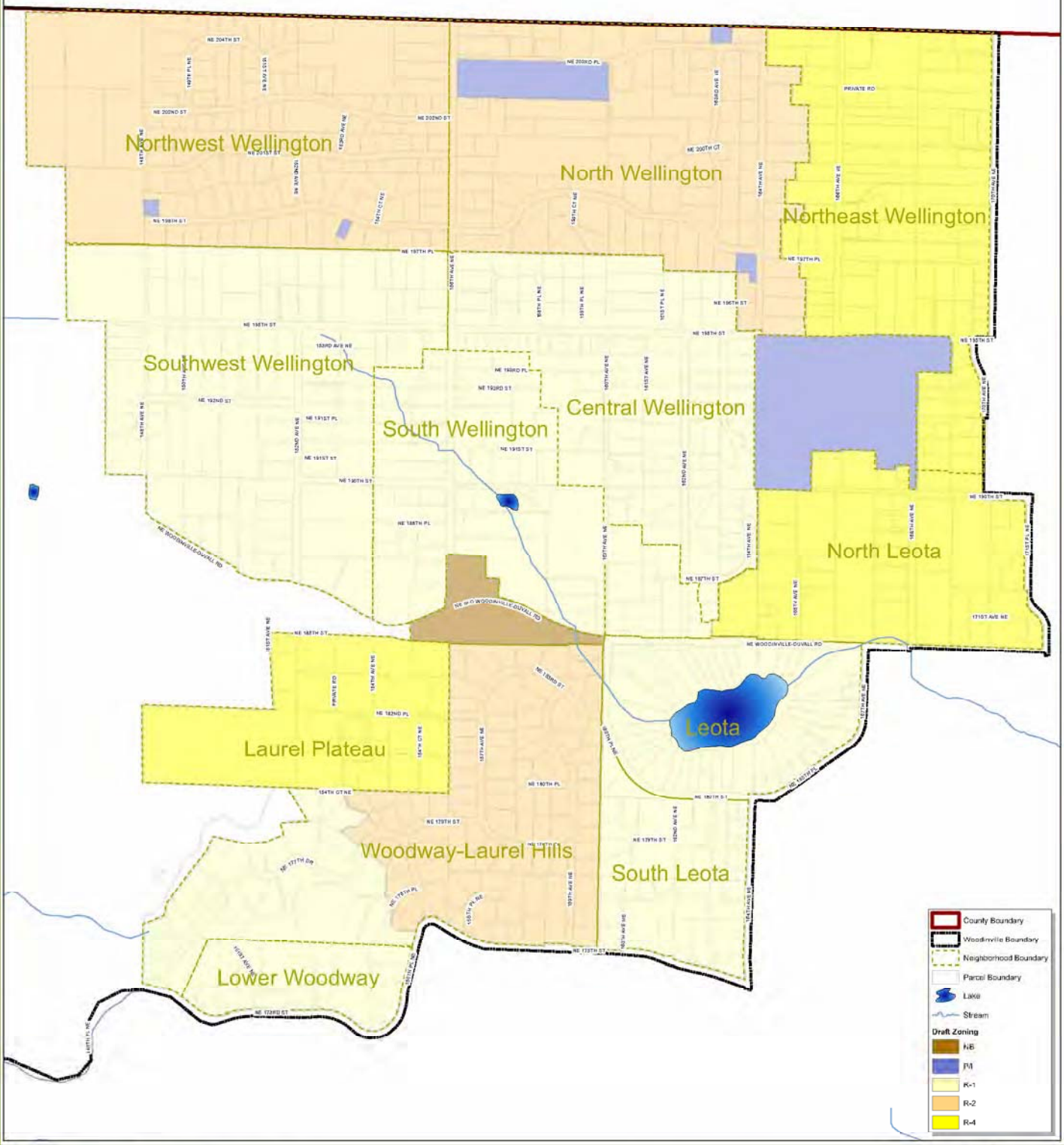

Figure ES-9. Zoning Option 3
R-Multiple Factors

0 500 1,000
Feet

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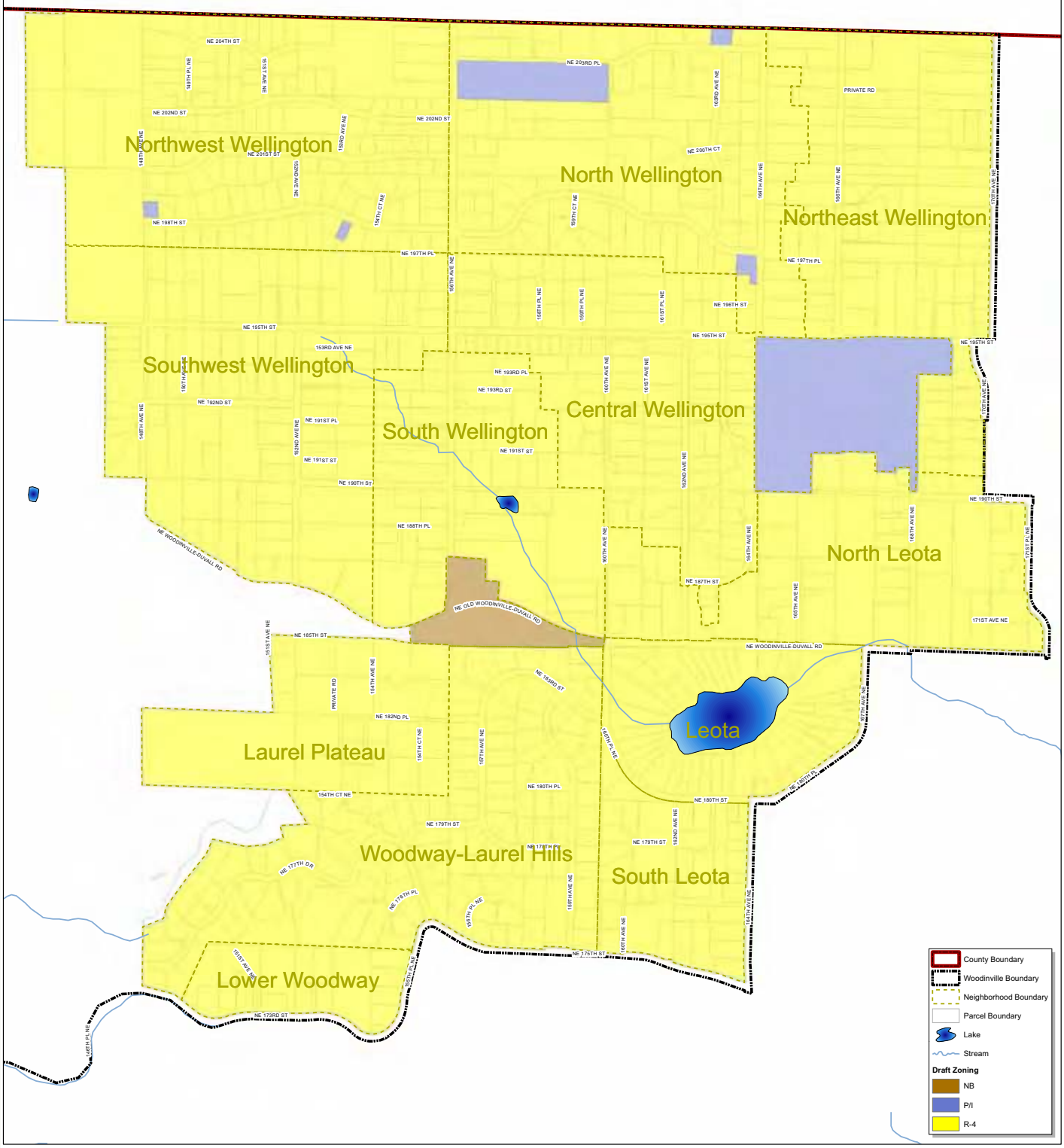

Figure ES-10. Zoning Option 4
All R-4

0 500 1,000
Feet

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Table ES-3. RESIDENTIAL DENSITY OPTIONS TABLE

OPTIONS	R-1 Only	R- *Litowitz* (Based on current Growth Management Hearings Board Decisions)	R- Multiple Factors	R-4 Only
DESCRIPTION	Retains existing R-1 zoning for entire study area without the option for R-4. (or could have option R1(a): No Action with allowance for rezone to R-4)	Retain R-1 zoning only for the Lake Leota Basin. R-4 zoning surrounding Leota drainage basin.	Combination of R-1, R-2 and R-4 zoning based upon the combination of the *Litowitz* test, neighborhood character analysis to ensure the vitality and character of existing residential areas, transportation and capital facilities.	R-4 zoning for the entire study area
EFFECT OF OPTION				
Environmental	Has the least impact on Cold Creek & Lake Leota	Recognizes the most environmental critical element within the study area that meets *Litowitz* test (large in scope, complex structure and functions, and high rank order): Lake Leota and Cold Creek. Requires consideration of lower densities beyond Critical Areas regulations. Other critical areas in other basins – wetlands, geologic hazard areas, fish and wildlife habitat do not meet *Litowitz* criteria, but continue to be protected by Critical Areas regulations.	Lake Leota Basin would be protected at R-1 density, with a relatively small exception in the upper basin. That area has high neighborhood character and already has an existing common density of R-2; therefore, the small area was identified for R-2.	Could have the most impact on Cold Creek & Lake Leota. Engineering and critical areas regulatory requirements would mostly mitigate impacts to the environment in all other areas.

OPTIONS	R-1 Only	R- *Litowitz* (Based on current Growth Management Hearings Board Decisions)	R- Multiple Factors	R-4 Only
Neighborhood Character*	No Change	In the Leota Basin, the current existing density is mostly R-1 to R-2. And the majority of the neighborhoods in the basin have lower neighborhood character commonality. Therefore, the Basin would remain nearly the same and therefore the neighborhood character the same. Outside the basin, R-4 could change the neighborhood character, because the high commonality areas would not be maintained.	The 5 high-order neighborhood character areas outside the Leota Basin were maintained under this option, with two exceptions: in the southwest portion of Woodway-Laurel Hills (some of the Woodin Creek Basin), where R-1 rather than R-2 would be most appropriate. Although the geologically hazardous area in the Woodin Creek basin is not identified as meeting the *Litowitz* criteria, there is a complex steep slope system, and associated constraints to future road improvements, making future development less feasible.	Does not recognize neighborhood character analysis.
Transportation	No Change	Transportation operation impacts can be mitigated under different density scenarios with one exception in SW corner of the study area.	Transportation operation impacts can be mitigated under different density scenarios with one exception in SW corner of the study area.	Transportation operation impacts can be mitigated under different density scenarios with one exception in SW corner of the study area.
Public Facilities	Police & Fire Service: Zoning density changes from R-1 to R-4 would not affect response time for police and fire service providers. Public safety services are neutral factors for purposes of this review. Schools: Student populations are currently in the decline. R-1 could perpetuate the decline. Water Service: R-1 zoning would not impact water service. Sanitary Sewer Service: Sewers would not be required for R-1. In addition, the western portion of the R-1 area has gravity access.	Police & Fire Service: Zoning density changes from R-1 to R-4 would not affect response time for police and fire service providers. Public safety services are neutral factors for purposes of this review. Schools: Student populations are currently in the decline and excess capacity exists. The R-4 zoning densities surrounding the Leota Basin could slow the decline in student population. Water Service: Buildout to R-1 in the basin and R-4 surrounding would not appreciably impact water	Police & Fire Service: Zoning density changes include a range of densities and would not affect response time for police and fire service providers. Public safety services are neutral factors for purposes of this review. Schools: Student populations are currently in the decline and excess capacity exists. Zoning densities would not impact the schools. Water Service: Buildout in the multiple factor option would not appreciably impact water service. Sanitary Sewer Service: The	Police & Fire Service: Zoning density changes from R-1 to R-4 would not affect response time for police and fire service providers. Public safety services are neutral factors for purposes of this review. Schools: Student populations are currently in the decline and excess capacity exists. Zoning densities could improve conditions Water Service: Buildout to R-4 would not appreciably impact water service. Sanitary Sewer Service: The western portion of the R-1 area has

OPTIONS	R-1 Only	R- *Litowitz* (Based on current Growth Management Hearings Board Decisions)	R- Multiple Factors	R-4 Only
	Economic feasibility would likely have an effect on providing sewer in the eastern portion.	service. Sanitary Sewer Service: Sewers would not be required in the Leota Basin (see exception directly surrounding the Lake). Economic feasibility would likely have an effect on providing sewer in the R-4 area outside the Leota.	western portion of the R-1 area has gravity access to existing sanitary sewer facilities and is physically better suited for R-4 zoning. The eastern portion is better suited for lower densities only until such time that it becomes economically feasible to provide pump stations to this area. The eastern portion of the study area is identified for R-4 zoning because of the lack of environmental constraints and high order neighborhood character. Sewer service did not outweigh other factors. R-4 densities would be phased in when service is available.	gravity access to existing sanitary sewer facilities and is physically better suited for R-4 zoning. The eastern portion is better suited for lower densities only until such time that it becomes economically feasible to provide pump stations to this area. The eastern portion of the study area is identified for R-4 zoning due to this option's focus as the upper density range approach. R-4 densities would be phased in when service is available.

Note: *The existence of covenants may further support neighborhood character conclusions.

Attachment A Environmental Report

Sustainable Development Project R-1 Area: Environmental Report
(Steward & Associates and City of Woodinville)

CITY OF WOODINVILLE
SUSTAINABLE DEVELOPMENT PROJECT
R-1 AREA

ENVIRONMENTAL REPORT

January 2007

Revised February 2007

Steward & Associates

With revisions by the City of Woodinville

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A. Hydrogeologic Analysis for City of Woodinville Sustainable Development Program, Golder Associates

B. Lake Leota Analysis for City of Woodinville Sustainable Development Program, C. Michael Falter

C. Wetland Evaluation for City of Woodinville Sustainable Development Program

   C-1. Woodinville Additional Wetland Reconnaissance Survey, Jones & Stokes

   C-2. Woodinville Wetland Survey, Cooke Scientific

   C-3. Citizen Advisory Panel Supplied Map

D. Low-Impact Development Analysis for City of Woodinville Sustainable Development Program, Perteet Inc.

Executive Summary

This report was commissioned by the City of Woodinville in June 2006 to help the City evaluate environmental conditions that could potentially affect zoning densities and development standards in its R-1 zone. The Growth Management Act (GMA) (RCW 36.70A.070(2)) calls for ensuring "the vitality and character of established residential neighborhoods" and past Central Puget Sound Growth Management Hearings Board (Board) decisions have explicitly authorized lower urban densities when they provide added or necessary protection for critical areas that are large in scope, complex in structure and function, and of a high rank order. (These criteria are known as the "*Litowitz* test," following the name of the plaintiff in the case where they were first identified[1].) This environmental report is one of four reports included in the analysis of Sustainability Study. The other three parts include neighborhood character, transportation, and capital facilities.

The city's R-1 zone, where the minimum size for new parcels is one acre, encompasses approximately 30% of the City's area and is located in the City's northeast corner. Under current codes, the R-1 zone density can be increased to R-4 only upon approval of a rezone. R-1 to R-4 in Woodinville's Comprehensive Plan is considered Low Density.

Viewed in the abstract, R-1 zoning has been inconsistent with past decisions by the Board regarding minimum urban densities, but recent Court and Board decisions indicate that such densities are not necessarily required in all urban areas as an absolute rule. The following are relevant contextual factors when determining densities and are specifically discussed in the neighborhood character report:

- The percentage of the overall land in the City where lesser densities may be permitted; and
- Whether the City is meeting its assigned growth target, the City's overall average density, what density and designations are applied to undeveloped/unplatted areas of the City, and whether, overall, the City's planning record indicates that it is meeting its obligations under the Growth Management Act (GMA).

One of the purposes of this environmental report is to evaluate whether there are any critical areas—including wetlands, fish and wildlife habitat conservation areas, geologically hazardous areas, and critical aquifer recharge areas—in or adjacent to the R-1 zone that meet the *Litowitz* test and if so, how they likely would be affected by different zoning densities. This report also advises the City on how it can best meet its overall environmental goals in this zone under a variety of densities, from R-1 to R-4. It is important to note that this study evaluates environmental issues at a planning level. At any future density, developments would be required to protect critical areas through the provisions of the Critical Areas Ordinance (WMC 21.24) and the Stormwater Manual (WMC 14.09), e.g., protective buffers, detention and discharge to safe locations.

In summary, we identify two critical areas in the R-1 zone that meet the *Litowitz* test: Cold Creek and Lake Leota. These two critical areas are linked via the Lake Leota drainage basin, which is the primary headwaters for Cold Creek. The outlet stream of Lake Leota is, in fact, Cold Creek, but for the majority of time the lake does not flow out through this stream, but instead infiltrates into groundwater, which reaches Cold Creek through seeps and springs to the east of the R-1 zone. Cold Creek's unusual reliance on groundwater is why it provides a steady flow of cold, clean water to the

[1] *Litowitz v. Federal Way*, CPSGMHB Case No. 96-3-005 (July 22, 1996).

Bear Creek system downstream. Bear Creek is the largest producer of naturally spawned salmon for a stream its size in western Washington, and Cold Creek plays a very important role in that.

Maintaining R-1 zoning within the 505-acre basin that drains to Lake Leota would help protect the lake from increasing phosphorus inputs from stormwater, which is crucial for the lake's future water quality. The Lake Leota basin comprises approximately 40% of the entire R-1 zone (see Figure ES-1 for a map of drainage basins in the R-1 zone). See Table ES-1 for a more detailed summary of our recommendations and technical findings.

Overall Conclusions

Based on environmental factors, the conclusions of this study differ for different areas of the R-1 zone, primarily because of complex patterns of surface water drainage and groundwater flow and the special needs to protect Leota Basin and Cold Creek that cannot be accomplished by the standard requirements of the city's Critical Areas Ordinance. The areas include six approximate drainage basins identified in Figure II-2: Lake Leota Basin; the School Basin; the small part of the R-1 zone that drains to Daniels Creek; the upper Woodin Creek Basin; the Hillside Drainages along the slopes of the northwest section of the zone; and the Golf Course Basin in the far northwest corner of the zone. The data collected for this study has been used to determine a broader planning level analysis that identifies whether or not different zoning densities could improve the protection of important critical areas in the city. Taking into account that individual developments are required to protect on-site critical areas such as streams, wetlands, steep slopes, aquifer recharge areas, and others by complying with the Woodinville Municipal Code, Critical Areas Ordinance, Chapter 21.24, the conclusions of this study determined that Lake Leota and Cold Creek required additional protection through decreased densities.

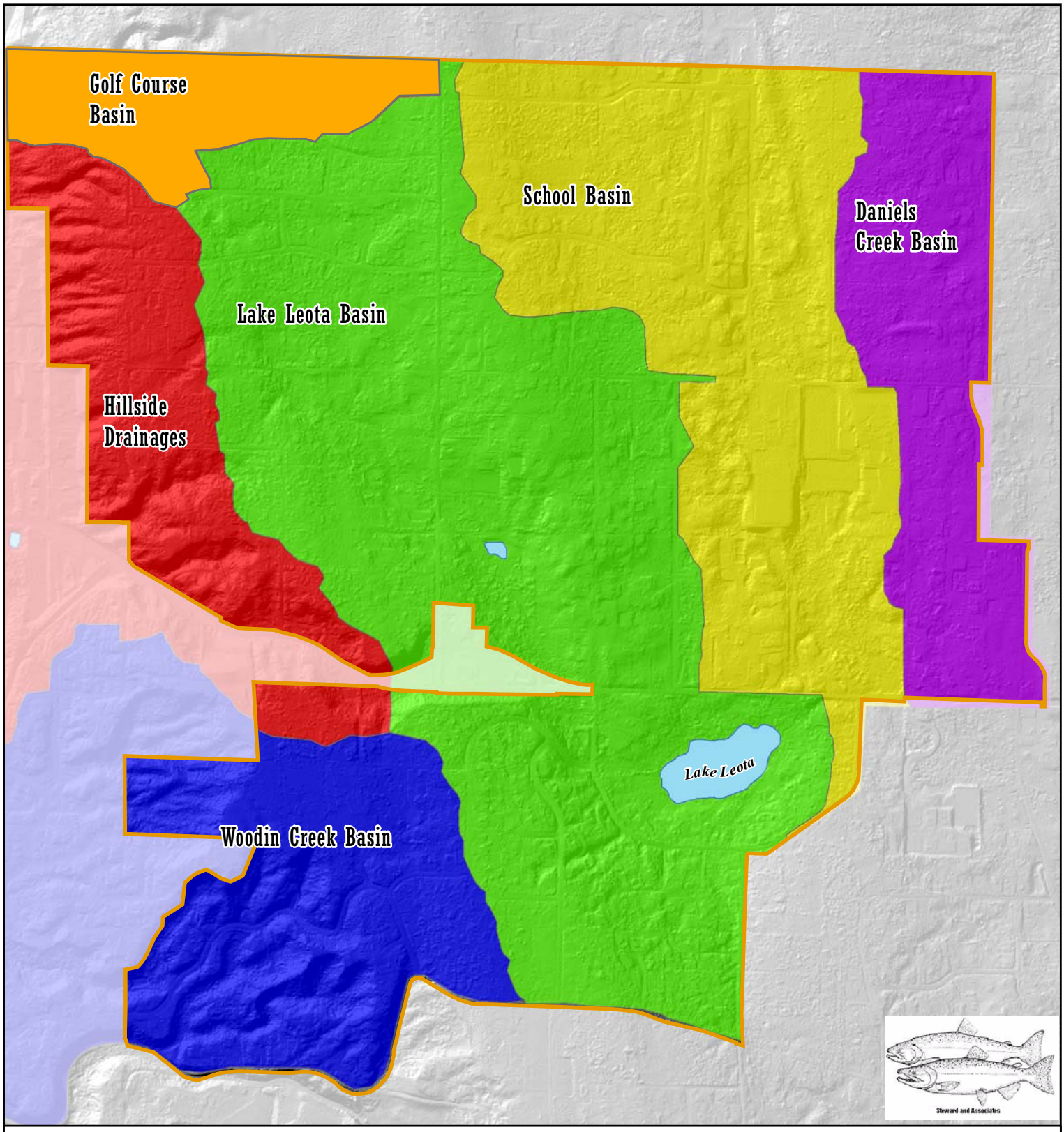

Figure ES-1. Woodinville Drainage Areas

Drainage areas

- Hillside Drainages
- School Basin
- Daniels Creek Basin
- Woodin Creek Basin
- Lake Leota Basin
- Golf Course Basin
- R-1 boundary
- Waterbodies

0 0.5 Miles

N W E S

1:13,500

Table ES-1. Summary of Environmental Conclusions and Technical Findings

Area	Conclusions	Technical Findings
Lake Leota Basin*	• *R-1 zoning provides substantial, long-term environmental benefits not solely achieved by requirements of the Critical Areas Ordinance* • Even if increased density is necessary to provide sewer service, there would be a net environmental benefit directly surrounding the lake • Require Low-Impact Development (LID) as part of stormwater regulations throughout basin. LID performs best at lower densities.	• Lake Leota and Cold Creek meet Litowitz criteria; lake is part of Cold Creek headwaters which flows to Bear Creek, high spawning tributary in Western Washington • Lake is at risk of accelerating eutrophication; which would worsen with increased development density • Lake is growing shallower, becoming more polluted • Trends pose long-term risks to Cold Creek, Bear Creek system • Goal: minimize eroded sediments from stormwater entering lake • Reducing net nutrient inputs by replacing septic systems directly adjacent/around lake with sewer would probably be positive even if accompanied by other impacts on water quality from increased density • Septic systems should be upgraded to increase nutrient removal • Limited Steep Slopes –per mapping • Wildlife – no protected species documented, many birds and mammals exist in an urban setting.
School Basin	• *R-1 zoning* benefits Cold Creek, but *with minimal effect on its most important attributes; maintaining low density in this part of R-1 Zone is not as important as in Lake Leota Basin* • *R-4 could have negative impact without LID* • Emphasis in this area is requiring LID through stormwater performance standards for new development. This provides greatest benefit at lower densities but, ironically, they may be more important at higher densities, where the potential impacts to downstream resources would be greater without such extra effort.	• Surface water from basin drains to Cold Creek; provides relatively small contribution to Cold Creek flows • Groundwater drains west, bypassing Cold Creek • Stormwater impacts have little effect on contribution of cold, steady summer flows downstream • Cold Creek remains important system to protect in its own right, supporting five salmon species • Limited Steep Slopes –per mapping • Wildlife – no protected species documented, many birds and mammals exist in an urban setting.

Table ES-1. Summary of Environmental Conclusions and Technical Findings

Area	Conclusions	Technical Findings
Daniels Creek Basin	• *R-1 zoning provides minor benefits to Daniels Creek, minimal benefits to Bear Creek system* • LID would provide some benefit, but lower priority than elsewhere	• Surface water from area is small part of Daniels Creek basin; groundwater drains to west • Cottage Lake attenuates impact of Daniels Creek Basin on rest of Bear Creek system • Limited Steep Slopes –per mapping • Wildlife – no protected species documented, many birds and mammals exist in an urban setting.
Upper Woodin Creek Basin	• *R-1 zoning provides some protection to geologic hazards, minor benefits to Woodin Creek* • Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of storm water • Infiltration near slopes would threaten geologic hazard areas • Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination • LID would provide some downstream benefit to Woodin Creek, but infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city.	• Woodin Creek probably does not meet Litowitz criteria, especially above fish blockages • R-1 area is relatively small part of basin • NGPEs provide valuable protection that remains regardless of zoning • Geologic hazards are common and significant • HDPE fuse-welded tightlines and tanks or vaults, not ponds, should be adequate to protect slopes from adjacent stormwater • Groundwater surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards; infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. • Large underdeveloped parcel has geologic hazards and wetland, is headwaters of North Tributary • Wildlife – no protected species documented, many birds and mammals exist in an urban setting.

Table ES-1. Summary of Environmental Conclusions and Technical Findings

Area	Conclusions	Technical Findings
Hillside Drainages	• *R-1 zoning provides some protection to geologic hazards, minor benefits to Little Bear Creek;* • Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of stormwater; • Infiltration near slopes would threaten geologic hazard areas; • Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination. • LID would provide some downstream benefit to Little Bear Creek, but infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. • Other forms of LID still encouraged.	• Hillside Drainages are relatively small part of Little Bear Creek basin flows • HDPE tightlines would be adequate to protect slopes from adjacent stormwater • Groundwater or perched water surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards • Along the northwestern portion of the basin, a large undeveloped forested hillslope runs north-south, connecting to a large vegetated area in the adjacent golf course to the north and an industrial area below. Although there are no documented protected species (threatened, endangered) in this area, the area provides a place for urban species to forage, nest, drink and move into adjacent open areas. Pileated woodpeckers are a "State Candidate" species without specific or designated protection, and are not expected to be impacted by future development. The industrial area and highway, limit the ability to support wildlife species that are not tolerant of substantial human disturbance.
Golf Course Basin	• *R-1 zoning provides some protection to geologic hazards, minor benefits to Little Bear Creek, helps minimize erosion in Golf Course Creek;* • Stormwater management is key to protecting geologic hazard areas; fuse-welded tightlines (e.g. HDPE pipe) for discharge of stormwater; • Infiltration near slopes would threaten geologic hazard areas; • Sewer service is needed for densities greater than R-1, to prevent slope instabilities and groundwater contamination;	• Golf Course Basin is relatively small part of Little Bear Creek basin flows. • HDPE tightlines would be adequate to protect slopes from adjacent stormwater. • Groundwater or perched water surcharge from increased infiltration or denser septic discharges would pose risk to geologic hazards. • Golf Course creek may be perennial, provides important source of water for wildlife in area. • Golf Course creek carries high sediment load from eroding ravine, which could be exacerbated by development in headwaters area without stormwater management focused on minimizing erosive

Table ES-1. Summary of Environmental Conclusions and Technical Findings

Area	Conclusions	Technical Findings
	• LID, especially in headwaters of basin, could provide significant benefits to Golf Course creek; infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city.	discharges.

*While zoning densities and development regulations are crucial to the long-term health of Lake Leota, there are additional actions that could provide both short-term and long-term benefits to the lake. These include constructing new stormwater management facilities and channel improvements to reduce erosion into the lake, as well as providing education and technical assistance to property owners—especially lakeside property owners—regarding best management practices for landscaping, septic system maintenance, and other issues.

I. Introduction

This report, commissioned by the City of Woodinville in June 2006, evaluates potential impacts on critical areas from different zoning densities in the City's R-1 zone (see Figure I-1) and provides recommendations to protect the functions and values of those areas. It also provides general recommendations concerning how the City can best meet its overall environmental goals in this zone under a variety of potential densities, from R-1 to R-4. The GMA (36.70A.070(2)) calls for ensuring "the vitality and character of established residential neighborhoods" and past Central Puget Sound Growth Management Hearings Board (Board) decisions have explicitly authorized lower urban densities when they provide added or necessary protection for critical areas that are large in scope, complex in structure and function, and of a high rank order. (These criteria are known as the "*Litowitz* test," following the name of the plaintiff in the case where they were first identified[2].) This environmental report is one of four reports included in the analysis of Sustainability Study. The other three parts include neighborhood character, transportation, and capital facilities.

At 1,258 acres, the R-1 zone is the largest contiguous residential area in the City, encompassing 30% of the City's total geographic area. Based on current zoning, it represents about 11% of the future residential development capacity in the City (B. Wuotila, City of Woodinville, personal communication). "R-1" refers the minimum size of one acre for new parcels in the zone. Past subdivision has created some smaller parcels than this; the median existing parcel size in the zone is 0.9 acre (Wuotila, personal communication). The City inherited one-acre zoning in this area from King County, when Woodinville incorporated in 1993. Most homes in the zone are twenty to thirty years old and were built under King County regulations. According to the City's 2002 Comprehensive Plan, 89% of the housing stock in the R-1 zone is ranked as either "good" or "very good." Most roads in the R-1 zone have narrower widths of 20 feet, no shoulders, and no sidewalks. All homes in the zone are served by septic systems. The zone is within the Woodinville Water District. In the eastern part of the study area, sewer service would be more expensive given topographic constraints, distance from existing sewer mains, and need for pump stations, which is generally more costly. (See Attachment D of the overall R-1 review report, "Capital Facilities and Utilities in the R-1 Area.") Under WMC 21.04.080(1)(a), development can proceed in the R-1 zone at densities up to R-4 (four units per acre) if adequate infrastructure can be provided. Change from the R-1 zone classification to R-4 would require a rezone.

The R-1 zone contains the following critical areas:

- Lake Leota, the largest lake in the City and part of the headwaters of Cold Creek, an important tributary to Bear Creek, a large producer of naturally spawned salmon for a stream its size in Western Washington;
- Steep slopes and other geologic hazards, which run along much of the zone's western border;
- Probably more wetlands than any other part of the City, although no Category I wetlands or wetlands with high habitat value;
- The headwaters of Woodin Creek, a salmon-bearing tributary to the Sammamish River;
- Aquifer recharge areas, some of which are designated as highly susceptible to pollution.

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[2] *Litowitz v. Federal Way*, CPSGMHB Case No. 96-3-005 (July 22, 1996).

City of Woodinville

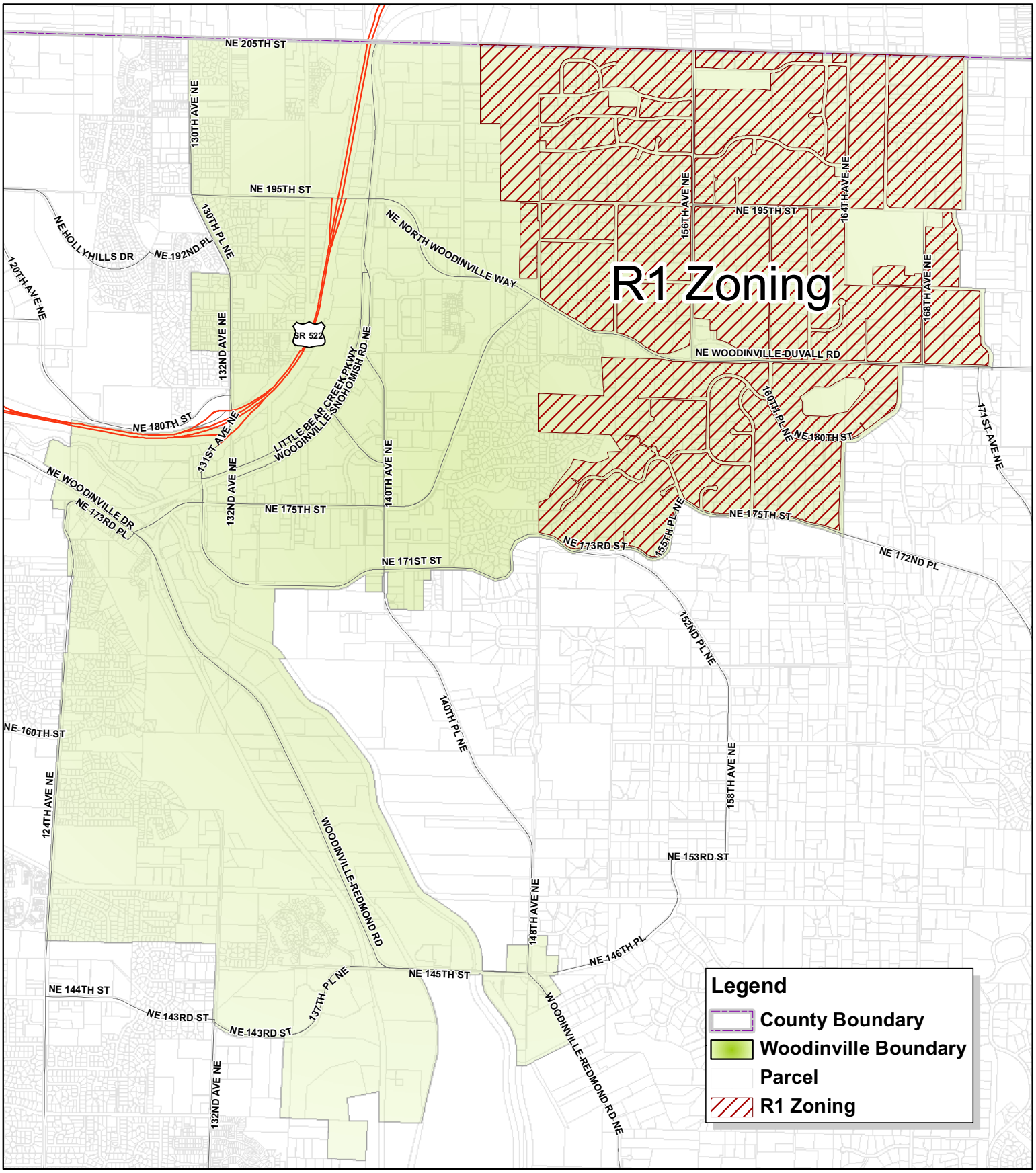

Figure I-1. R-1 Zoning

1 inch equals 2,200 feet

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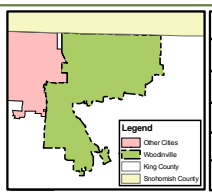

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The R-1 zone also contains the most mature and dense tree canopy in a City that prides itself on its "Northwest woodland character" (for example, see goal LU-1 in Woodinville's Comprehensive Plan in the Land Use Element). This tree canopy helps protect all of the critical areas mentioned above, and also provides habitat for birds and other wildlife that are an important part of the quality of life in the R-1 neighborhoods and the City as a whole.

By City Ordinances 419, 424, and 427, there is currently a moratorium on most new building and land use permits in the R-1 zone, with the exception of some construction related to existing structures, public facilities, accessory living quarters, and vested development (see Attachment E of overall R-1 review). This moratorium was first adopted on March 20, 2006 and has been extended through March 20, 2007. The purpose of the moratorium is to provide time for this environmental report to be completed, as well as for the City to perform other studies and actions that are part of its Sustainable Development project, which are necessary to ensure that development proceeds in the R-1 zone in a manner consistent with the Growth Management Act and the City's goals, policies, and legal requirements.

Regulatory Basis: Growth Management and Urban Densities

In 1995, the Central Puget Sound Growth Management Hearings Board established a "general rule" of four net dwelling units per acre as a minimum density for urban areas under the Growth Management Act.[3] Calling this standard a "bright line," the Board stated:

> Any residential pattern at that density, or higher, is clearly compact urban development and satisfies the low end of the range required by the Act. Any larger urban lots will be subject to increased scrutiny by the Board to determine if the number, locations, configurations and rationale for such lot sizes complies with the goals and requirements of the Act, and the jurisdiction's ability to meet its obligations to accept any allocated share of County-wide population. Any new residential land use pattern within a UGA [Urban Growth Area] that is less dense is not a compact urban development pattern, constitutes urban sprawl, and is prohibited.

The next year, the Central Board identified the criteria it would use to determine whether environmental factors could justify a lower density in urban areas:

> The Board holds that when environmentally sensitive systems are large in scope (e.g. a watershed or drainage sub-basin), their structure and functions are complex and their rank order value is high, a local government may also choose to afford a higher level of protection by means of land use plan designations lower than 4 du [dwelling units]/acre.

These criteria have come to be known as "the *Litowitz* test," following the name of the plaintiff in the case. The criteria have not changed, nor have they been substantially clarified, under subsequent Growth Board decisions. This leaves many important details somewhat ambiguous. Watersheds and drainage sub-basins can be identified across a wide range of sizes, from a large river system like the Columbia River to an individual wetland or small stream. To some degree, the structure and functions of nearly all natural systems are complex. The meaning of "rank order value" is also unclear and depends on scale. A particular stream or wetland, for example, could rank of high importance within a small jurisdiction or small drainage basin but of much less importance when

[3] *Bremerton v. Kitsap County*, CPSGMHB Case No. 95-3-0039c (October 9, 1995).

considered at larger geographic scales. Nevertheless, it is clear that critical areas that are not of high relative value within the larger natural systems in the surrounding vicinity or within an individual jurisdiction would be unlikely to pass the *Litowitz* test.

In a later case, *Fuhriman v. Bothell*[4], the Board acknowledged "a possible expansion of *Litowitz* analysis," where lower densities might be allowed to protect critical areas that do not, strictly speaking, meet the *Litowitz* test. It noted that critical areas that are linked hydrologically could have "unique geologic or topographical features that would also require the additional level of protection of lower densities in those limited geologically hazardous landscapes." Such areas might, for example, provide sources of cool water for streams and rivers, wildlife habitat, and other ecological functions.[5] The Board has never explicitly addressed whether it would support reduced densities solely to reduce the public safety threat of geologic hazards, which generally can be addressed through other means (e.g., setbacks, vegetation retention, appropriate stormwater management, and site-specific conditions on development).

Complicating this legal context further, in 2005 the Washington State Supreme Court found that the Growth Boards do not have the legal authority to set "bright line" rules that are not contained within the GMA.[6] In March 2006, a King County Superior Court judge found that this Supreme Court ruling voided a Central Board decision against the City of Normandy Park, where much of the existing zoning is well below four units per acre.[7] Judge Bruce Hilyer found that, both under the Supreme Court case and under his own independent reading of the GMA, Growth Boards do not have the authority to impose "bright line" rules of their own construction, heightened scrutiny tests, or uniform minimum residential densities. Judge Hilyer emphasized that, under the GMA, deference must be given to a local government's decision regarding appropriate urban densities, based on local circumstances.

The Superior Court case is currently on appeal. Thus, it is not absolutely certain what criteria might be applied to judge the validity of Woodinville's R-1 zoning, should it be challenged to the Central Board or the courts. It is worth noting, however, that the GMA provides for a "broad range of discretion" in local planning. The Act's housing goal explicitly promotes "a variety of residential densities and housing types, and encourage[s] preservation of existing housing stock" (RCW 36.70A.020(4)). The Act also calls for housing elements in local Comprehensive Plans that ensure "the vitality and character of established residential neighborhoods" (RCW 36.70A.070(2)).

Under the King County population allocation process performed under the GMA, the City of Woodinville is required to provide up to 1,869 new housing units by the year 2022. In an extensive public process, the City strategically evaluated where and how it could locate its population growth with the goal of preserving its woodland community character. The City did this through creation of a Central Business District zone for the downtown, which allows a base density of 36 units per acre, up to a maximum of 48 units per acre. With development standards that encourage high density housing and transit oriented design, the City's buildable land analysis shows that the City has sufficient capacity under its current zoning to accommodate up to 1,947 new housing units, 78 more

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[4] *Fuhriman v. Bothell*, known as "Fuhriman II," CPSGMHB Case No. 05-3-0025c (August 29, 2005).

[5] This decision drew on *Kaleas v. Normandy Park*, CPSGMHB 05-3-0007c (July 19, 2005).

[6] *Viking Properties v. Holm, et al*, 155 Wn.2d 112, 118 P.3d 322 (2005).

[7] *City of Normandy Park v. Central Puget Sound Growth Management Hearings Board et al*, King County No. 05-2-27090-0 KNT (March 30, 2006).

than are needed to meet its 2022 population allocation. (See Attachment B for more information on the City's land capacity analysis.)

Refined Goals of This Report

At a minimum, this report evaluates and applies the *Litowitz* test and takes into account refined goals expressed by the City Council, City staff, the Planning Commission and the Citizen Advisory Panel (CAP). The following refined goals were evaluated for their achievability and appropriateness at a planning level analysis. During a City Council meeting, staff explained that completing a detailed "survey" of all wetlands and steep slopes could costs in the millions of dollars and would not provide proportionate benefit. The council determined that the level of analysis being proposed by staff was adequate to defend a planning level of analysis. Parentheses indicate the council's acceptance

- Inventorying critical areas that are in the R-1 zone or may be influenced by development in the R-1 zone (without conducting detailed surveys or identifying all wetlands);
- Identifying those critical areas that are "large in scope, complex in structure and function, and of a high rank order;"
- Evaluating how those critical areas may be impacted by different potential development densities in the R-1 zone, and the degree to which those impacts could be mitigated;
- Evaluating sustainable and low-impact approaches to development in the R-1 zone that could, under different potential densities, provide the greatest environmental benefits to residents of the R-1 zone, the City of Woodinville, and the ecosystems of which they are a part, at a reasonable public and private cost; and
- Developing recommendations to the City based upon environmental issues for appropriate development densities and regulations in the R-1 zone, to help the City meet its legal responsibilities and the full range of goals for the R-1 zone.

Chapter II of this report, together with Appendices A, B, and C, addresses the first three of these goals. A comprehensive inventory of all critical areas within the R-1 zone was not possible to the level of detail required of all development proposals. Chapter II also includes a detailed review of those critical areas in or adjacent to the R-1 zone that, in our judgment, meet the *Litowitz* test. The current status of these critical areas and potential threats to their functions and values from future development at different zoning densities were evaluated. This provides the technical basis for further discussion of recommended actions later in the report.

Appendix D addresses the fourth goal listed above for the report. It reviews different techniques and approaches to site and building designs, construction materials, and stormwater management that can reduce the environmental impacts of new development and redevelopment. This report collectively defines these techniques and approaches as "low-impact development" or "LID." Different zoning densities with different environmental constraints provide different capacities for LID, affecting the degree of benefit that LID techniques can provide, individually and collectively. We reviewed the feasibility and appropriate expectations for a wide range of LID techniques under different zoning densities. We also review special considerations for LID techniques to minimize impacts on specific critical areas within the R-1 zone.

Chapter III concludes with our recommendations, which are organized by drainage basin within the R-1 zone.

Public involvement opportunities have been numerous and are listed in the Executive Summary of the overall R-1 Sustainable Development Review report.

II. Critical Area Review

Inventory

Four different types of critical areas are found in or adjacent to the R-1 zone: fish and wildlife habitat conservation areas (which include streams); wetlands; geologically hazardous areas; and critical aquifer recharge areas. The other type of critical area that is identified in the Growth Management Act, frequently flooded areas, is not found in the zone. Our inventory discusses each of the other four types of critical areas in turn.

Fish and Wildlife Habitat Conservation Areas

The most important fish and wildlife habitat conservation area (FWHCA) in or adjacent to the R-1 zone is Cold Creek, a tributary to Cottage Lake Creek within the Bear Creek basin, which is predominantly to the east of the R-1 area. While Cold Creek's functions and values are affected by conditions in the R-1 zone, just how much they are affected is less clear. As discussed in Appendix A, groundwater from most of the R-1 zone appears to flow to the west, away from Cold Creek (see Figure II-1). The Lake Leota basin is part of the headwaters of Cold Creek, but the lake's outlet stream (which directly connects to Cold Creek, and on some maps is named Cold Creek) flows only intermittently, when the lake is high. Cold Creek is primarily fed by groundwater from a large receiving area to the north, as well as by groundwater discharge from Lake Leota, as discussed in Appendix A. Cold Creek's steady flow of cold water is most important to the Bear Creek system in the summer and early fall, when Cold Creek currently has little if any surface connection with Lake Leota. The lake is growing shallower, however, through a natural process of eutrophication, which has been dramatically accelerated by development within its drainage area. The implications of this change for Cold Creek are discussed later in this chapter. Appendix B describes the status and trends for the lake in detail.

There are three inlets to Lake Leota, from the south, north and west. The inlets from the north and south are essentially stormwater channels. They carry significant volumes of water and sediment during storms, but otherwise appear to be dry most of the year. The City has not mapped these inlets as intermittent streams, but based on their substrate and channel characteristics, they could potentially be mapped as such. The City has mapped the inlet to the west as a Type 4 (non-fish-bearing, intermittent) stream. This stream is called "Cold Creek" on at least one City map. The riparian corridor originates at the corner of 152nd Avenue NE and NE 195th Street and proceeds in a southeasterly direction before entering Lake Leota at its far western end (see Figure II-2). There is evidence that water flows through this corridor during the winter rainy season (no water was obvious in any stretch we could observe in August) to at least the area north of NE Woodinville-Duvall Road. Downstream of the road, the creek appears to have been dry for many seasons. There were no recent scour marks, algae layers, or any other indication that water had flown through this area in the recent past. The channel on the lot adjacent to the lake did show some patches of gravel habitat, but the channel was dry in August. The resident of the lot (Verna Zander) did not know if water flowed in the channel in the past few years. Prior to the 1980's, she reported it had flowed quite regularly for the entire year.

Woodin Creek, a Type 2 (fish-bearing, perennial) tributary to the Sammamish River, also has its headwaters at least partly within the R-1 zone. The mainstem of the creek originates near NE 177th Drive, in the southwest corner of the R-1 zone. The drainage basin for this upper reach of Woodin

Creek extends further into the R-1 zone, including a substantial Native Growth Protection Area[8] that is established on either side of NE 177th Drive. Headwaters for the creek also include a larger area of unincorporated rural lands outside of the City boundary as well as an R-6 zone within the City that comprises most of the headwaters area for the two forks of Woodin Creek's North Tributary. No fish are found in the portions of Woodin Creek within the R-1 zone, due to substantial blockages downstream (Adolfson Associates 2004). Pileated woodpeckers, Pacific chorus frogs, and many other wildlife species are found in forested headwater areas (Adolfson Associates 2004). One of the largest developable parcels in the R-1 zone is part of the headwaters for the North Tributary.

Small, at least seasonal streams appear to be located at the base of some of the ravines along the northwest edge of the R-1 area. The largest of these streams, which may be perennial, is located in the far northwest corner of the R-1 zone, at the base of a particularly steep ravine that extends into the Wellington Hills Golf Course in Snohomish County. While this stream is unnamed, for purposes of this report we refer to it as "Golf Course Creek." This creek and the other streams along the northwest slope of the R-1 zone are piped under the industrial area to the west before entering Little Bear Creek. Golf Course Creek appears to be a significant source of water for wildlife in the vicinity. The other streams provide some localized habitat value within the ravines and presumably have some effect on flows and water quality in Little Bear Creek, but this effect is likely minor and not greatly impacted by development in the R-1 zone. While Golf Course Creek is the largest of all these streams, it likely also has only minor effects on flow and water quality in Little Bear Creek. However, small landslides or heavy erosion in the steep ravine in which Golf Course Creek is located could be a significant source of fine sediments in lower Little Bear Creek.

The City has designated Native Growth Protection Easements as FWHCAs, in recognition of their habitat value. By far the largest concentration of these easements in the R-1 zone is in the headwater drainage area for Woodin Creek discussed above. These easements cannot be developed, even if the underlying zoning is changed (D. Crawford, City of Woodinville, personal communication). Outside of upper Woodin Creek, there are only a few other such easements in the R-1 zone, in some cases associated with wetlands.

The R-1 zone contains the most extensive and mature tree canopy in Woodinville, a City that prides itself on its northwest woodland character. Forested areas in the R-1 zone include a mixture of coniferous and deciduous, young to middle-aged, second- to third-growth trees. Common species include western red cedar (*Thuja plicata)*, western hemlock (*Tsuga heterophylla*), big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), Douglas fir (*Pseudotsuga menziesii*), and bitter cherry (*Prunus emarginata*). Most appear to be approximately 60' to 70' tall and 15-19 inches in diameter at breast height (dbh). There is typically 40 to 75 percent canopy closure in the denser forested tracts. Our field review, although not exhaustive, noted 13 "heritage trees" (identified mostly by girth) dispersed across the north central portion of the R-1 zone. The density of homes and narrow streets made a determination of tree height difficult.

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[8] WMC 21.06.406 Native growth protection area (NPGA). Native growth protection area (NPGA): an area where native vegetation is preserved for the purpose of preventing harm to property and the environment, including, but not limited to, controlling surface water runoff and erosion, maintaining slope stability, buffering and protecting plants and animal habitat.

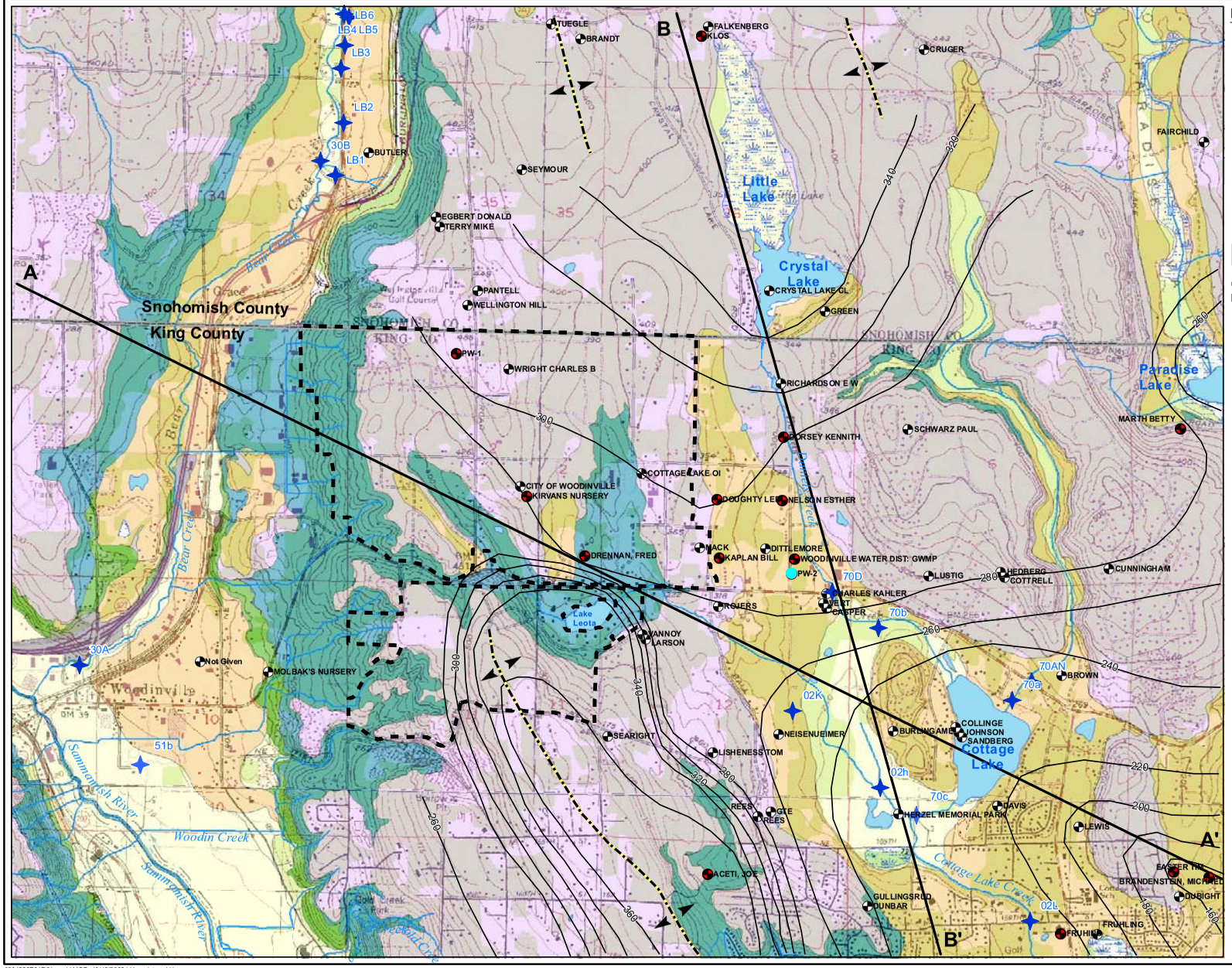

FIG. II-1

GROUNDWATER CONTOUR MAP OF WOODINVILLE R-1 AREA

SA/WOODINVILLE HYDROGEO SVCS/WA

0631230F04R01.mxd | MOD: 10/19/2006 | Unregistered User

Golder Associates

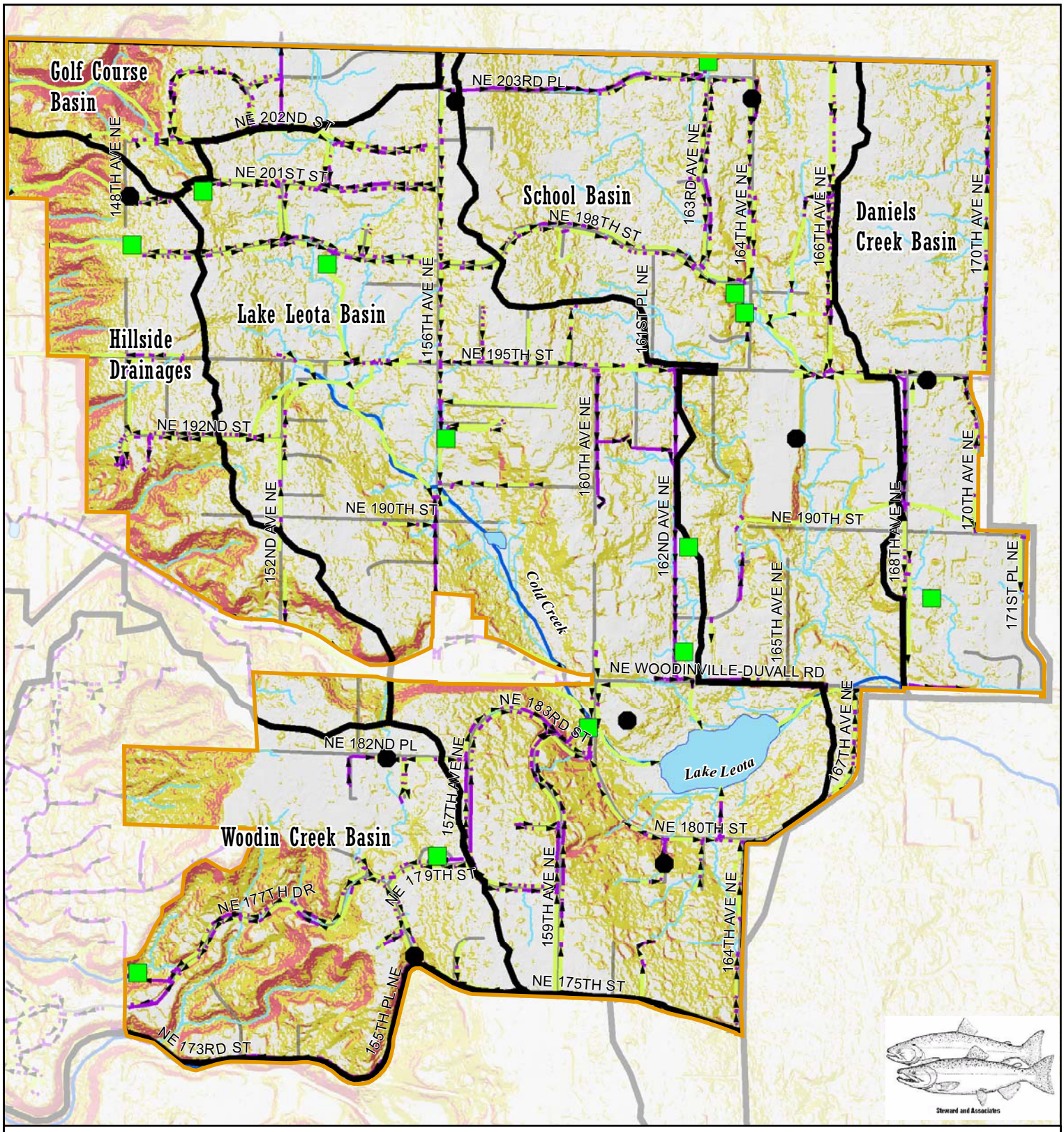

Figure II-2. Woodinville Slopes and Storm Drainage

R-1 Boundary

Slope information

- 0 -15
- 15.1 - 40
- >40.1

- Stormwater pond
- Stormwater tank
- Known streams
- Potential streams
- Waterbodies
- City streets
- Stormwater pipes
- Open channel
- Drainage area

Data for locations of stormwater pipes, ponds, tanks, known streams, open channels and drainage areas are from the City of Woodinville. The locations of potential streams are based on use of LiDAR data. These locations have not been field tested and do not necessarily represent the actual locations of intermittent or perennial flow. This method of identifying potential streams does not account for groundwater seepage.

0 0.5 Miles

N W E S

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The most significant tract of undeveloped forest in the R-1 zone is found along the slopes of the northwestern edge of the zone, including the western portion of the Wood Trails Preliminary Plat and Rezone site and extending north of the City into the Wellington Hills Golf Course. This approximately 75-acre parcel is generally covered with second- to third-growth trees, as described in the preceding paragraph. There is some downed wood, but snags are uncommon (City of Woodinville 2006). The size and character of the site, adjacent to a noisy industrial area and highway, limit its ability to support wildlife species that are not tolerant of substantial human disturbance. Mule deer (*Odoceoileus hemionus*) and coyote (*Canis latrans*) traverse the site in a north-south direction. Pileated woodpeckers (*Dryocopus pileatus*) have been observed on the site, and may possibly nest there (City of Woodinville 2006). Pileated woodpeckers are a "State Candidate" species, but without specific or designated protections issued by the Washington Department of Fish and Wildlife.

Wetlands

Appendix C provides a map of wetlands in the R-1 zone, that were identified with corrections and additions developed as a part of this study. This study focused on wetlands that were part of the area draining to Lake Leota, particularly those that have a direct hydrologic connection to the lake, at least seasonally. We also examined some of the larger wetlands in the vicinity of Leota Junior High School, where the City's maps generally show the greatest concentration of wetlands in the R-1 area. Lastly, we examined a large wetland in the northwestern part of the R-1 area (identified as BBC127 in Appendix C).

While we did not calculate formal rating scores on these wetlands using the Washington Department of Ecology's latest rating system (WDOE 2004), we did describe the vegetation community observed for each wetland studied and we made estimates of the likely ratings the wetlands would have received. Details are in Appendix C. In general, all of the wetlands we observed have been substantially degraded by past alterations and impacts from surrounding development. We found no Category I wetlands and none that were likely of great significance to fisheries resources downstream. No wetland in the R-1 zone has high habitat values, based on the Washington Department of Ecology's rating system (Hruby 2004); most have low habitat scores, but some around Lake Leota would likely be rated as having moderate habitat values (scores between 20 and 28 in Ecology's system). Wetlands in the Lake Leota basin are still important for protecting the lake's water quality, both through filtration of pollutants and detention of stormwater to reduce erosion downstream.

Lake Leota is surrounded by a narrow band of wetland vegetation, which expands further in the vicinity of the lake's three inlets and one outlet and in other localized areas, particularly along the southwestern edge of the lake. Dominant plants observed in this band are: Douglas spirea (*Spirea douglasii*), willows (*Salix sitchensis, Salix lucida, and Salix scouleriana),* Nootka rose (*Rosa nutkana*), Soft rush (*Juncus effusus*), Yellow flag iris (*Iris pseudacorus*), reed canarygrass (*Phalaris arundinaceae*), marsh cinquefoil (*Potentilla palustris*) Slough sedge (*Carex obnupta*), sawbeak sedge (*Carex stipata*), creeping buttercup (*Ranunculus repens),* Common horsetail (*Equisetum arvense),* giant horsetail *(Equisetum telmateia), redtop (Agrostis gigantea*). It is common to see western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa),* and Oregon ash (*Fraxinus latifolia*) near the shoreline. Bullfrogs appeared to be plentiful in the adjacent shallow water.

A portion of the wetland area along the lake's southwestern edge, as well as some of the riparian wetlands along the seasonal tributary to the lake from the northwest, have been delineated within the past decade. We have reviewed those delineations (Shapiro and Associates 1999; Pentec Environmental 2000) and found them still to be generally accurate. Appendix C provides more detail

from our further review of these two areas, which comprise two of the three largest extensions of the Lake Leota shoreline wetland system. We did not have access to the third large wetland area, along the lake's seasonal outlet stream.

We investigated the wetland at the toe of the slope in the northwestern portion of the R-1 zone (identified as BBC127 in Appendix C) from the uphill and downhill edges. We could not determine its toe-of slope boundaries because of a very dense thicket of blackberries that ran along both the upslope and downslope edges. We did verify the east-to-west portion of the wetland. This portion of the wetland is located within a steep-walled ravine and there is a stream in the bottom of the ravine. The vegetation in this corridor consists of devil's club (*Oplopanax horridus*), skunk cabbage (*Lysichiton americanum*), Cooley hedgenettle (*Stachys cooleyea*), piggy-back plant (*Tolmeia menziesii*), lady fern (*Athyrium filix-femina*), with an overstory of salmonberry (*Rubus spectabilis*), red alder (*Alnus rubra*), vine maple (*Acer circinatum*), and paper birch (*Betula paperifera*).

Geologic Hazards

The primary geologic hazards in and adjacent to the R-1 zone occur along the slopes of the zone's western edge, which extend into adjacent land use zones. Currently, City maps designate much of the slopes north of the intersection of NE North Woodinville Way and NE Woodinville-Duvall Road as an erosion hazard area, based on soil and slope conditions. They also indicate scattered steep slopes in the R-1 zone that would qualify as potential landslide hazards. More recent data, however, indicate that landslide hazards due to steep slopes may be more prevalent than this in the area north of NE North Woodinville Way, and that both erosion and landslide hazards likely extend along the slopes from NE North Woodinville Way south to the City limits. As discussed in more detail in Appendix A, these more recent data sources include an updated regional geology map developed through the University of Washington, topographical maps based on LIDAR, and citizen comments, with some brief visual confirmation we have made in the field. These data are further corroborated by geologic analysis performed for the Wood Trails/Montevallo FEIS (Nelson Geotechnical Associates 2006).

Groundwater seepage occurs in many locations along the slopes and ravines of the areas just described. While much of the R-1 zone and lands immediately to its north likely serve as sources for this groundwater, the most important sources are likely relatively close to the slopes, particularly where soils are porous. Activities that alter the hydrologic regime in these areas, such as increased infiltration or inappropriate storm water management practices, can cause changes to the hydrogeologic conditions that could destabilize slopes and enhance erosion.

Critical Aquifer Recharge Areas

The City has identified part of the area north of Lake Leota and Woodinville-Duvall Road as an area of high susceptibility to groundwater contamination, apparently based on earlier King County analysis (Wuotila, personal communication). However, the more recent University of Washington analysis identifies a considerably larger, V-shaped area with its base in the vicinity of Lake Leota as having porous glacial outwash geology (see Figure II-1 and II-3). This geology extends in a narrow band approximately along NE Woodinville Way until it reaches the western slopes of the R-1 zone, where glacial outwash geology is also characteristic. The southwestern edge of the "V" of porous geology and most of the porous geology in the Woodin Creek basin is also characterized by "somewhat excessively drained soils," based on maps from the Natural Resource Conservation Service (see Figure II-2). Where excessively drained soils overlie glacial outwash geology, aquifer recharge areas have a particularly high susceptibility to groundwater contamination.

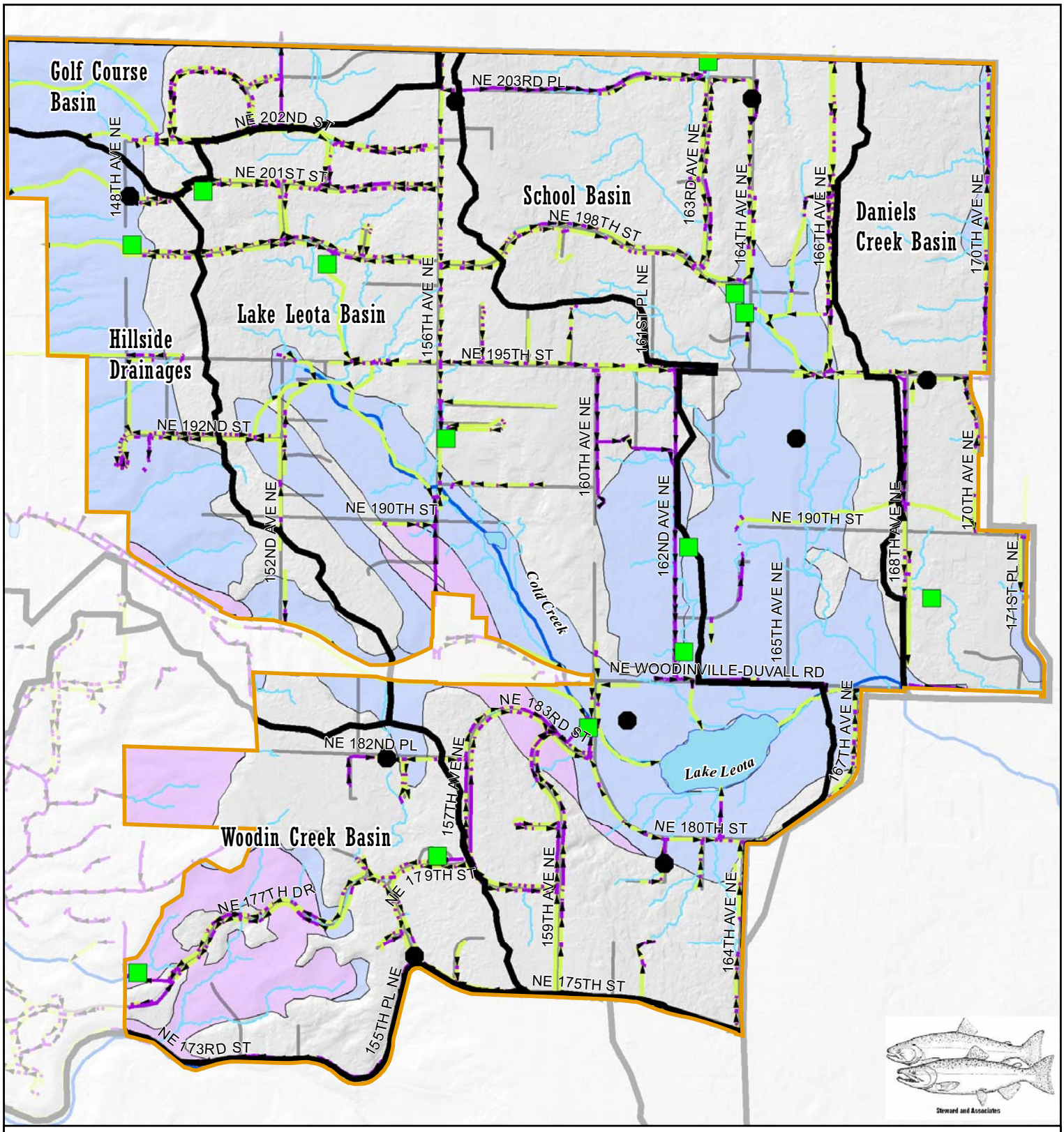

Figure II-3. Moderate & High Critical Aquifer Recharge Areas (CARAs)

CARAs

- Moderate
- High

- Stormwater pond
- Stormwater tank
- Known streams
- Potential streams
- Waterbodies
- City streets
- Stormwater pipes
- Open channel
- Drainage area

CARAs are identified wherever the underlying geology is glacial outwash, which is much more permeable then the glacial till found under the remainder of the R-1 zone. In CARAs with "High" susceptibility to contamination, this geology is overlain by "somewhat excessively drained" soils; CARAs with "Moderate" susceptibility to contamination are overlain by "moderately well drained" soils. Data is from Appendix A to this report.

0 0.5 Miles

N W E S

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Much of the rest of the "V" area with glacial outwash geology is also likely at least moderately susceptible to contamination. Because the entire R-1 zone is residential, the primary concern for aquifer contamination in this area would be from on-site sewage treatment systems. If such systems are properly maintained, the risk of groundwater contamination at current densities is relatively low. The risk could increase significantly, however, with denser development if it is not served by sewers. Groundwater from most of the R-1 zone flows to the southwest, toward the potentially geologically hazardous areas discussed above. Under normal conditions, this groundwater ultimately seeps out in ravines or serves as the source for streams with headwaters in these areas. As just discussed, however, activities that alter the hydrologic regime near these geologically hazardous areas could destabilize slopes and enhance erosion. That would be particularly true in areas with permeable soils or permeable underlying geology.

Litowitz Test

This section evaluates critical areas in the R-1 zone relative to the three *Litowitz* test criteria: whether they are large in scope, complex in structure and function, and of a high rank order. We also evaluate whether lower density zoning would substantially aid efforts to protect the functions and values of such areas.

The *Litowitz* criteria have generally been applied to wetlands, streams, and other fish and wildlife habitat conservation areas, because the importance of these critical areas often relates to their connections with larger systems. The criterion for complexity, however, has also considered whether such larger systems have included other types of critical areas, such as geologically hazardous areas, frequently flooded areas and critical aquifer recharge areas.

Based on the analysis in the last section, we believe there are two critical areas in or affected by the R-1 zone that meet the *Litowitz* criteria: Cold Creek and Lake Leota. Other critical areas were ruled out for the following reasons:

- No wetlands in the R-1 zone are of a high rank order; few, if any, could be argued to be large in scope or unusually complex in structure and function.

- No stream within the R-1 zone beside Cold Creek is of a high rank order. Woodin Creek, while arguably large in scope (at least within the City's jurisdiction) and complex in structure and function, does not support fish in the R-1 zone and supports very few spawning salmon downstream. Juvenile salmonids have been observed in the Woodin Creek's lowest reach, but these have likely been either salmon spawned elsewhere or cutthroat trout, which are common in urban streams and are, in fact, an important predator of salmon. We therefore do not believe that Woodin Creek is of a high rank order.

- Increased density in the R-1 zone would likely have only small impacts on all affected streams beside Cold Creek. These impacts could be further minimized by appropriate stormwater management and mitigation. The portions of the R-1 zone that drain to these other streams (including Little Bear Creek, Woodin Creek, and Daniels Creek—an upper tributary of the Bear Creek system) are small relative to their overall basins. Moreover, existing NGPEs in the upper basin of Woodin Creek would significantly reduce potential downstream impacts.

- Protection of geologically hazardous areas in and adjacent to the R-1 zone depends primarily on proper development practices and stormwater management, not maintenance of R-1 zoning. For example, conveying storm water via fuse welded HDPE pipe down steep slopes to a safe discharge point or detaining storm water in a detention vault or tank rather than a pond.

- To the extent that critical aquifer recharge areas within the R-1 zone are threatened by contamination, the greatest current threat is from inadequate or poorly maintained septic systems. This threat would increase with more dense development on septic systems, but would decrease or be eliminated by development accompanied by sewers serving new and existing development.

Our evaluation of Cold Creek and Lake Leota against the *Litowitz* criteria follows.

Cold Creek

Large In Scope

The Bear Creek watershed, which covers approximately 50 square miles and includes 100 miles of stream habitat and over 30 different tributary systems (King County et al. 1989; Kerwin 2001), is certainly large in terms of its physical size and scope.

Cold Creek is one of the tributary systems within the Bear Creek watershed that also warrants a "large in scope" description. The outlet of Lake Leota is a seasonal contributor of surface flow to the perennially flowing, spring-fed portion of Cold Creek further downstream. Cold Creek is an integral part of the Bear Creek watershed in that it provides cold, clean water to Cottage Lake Creek and to subsequent reaches downstream in mainstem Bear Creek. The Bear Creek watershed is one of the largest producers of naturally spawned salmon for a stream its size in western Washington, primarily because of its large runs of sockeye and Chinook salmon (King County et al. 1989; Kerwin 2001). Conditions that allow the Bear Creek watershed to produce salmonids at a rate greater than other streams its size directly relate to quantity and quality of instream habitat, which is driven in part by the groundwater spring sources provided by Cold Creek. Water quality problems in the Bear Creek Basin include elevated water temperatures (Kerwin 2001). Temperatures in Cold Creek are consistently 5-7°C colder than other streams in the Bear Creek watershed due to its groundwater spring influence, allowing it to serve as a thermal refuge for salmonids (King County 2001a; Kerwin 2001). Although Cold Creek might present a small fraction of the total tributary flow to the Bear Creek Basin, its ability to provide a steady source of cold water to the system in the critical summer and fall months underscores its important influence on instream habitat and salmon production in the Bear Creek Basin and the Greater Lake Washington Watershed.

Complex in Structure and Function

Bear Creek supports populations of Chinook, sockeye, coho, and kokanee salmon, as well as steelhead and cutthroat trout (King County 2001a). Bear Creek is known to contain the largest freshwater mussel population in King County and also contains freshwater sponges, river otters, crayfish, and a good representation of aquatic insects (Kerwin 2001). The diversity and number of aquatic resources in the Bear Creek basin distinguish it as one of the top six natural resource basins in King County in the Waterways 2000 program.

Cold Creek flows through mixed-forested wetlands that include diverse instream structure and complex morphology. The stream contains pool and riffle habitat in its upper reaches with glide and riffle habitat very common in the lower gradient reaches further downstream. A diversity of cold-water macroinvertebrate fauna and salmonids, including cutthroat trout, coho salmon, and even Chinook salmon are present in the stream (King County 2001b). A field visit to Cold Creek in the summer of 2006 by project personnel noted the presence of a wide range of substrate types, including sand, pebble, and cobble. In addition, an abundance of large-woody debris was apparent in the riparian area, providing excellent wildlife habitat for many amphibian, small mammal, and bird species.

The Cold Creek watershed remains relatively undeveloped (King County 2004). Approximately 38% of the watershed is comprised of undeveloped forest, grassland, and scrub/shrub areas. The remaining 60% of the watershed is developed, but over 50% of that area is defined as low intensity development. Moreover, groundwater sources for Cold Creek extend further north, into an area that is almost completely zoned rural (the only exception being the Lake Leota area). Minimal development in the Cold Creek watershed has resulted in high quality biological conditions relative to other developed and developing watersheds in the Greater Lake Washington Watershed. This finding is corroborated by the results of macroinvertebrate sampling in 2002, 2003, and 2005 in the Greater Lake Washington Watershed (King County 2004; King County 2005).

The Cold Creek Natural Area, comprised of nearly 250 acres in the Bear Creek basin, is a very complex stream and wetland system located northeast of the City of Redmond, east of the City of Woodinville, and just south of the Snohomish County line (King County 2001a). The Natural Area contains high quality peat bog wetland habitat as well as reaches of Cold Creek, Daniels Creek and Cottage Lake Creek. Increased structural complexity provided by different vegetation types within the wetland and riparian habitats associated with Cold Creek optimizes potential breeding areas, escape, cover, and food production for the greatest number of species (Hruby et al. 2004).

High Rank Order

Cold Creek is of a high rank order both because of its ecological importance, discussed above, and because actions by the City of Woodinville will be a primary determinant of its future quality. In comparison, approximately 80% of the Little Bear Creek Basin is in Snohomish County and the stream only enters the City of Woodinville just prior to its confluence with the Sammamish River. As such, much of what the City can do to improve Little Bear Creek water quality and habitat pales in comparison to what needs to be done further upstream in the watershed. In contrast, much of what the City of Woodinville decides to do in relation to development in the R-1 zone will play a direct role in determining future water and habitat quality of Cold Creek.

The Bear Creek watershed and Cold Creek in particular rank high among other streams within the Lake Washington Watershed. Bear Creek is one of only two "Tier 1" streams (receiving the highest priority for salmon conservation) in WRIA 8, the other being the lower Cedar River (WRIA 8 2005). Cold Creek was specifically identified in the WRIA 8 Chinook Salmon Conservation Plan (2005) as a stream in need of protection due to its ability to reduce water temperatures in the Cottage Lake Creek/Bear Creek watershed. The WRIA 8 Plan (2005) also recommends that "growth within Woodinville should be managed to minimize impacts" to Cold Creek, further strengthening its importance and ranking related to other streams in the City and other streams in the larger watershed.

Lake Leota

Large in Scope

At 10.4 to 12.3 acres (depending on water level), Lake Leota is the largest lake within the City of Woodinville. Its 505-acre watershed comprises 40% of the R-1 zone and is almost completely contained within it (see Figure II-2). Considered within the City's jurisdictional area, the lake is clearly large in scope. At a regional level, the size and importance of the lake should be considered in the context of its being at the headwaters of Cold Creek. Seepage from the lake contributes to the cool summer water temperatures that are the primary basis for Cold Creek's importance within the Bear Creek system. The lake therefore plays an important role in the 50-square-mile Bear Creek system, which clearly is large in scope.

Complex in Structure and Function

Lake Leota's advance towards eutrophy (high productivity, characterized in part by large and extended algae blooms) is evident by in-lake conditions in late summer/early fall measured in recent years. The lake's eutrophic status has evolved through the complex interaction of multiple factors:

1) Septic and landscaping seepage of nutrients, which has entered shallow peaty soils over glacial gravels of high hydraulic conductivity;

2) Storm runoff of sediments and nutrients *via* surface channels to the lake;

3) Lake shallowing by sediments delivered to the lake *via* surface runoff;

4) Lake shallowing by organic production from algae production, high production of near-shore submergent plants including the exotic Eurasian watermilfoil and/or its hybrid, and high production of near-shore emergent plants, such as the exotic white water lily as well as native yellow water lilies and cattails.

These environmental factors, which increase with greater urban development, have combined to increase nutrient supply to water column algae and rooted plant production, as sediments increasingly interact with well-lit, warm productive surface waters. Entrainment of nutrients from these shallow sediments is becoming an increasingly important nutrient source. Algae blooms, fed by high nutrient levels, are becoming more common.

The shallow band of near-shore rooted plants is now encroaching on open waters in the central lake basin. These plants will continue to make this band wider and more shallow around the lake until wetland conditions predominate across the lake. Continued external loading of sediments and nutrients will eventually transition the wetland to a wet meadow. At that point, lake outflow will be largely *via* a warmer *surface* channel with reduced groundwater seepage outflow from a lakebed sealed with deeper sediments. Cold Creek will have lost part of its cold, clear, high quality water source through the low flow summer/fall months, replaced with warm water that will reduce its capacity to benefit the entire Bear Creek system downstream.

Lake Leota appears to be moving into or is already in a phase when phosphorus (the nutrient that controls the lake's productivity) will regenerate on a self-sustaining basis, recycling nutrients stored in lake sediments. Under those conditions, even maintaining present levels of nutrient loading would likely lead to accelerating eutrophication. In time, a shallower, more eutrophic lake will discharge warmer water downstream to the Cold Creek system.

Heavy metals are also accumulating in lake sediments, well beyond regional background concentrations. Some metals, such as lead and nickel, are now much higher than "consensus" concentrations accepted to cause adverse environmental effects in at least 50% of bottom invertebrate fauna. Accelerating eutrophication will increase the time period each year when bottom sediments become anaerobic (oxygen-starved). This has the chemical effect of increasing the mobilization of these heavy metals from sediments into the water column and uptake by plant and animal communities both in Lake Leota and downstream in the Cold Creek system.

In short, Lake Leota is both complex in structure and function itself and in relation to Cold Creek. If current trends in Lake Leota continue, Cold Creek will become a warmer, lower flow stream in summer/fall, with higher heavy metals concentrations, significantly reducing its value to the entire Bear Creek system. The lake itself will also become a much less attractive amenity for surrounding property owners and the Leota neighborhood.

High Rank Order

For all of the reasons discussed above, concerning both Cold Creek and Lake Leota, the lake clearly is of a high rank order, both within the City and in a regional context.

Implications for Development Densities

Lake Leota

There are a wide variety of actions, or combinations of actions, that could be taken to protect Lake Leota, as discussed in more detail in Chapter III of this report. These include low-impact development (LID) standards for appropriate development in the lake basin, providing sewer service to properties around the lake, controlling the lake outlet, dredging, an aggressive education program regarding best management practices for lakeside property owners and others within the basin, and stormwater and channel improvements upstream of the lake to reduce erosion and high flows. No one action will be sufficient to protect the lake, given the complex factors affecting its water quality, trophic status, and metals accumulation. Under any scenario, one factor that must be addressed for long-term success is to reduce sediment, nutrient, and heavy metal inputs into the lake from stormwater. Zoning density will play a significant role in determining the City's and the community's ability to accomplish this.

Increases in density will almost certainly increase runoff from impervious surfaces and therefore erosive pressures on stream channels. Stormwater management requirements on new development can mitigate this to a degree. But engineered stormwater facilities are short of 100% effective at removing nutrients (such as phosphorus) from stormwater (see Appendix D of this environmental report).

To an extent, stormwater impacts from increased density could be mitigated by requiring LID standards, provided that some developments were exempt from these requirements. But, as discussed in more detail in Appendix D, the potential benefits of low impact development techniques decrease with increased density, particularly above R-2 (two units per acre). Increased density necessarily removes tree cover and soils that the LID techniques rely on for successful stormwater control. Increased density also will impact groundwater quality unless it is served by sewers. Yet in the eastern part of the study area, sewer service would be more expensive given topographic constraints, distance from existing sewer mains, and need for pump stations, which is generally more costly In addition, LID techniques such as infiltration of storm water may not be advisable along steep slopes unless setback appropriately (see also Appendix A of this environmental report for the Golder Inc. "Preliminary Assessment of Hillside Drainages Infiltration").

In short, maintenance of R-1 zoning in the area that drains to Lake Leota—and even removing the possibility of rezones to R-4 with adequate infrastructure—would be a helpful and potentially necessary component of a strategy to maintain the lake's water quality and its supportive role in the regionally unique Cold Creek system. R-4 zoning most likely would lead to a significant increase in phosphorus inputs to the lake from stormwater, which would place a greater burden on other strategies to reduce other phosphorus inputs and on lake management strategies to respond to the results. In the worst case, the increased phosphorus inputs from stormwater would push the lake into a self-sustaining cycle of increased eutrophication, which would threaten serious damage to Bear Creek salmon runs in the long-term or require expensive and ongoing management interventions to avoid.

There is one potential exception to these concerns over increased density in the Lake Leota Basin. As discussed in Appendix C, if sewer service were provided just to the properties around the lake (between NE Woodinville-Duvall Road and NE 180th Street and 160th Avenue NE and 167th Avenue NE), this would likely provide substantial benefits to lake water quality. Even optimally maintained septic systems release a substantial amount of phosphorus in their effluent, which the soils around the lake are poorly suited to remove. Effluent from septic systems further from the lake generally either flows away from the lake or loses more of its phosphorus as it passes through intervening soils before reaching the lake. The benefit to Lake Leota's water quality from connecting properties around the lake to a sewer system would likely be large enough to outweigh the likely increases in phosphorus from stormwater that would result from denser development there, assuming increases in density would be necessary to support the sewer service. However, the gain from sewer service would not outweigh the likely increases in phosphorus from stormwater if substantially more of the Lake Leota basin would need to become more dense to support the service.

An option to sewering near-lake residences would be conversion of existing near-lake septic systems to enhanced septic systems capable of greater nutrient removal. The most common form of these "super septics" is an elevated mound system, in which standard septic tanks discharge effluent to a drain field on an artificially created mound of layered absorbent soils. The built-up drain field distributes liquid effluent on these high quality absorbent materials and is structured to provide ideal porosity, which minimizes clogging yet provides high rates of selective nutrient removal before effluent reaches native soils. Elevated, artificial drain fields have been proven effective where native soils are either too porous or too readily clogged; in either case, the septic system will eventually fail to trap nutrients without this modification.

In the case of Lake Leota, near-lake septic systems probably fail more because of clogging, given the high clay and peat content of soils with anaerobic characteristics. This situation is probably worsened by the likelihood that many drainfields are very close to, or even in, shallow groundwater flows moving to the lake. In this situation, perched drainfields are particularly effective. Nutrient removal efficiency of such perched systems is easily monitored by sampling of groundwater flows downslope of the drainfields via shallow standpipes. Loss of drainfield function can then be surgically remedied by adjustment of fill in individual mounds. As with any septic system, the distance between drainfields and surface water should be maximized; in some situations, leachate could be pumped from the septic tank to drainfields constructed further upslope. Also as with standard septic drainfields, perched drainfields may be landscaped with non-woody plant cover.

School Basin

There is also a part of the R-1 zone that drains directly to Cold Creek (the surface outlet channel from Lake Leota). This 286-acre basin, which includes Wellington Elementary and Leota Junior High Schools (leading us to call it the "School Basin" in this report), has a substantially different relationship to Cold Creek compared to the Lake Leota basin. Based on our current understanding of groundwater flows, groundwater from almost all of the School Basin flows to the west, away from Cold Creek (see Figure II-1), even though its surface water flows to the creek. So the School Basin has little effect on Cold Creek's cold, steady flow in the important summer and early fall months. The basin also has no clearly defined channel through which its surface water flows into Cold Creek, at least as we were able to determine in relatively brief field visits. Much of the stormwater from the School Basin is piped, although there are open channels in parts of the basin (see Figure II-2).

Higher density in the School Basin could potentially have some negative impacts on habitat quality and channel stability in Cold Creek downstream, given the sort of stormwater impacts discussed above for Lake Leota. But Cold Creek is a predominantly groundwater fed stream, with a remarkably

steady flow pattern (see Figure 7 in Appendix A), based on a contributing area considerably larger than the School Basin. Higher stormwater volumes and peak flows from the School Basin would therefore likely have relatively small impacts on habitat quality and channel stability in Cold Creek. From the perspective of the larger Bear Creek system, these are, in any case, less important features of Cold Creek than its steady flow of cold water, which would be largely unaffected by increased density in the School Basin. Higher stormwater flows from the School Basin would also not impact water quality in Cold Creek nearly as much as would higher stormflows from the Lake Leota basin, which would be warmer and carry higher loadings of nutrients and metals. Even in a worst case scenario, including R-4 zoning with no LID and no new public infrastructure to manage increases in stormwater, impacts to Cold Creek's steady flow of cold water would be minimal.

There is, therefore, a much weaker argument on strictly environmental grounds for maintaining R-1 zoning in the School Basin than in the Lake Leota basin. Stormwater management in the School Basin would be important to reduce impacts on downstream habitat quality and channel stability, but with appropriate stormwater management, densities up to R-4 would probably not cause substantial harm to downstream resources. LID, even with its more limited effectiveness at higher densities, would be a valuable component of stormwater management in this area.

III. Conclusions

Based on environmental factors, the conclusions of this study differ for different areas of the R-1 zone, primarily because of complex patterns of surface water drainage and groundwater flow and the special needs to protect Leota Basin and Cold Creek that cannot be accomplished by the standard requirements of the city's critical areas ordinance. The areas include six approximate drainage basins identified in Figure II-2: Lake Leota Basin; the School Basin; the small part of the R-1 zone that drains to Daniels Creek; the upper Woodin Creek Basin; the Hillside Drainages along the slopes of the northwest section of the zone; and the Golf Course Basin in the far northwest corner of the zone. The data collected for this study has been used to determine a broader planning level analysis that identifies whether or not different zoning densities could improve the protection of important critical areas in the city. Taking into account that individual developments are required to protect on-site critical areas such as streams, wetlands, steep slopes, aquifer recharge areas, and others by complying with the Woodinville Municipal Code, Critical Areas Ordinance, Chapter 21.24, the conclusions of this study determined that Lake Leota and the Cold Creek required additional protection through decreased densities.

Lake Leota Basin

Maintenance of R-1 zoning in the Lake Leota Basin, ideally without allowing rezones to R-4 that are conditioned on adequate infrastructure, should provide substantial, long-term benefits to both Lake Leota and Cold Creek by minimizing erosion and other pollutants from stormwater entering Lake Leota. With this in mind, applicable low-impact development (LID) performance standards are encouraged in this area. LID techniques and performance standards are discussed in detail in Appendix D of this environmental report.

Other Considerations

In addition to R-1 zoning, improving stormwater and channel improvements upstream of the lake could address some of the long-term pressures of eutrophication of Lake Leota. These could include new stormwater ponds and treatment facilities to serve existing development, and channel stabilization and riparian improvements where erosion is currently occurring during high flows. A separate study and environmental inventory would be needed to identify these actions, and there necessary funding source.

The separate study could come in the form of a grant from the Washington Department of Ecology to develop a management plan for Lake Leota, which could review all potential actions to protect the lake and help prioritize them most cost-effectively. Sometimes management plans are funded at least in part by management districts, which involve annual pro-rated assessments on properties that potentially impact the resource, depending on the degree of impact.

However, the City need not wait for a lake management plan to take or continue other actions that would benefit the lake such as,

- Continue the current rule against boat engines on the lake. If allowed, propwash from powerboats could disturb the bottom of the shallow lake, which would increase entrainment of nutrients, sediments, and metals into the water column.

- Initiate education and technical assistance to property owners in the basin, particularly those along the lakeshore, regarding best management practices that can benefit the lake. These include:

  - Regular maintenance of septic systems, including upgrading drain fields to enhance nutrient retention;
  - Minimizing the use of fertilizer, particularly phosphorus-rich, artificial fertilizers used on lakeside lawns;
  - Management of aquatic plants (all harvested material should be removed from the lake, to avoid releasing nutrients and metals taken up by the plants back into the lake);
  - Other landscaping issues, including maximizing native vegetation and minimizing lawns near the lakeshore to enhance nutrient retention;
  - Stopping all irrigation pumping from the lake, with or without a permit, to maximize water retention and volume in the lake, thereby maximizing groundwater seepage to Cold Creek;
  - Limiting the size of docks on the lake and designing them to increase the amount of light reaching the water, which will improve the diversity of plant and animal communities near the shoreline; and
  - Avoiding the use of laundry detergents that contain phosphorus, particularly for lakeside property owners.

- Work with King County and lakeside residents to improve monitoring of Lake Leota to better understand its status and trends and to help prioritize management actions. This could include, in order of increasing cost:
  - Monitoring oxygen levels in the lake's water column (particularly in deeper water) to evaluate oxygen deficits each summer and fall (the cost for this would be very low);
  - Monitoring days of anoxic sediments and the extent of the lake bottom that is anaerobic at the peak of summer/fall algae blooms each year, which would aid in evaluating the lake's trophic state;
  - Updating Lake Leota's bottom contour map to permit more accurate measures of the lake's volume;
  - Monitoring lake sediments for metals concentrations on a periodic basis; and
  - Monitoring surface channel inflows to establish water, sediment, nutrient and metals budgets for the lake.

A lake management plan could also help the City and the community further evaluate the potential benefits of:

- Connecting lakeside homes to sewer service – would reduce nutrient input by replacing septic systems with sewer directly around the lake and could create a positive net benefit to water quality even if the R-1 density was amended to R-4. However, modifying existing septic systems to provide extra nutrient removal could potentially provide similar benefits without increasing density.
- Dredging lake sediments – would require state and potentially federal permits.

- Controlling the lake's outlet – is potentially the simplest way to increase the lake's depth, which would enhance seepage to the Cold Creek system, and reduce eutrophication, thus, improving both in-lake and downstream water quality. This action would require state and federal permits.

School Basin

Maintaining the R-1 density in this part of the R-1 Zone is not as important as in the Lake Leota Basin because the surface water flows are only a small portion of the overall flows to Cold Creek. In addition, groundwater from this basin flows to the west and not to Cold Creek or Lake Leota. The emphasis in this area is requiring LID through stormwater performance standards for new development, which would minimize stormwater impacts to Cold Creek. In this case, LID techniques are valuable no matter what zoning density is designated for this basin. They provide the greatest benefit at lower densities but, ironically, they may be more important at higher densities, where the potential impacts to downstream resources would be greater without such extra effort.

In addition, improvements in the City's identification of stream channels and wetlands are also probably more important in this basin than in any other in the R-1 zone. In this study, stream channels in this basin were cursorily identified and need to be further defined. Figure II-2 identifies potential streams based on LIDAR analysis, but they are approximate and need to be further verified. There were also a number of wetlands in this basin that were identified in this study and will need to be accurately located on the City's maps, as shown in Appendix C of this environmental report.

Daniels Creek Basin

The northeastern edge of the R-1 zone drains to Daniels Creek, as shown on Figure II-2. While LID and lower densities essentially always benefit downstream resources, they are less important here, given the considerably larger area that drains to Daniels Creek, all of which is zoned rural outside of Woodinville. Daniels Creek, moreover, flows into Cottage Lake, which attenuates stormwater impacts downstream. The lake's outlet stream, Cottage Lake Creek, is fed in the summer and early fall by the lake's warm upper layer of water, whose temperature is controlled primarily by air temperatures and solar radiation. Changes to the temperature of Daniels Creek therefore have essentially no effect on water temperature downstream of Cottage Lake. (Cottage Lake Creek depends on Cold Creek, which joins it less than ¼-mile downstream of the lake, to provide hospitable temperatures for salmon during the summer and early fall.)

Upper Woodin Creek Basin

LID and lower densities are more valuable here than in Daniels Creek, but not dramatically so, given the relatively small portion of the Woodin Creek basin within the R-1 zone, as well as the substantial Native Growth Protection Easements already in place on either side of NE 177th Drive. These easements provide valuable protection to the upper mainstem of Woodin Creek and, to a lesser extent, the North Tributary. This protection would remain regardless of changes in zoning density. The NGPEs also provide valuable protection for the landslide and erosion hazard areas within and below the easement areas.

Although at this time none of the upper Woodin Creek Basin is currently identified by the City as an erosion hazard area, this study does include these areas as erosion and landslide hazards based on geologic instabilities as well as steep slopes. With this study's review of LIDAR, the latest geologic maps available from the University of Washington, and field reconnaissance, the City's maps will be updated to include this most recent information after completion of the Sustainable Development

Study. Geologic hazards in this area will limit the appropriateness of infiltration as a LID strategy near the steep slope part of the basin. Proper setbacks and stormwater management should address most issues, even at densities higher than R-1, although development of any particular site should receive its own, site-specific geotechnical evaluation. More detailed information is available in Appendix A of this environmental report.

In general, with the latest geotechnical information (see Appendix A of this environmental report), infiltration should be prohibited within 50' from top of slope, and within 50-500 feet should be thoroughly reviewed and supported by geotechnical reports and approved by the city. In addition, any development including single family building permits should be required to convey storm drainage over steep slopes to a safe location using appropriately sized HDPE (high density polyethylene) pipe[9] or similar fuse welded pipe. The pipe is typically installed above-ground and supported with metal collars with pins or some form of anchor to secure the tightline in-place. Above ground installation is preferred as it provides ready access to the pipeline if problems develop and makes for easy detection of leakage should it occur. If aesthetics or other issues are a concern, the pipeline may be buried. Burying the pipeline within a shallow trench will require additional measures such as trench breakers to minimize erosion and piping of the backfill. Some type of energy dissipater structure is necessary at the end of the tightline. Such structures could include a concrete vault with weirs and baffles or grouted or rip rapped open channels. Discharge from the tightline system could be tied into an existing storm water system if one is located in the vicinity, or some form of infiltration facility.

Development not served by sewers would raise similar concerns about effects on slope stability due to infiltration of sewage through on-site systems. R-1 zoning would minimize potential impacts to steep slopes, provided that drainfields are set back at least 50 feet based on geotechnical reports.

There is one large, developable parcel in the north part of this basin where the opportunity for LID is greatest. The 19.8-acre property, which drains to the North Tributary, includes steep slopes, a substantial wetland, and forest that provides valuable wildlife habitat. Whether or not this parcel remains in R-1 zoning, when it is ultimately developed the City should work with the property owner to maximize the potential environmental benefits from this site.

Hillside Drainages

This basin in the R-1 zone is comprised of a collection of many smaller, but steeply incised drainages located in the northwestern edge of the zone. All of the drainages ultimately feed to Little Bear Creek, in many cases passing through an extensive system of underground stormwater pipes after leaving the R-1 zone.

Geologic hazards along the slopes are the primary concern. More detailed information is available in Appendix A of this environmental report (in particular sub-appendix C of the Golder Inc. Hydrologic Study titled "Preliminary Assessment of Hillside Drainages Infiltration"). We would again recommend an update to the City's map of geologic hazards using LIDAR, the latest geologic maps available from the University of Washington, and field reconnaissance.

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[9] Fuse welded HDPE pipe has a smooth interior wall and a continuous welded seam between pipe sections. This method is preferred over bell and& spigot pipes because it decreases the potential of leakage at pipe joints and the pipe itself can withstand most tree falls or other impacts.

All recommendations concerning slope stability, geologic hazards, and infiltration for the upper Woodin Creek Basin would also apply to the Hillside Drainages. See the discussion in the Woodin Creek Basin.

Golf Course Basin

As with the Hillside Drainages, all recommendations concerning slope stability, geologic hazards, and infiltration for the upper Woodin Creek Basin would also apply to the Golf Course Basin. See the discussion in the Woodin Creek Basin.

Golf Course Creek appears to provide a locally important steady source of water for wildlife in the vicinity. Citizen testimony and LIDAR analysis suggest that Golf Course Creek may be perennial. The steep ravine in which Golf Course Creek is located appears to be highly erodable with significant potential for slumps or at least small landslides, which could be significant localized sources of fine sediment in lower Little Bear Creek. Stormwater management in the part of Golf Course Creek's headwaters that is within the R-1 zone should therefore protect against discharges that would cerate additional erosion or further impact downstream systems that are already partially blocked and possibly undersized.

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Appendix A.

Hydrogeologic Analysis for City of Woodinville Sustainable Development Program, Golder Associates

Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, WA USA 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498
www.golder.com

HYDROGEOLOGIC ANALYSIS

FOR

CITY OF WOODINVILLE
SUSTAINABLE DEVELOPMENT PROGRAM

Submitted to:

Steward and Associates
120 Avenue A, Suite D
Snohomish, WA 98290

Submitted by:

Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052

Robert H. Anderson, L.Hg.
Senior Hydrogeologist, Principal

David P. Findley, L.Eg
Senior Engineering Geologist, Associate

Distribution:

2 Copies - Steward and Associates
2 Copies - Golder Associates Inc.

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1.0 INTRODUCTION

This report summarizes one component of an overall technical study being prepared by Steward and Associates that includes an assessment of a number of other issues. The overall study assesses potential effects of development density associated with the R-1 area on critical areas that are large in scope, with complex structures and functions and a high rank order, following the Litowitz criteria. The two critical areas that are the focus of this study are Cold Creek (a tributary of the Bear Creek system) and Lake Leota. The evaluation also addresses how the effects of density can be mitigated through low impact development techniques.

This report summarizes the hydrogeologic and geologic hazards review of the City of Woodinville's R-1 zoning area and its relationship to important critical areas in the vicinity of the R-1 area, and to low impact development considerations. This report is based on a review of the following:

- LIDAR image of the Woodinville Area; 1 inch = 600 feet.
- City of Woodinville; Title 21 Zoning Ordinance.
- USGS Topographic map of the Bothell quadrangle 1: 24,000.
- Recent geologic mapping associated with the Pacific Northwest Center for Geologic Mapping Studies (Troost, personal communication) http://geomapnw.ess.washington.edu.
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Additional references are provided in Section 5.

2.0 CRITICAL AREA REVIEW

This section summarizes basic hydrogeologic information in the City's R-1 zoning area and vicinity.

2.1 Groundwater

2.1.1 Surficial Geology

Figure 1 is a geologic map of the Woodinville area. The map is the most recent update to older mapping and was provided by the University of Washington GeoMap program (Troost, personal communication). The figure describes the distribution of geologic units at the ground surface.

Descriptions of the stratigraphic units, from youngest to oldest, are summarized below:

1. Quaternary alluvium (Qal) – These units consists of recent stream, lake, and landslide deposits. Qal is present in all of the stream drainages and lakes in the study area. It is represented in Figure 1 by the light yellow color.

2. Vashon recessional outwash (Qvr) – This unit is a stratified fine-grained silt to coarse-grained sand and gravel deposit that is moderately sorted to well sorted. The deposition of this unit occurred during the retreat of the Vashon glacier approximately 13,000 to 15,000 years ago. The Qvr is usually present at ground surface and is locally discontinuous. Thicknesses of this unit typically range from <1 to 20 feet. This unit is represented on Figure 1 by a darker shade of yellow.

3. Vashon till (Qvt) – This unit is a very dense to compact poorly sorted composite of clay, silt, sand, and gravel that was glacially transported. Qvt occurs at depth below the Qvr, as well as at ground surface where Qvr is absent or has been eroded, such as a large portion of the upland plateau surface of the R-1 area. It typically forms elongate surfaces less than 30 feet thick, but can be as thick as 150 feet in some places. It is represented by violet in Figure 1.

4. Vashon advance outwash (Qva) – This is a well sorted medium sand and gravel layer deposited from the meltwaters of the advancing Vashon glacier. Qva occurs at depth below the Qvt and at ground surface where Qvr and Qvt are absent or have been eroded. This unit can be over 200 feet thick in some areas, with occasional thin interbeds of silt and clay (Leisch, 1963). It is represented in blue on Figure 1.

5. Pre-Fraser undifferentiated sediments (Qpf) – Very dense and hard interbedded sediments of sand, silt, and gravel. The deposition of this unit pre-dates the Fraser glaciation. It is represented by green in Figure 1.

The surficial geology of the Woodinville area is predominantly Vashon till (Qvt). In the Bear Creek drainage and the area surrounding Lake Leota, the Vashon advance outwash (Qva) deposits have been exposed from the erosion of Qvt. The Vashon recessional outwash (Qvr) deposits are depicted in a channelized form along the Paradise Lake drainage and in the area surrounding Cottage Lake (Figure 1).

2.1.2 Aquifer Units

An aquifer is generally defined as a geologic unit saturated with water and permeable enough to supply sufficient amount of water to a well. In the Woodinville area, there are two aquifers present –

a shallow, unconfined aquifer in the sediments of the Qvr and a deeper, semi-confined aquifer within the sediments of the Qva. The Vashon till (Qvt) is not generally considered to be an aquifer, but it is saturated and capable of transmitting groundwater recharge

The Qva aquifer is located between 20 to 100 feet below ground surface, and daylights (is exposed at the ground surface) along the Little Bear Creek, Paradise Valley and Evans Creek drainages. The aquifer consists of medium to coarse sand, with gravel. Localized zones of finer sand, silt, and clay are reported in various well logs, but the aquifer is generally extensive and relatively homogeneous in composition. The deeper aquifer is locally known as the Cross Valley Aquifer and is an important source of ground water. The Cross Valley Water District, located north of the study area in Snohomish County serves over 6,000 customers using groundwater from the Cross Valley Aquifer. In 1993 and 1994, the Woodinville Water District drilled two wells (PW-1 and PW-2) for water supply in the deeper Qva aquifer, but to date, neither well is in operation (Brown, personal communication, 2006). Currently, all of the water supplied by the Woodinville Water District is bought from Seattle Public Utilities. In 2004, the Woodinville Water District supplied water to over 13,500 customers. By 2020, they are expecting to serve over 25,000 customers.

The shallow, unconfined aquifer exists within the zone of saturation in the Qvr sediments. The Qvr aquifer is not as extensive as the deeper aquifer in the Qva, but it does support some domestic wells, and probably provides baseflow to lakes and streams.

The USGS (Thomas et al., 1997) presented hydraulic properties for the Vashon advance outwash and other hydrogeologic units. The USGS determined hydraulic conductivity based on the specific capacity from water wells in the area. As noted by the USGS (Thomas et al., 1997), the estimated hydraulic conductivity for the low permeability units (Qvt, Qtb, Tb) are biased toward higher values, as wells were only completed in the most permeable materials encountered. The USGS estimated the following hydraulic conductivity values:

		Hydraulic Conductivity (ft/day)		
Hydrogeologic Unit	*Number of Wells*	*Min.*	*Median*	*Max.*
Alluvium (Qal)	30	3.6	88	3,200
Vashon recessional outwash (Qvr)	48	0.08	180	1,800
Vashon till (Qvt)	60	0.04	53	1,000
Vashon advance outwash (Qva)*	171	3.8	86	3056
Transitional beds (Qtb)	16	0.025	20	280
Undifferentiated deposits (Qu)	54	0.22	31	1,800
Tertiary bedrock (Tb)	47	0.0023	0.82	310

Note: *Vashon advance outwash data is a compilation of upper and lower advance outwash and includes analyses of pumping tests in municipal production wells.

The hydraulic conductivity data presented above all pertain to the horizontal direction. The hydraulic conductivity, however, has a different value for groundwater flow in the vertical direction. In horizontally layered materials, the vertical hydraulic conductivity will be less than that for the horizontal direction. Vertical hydraulic conductivity may range from 1/10 to 1/1,000 of the horizontal value. In general, a higher horizontal hydraulic conductivity will correspond to a higher vertical hydraulic conductivity that, in some cases, structural or depositional anomalies (cracks,

fissures, erosional features) can result in higher vertical hydraulic conductivity than would be predicted based on a percentage of the horizontal hydraulic conductivity. No measurements of vertical hydraulic conductivity were identified in the project area. Hydraulic conductivity data in both the vertical and horizontal direction is important in evaluating stormwater infiltration feasibility.

2.1.3 Hydrogeologic Cross Sections

Figure 1 also shows the location of selected wells in the study area and the location of two geologic cross-sections prepared for this report. These sections depict the sub-surface geology based on the well logs located adjacent to the line of section (represented by the thick black lines labeled A-A' and B-B' on Figure 1). The well logs used for both cross-sections are included in Appendix A.

Figure 2 presents a west-east hydrogeologic cross-section showing the subsurface geology across the study area. The interpretations of the subsurface geology are based on the geologic information noted on the well logs available. In this cross-section, the Qva aquifer is exposed at ground surface in the vicinity of Lake Leota and along the valley margins of Bear Creek. The Qva aquifer is overlain by till (Qvt) in all other locations. The shallower Qvr aquifer is present at ground surface around Cottage Lake. The thickness of Vashon till is not well characterized along this cross-section.

Figure 3 is a north-south hydrogeologic cross-section labeled B-B' on Figure 1. In this cross-section, the lower Qva aquifer is completely confined by the overlying Qvt, which separates the Qva aquifer from the upper Qvr sediments. Till thicknesses are generally uniform at around 50 feet.

2.1.4 Groundwater Recharge

Groundwater recharge occurs from precipitation that infiltrates the land surface and percolates through the root zone into the underlying aquifers. Estimates of groundwater recharge on Snohomish County were developed by the USGS as part of the Snohomish County Groundwater Management Program (Thomas et al., 1997). The USGS estimates vary as a function of soil type, impervious surface, and precipitation rate. Assuming a precipitation range of 39.9 to 46.8 inches, the USGS estimated 15 inches/yr to 19 inches/yr of groundwater recharge in areas covered by till soils, and 23 to 29 inches for areas covered by outwash soils. Figure 4 shows the recharge/precipitation relationship for conditions in the vicinity of Woodinville. Other sources of recharge can include surface water bodies (lakes and streams) that contribute water to the underlying aquifers.

2.1.5 Groundwater Quality

Groundwater quality data is readily available for the Qva aquifer, but less so for the Qvr aquifer. The Cross Valley Water District (north of Woodinville) regularly monitors water quality and the USGS sampled many wells throughout Snohomish County in 1993. In general, water quality is very good, with concentrations meeting all Federal and State drinking water standards. Nitrate is a common constituent that is used to assess the general water quality of aquifers and the effects of development. Nitrate has a drinking water standard of 10 mg/L. The wells in the Cross Valley Water District Wellfield have observed nitrate levels ranging from 0.5 to over 4.4 mg/L over the past 10 years, with the highest concentration observed in the Woodlane well, just north of Woodinville. These data suggest that land use activities have affected groundwater quality, but not to levels that would be a concern for water supply and human health.

2.1.6 Groundwater Flow

The direction of groundwater flow can be determined using water level elevations measured in wells. Water levels are plotted on a map and contours are drawn to show lines of constant elevation. Groundwater flows from higher to lower elevations. The direction of groundwater flow is influenced by the geometry of topographic highs and lows, and the presence of streams and lakes. Streams and lakes can be areas of groundwater discharge or areas of groundwater recharge, depending on the elevation of the stream or lake relative to the groundwater. If the stream or lake is located at a lower elevation than the groundwater, it will generally receive groundwater discharge. If it is at a higher elevation than the groundwater, it will generally provide groundwater recharge to the aquifer.

A regional groundwater flow interpretation was prepared for the Cross Valley Water District Wellhead Protection Plan (Golder, 2000) based on approximately 170 wells and a coutour interval of 50 feet. This figure is shown on Figure 5. At a regional scale, groundwater generally follows the local topography and moves from high altitude areas toward stream channels and the edges of the plateau. Mounds of groundwater typically occur under the areas of relatively higher topography with flow radially outward from the center of the mounds. An important regional groundwater divide exists along an approximately north-south alignment trending through Clearview, Maltby and Crystal Lake. Groundwater on the east side of the divide discharges toward Paradise Creek and the Snohomish/Snoqualmie River basin, while groundwater on the west side of the divide discharges toward Little Bear Creek. The divide crosses into King County south of Crystal Lake and trends toward Lake Leota.

Figure 6 shows interpreted groundwater flow contours within the study area for the primary aquifer (Qva Aquifer) based on water level information compiled for 10 wells completed in the Vashon advance outwash. The contour interval for this map is 20 feet. This map is generally consistent with the regional flow map, and the groundwater divide that appears at a regional scale is also present at a local scale.

2.1.7 Cold Creek Springs and Lake Leota

Springs can be found in areas where groundwater elevations intersect the ground surface, which can occur because of geologic anomalies or other factors. Flow and temperature data from Cold Creek and Lake Leota were examined further. The 02k stream gage, maintained by King County, is located approximately 1 mile downstream from the lake (refer to Figure 1) and has recorded temperature and flow data since 2001. Temperature in Lake Leota is available for 2003 and 2004.

Figure 7 compares the temperature of Cold Creek at the 02k stream gage with the temperature of Lake Leota for 2003 and 2004. The temperature of Cold Creek remains relatively constant throughout the year compared to the temperature of Lake Leota, which suggests that Cold Creek is fed by groundwater. The temperature of Lake Leota generally fluctuates by about 15°C, while the temperature in Cold Creek varies by less than 3°C.

2.1.8 Cold Creek Springs and Cottage Lake Creek

Cold Creek mixes with Cottage Lake Creek, which contains important salmon habitat. Figure 8 shows flow and temperature data for both Cottage Lake Creek at stream gage 02L and Cold Creek at stream gage 02K. The Cottage Lake Creek gage is located below the confluence with Cold Creek, and has only been in operation since October 2005. Data for June through September 2006 is not yet available at the Cottage Lake Creek gage (02L). However, the October through May data show that Cottage Lake Creek shows a more pronounced seasonal fluctuation in both flow and temperature

compared to Cold Creek. It is likely that Cottage Lake shows similar temperature fluctuations to Lake Leota. The flow ranges shown on Figure 8 suggest that some sort of flow control regulates flow out of Cottage Lake during the spring and summer. After reaching peak flow in January, flows out of Cottage Lake recede to a level in May that is very similar to the flow during October.

Cold Creek has a cooler temperature than Cottage Lake Creek during the summer and a warmer temperature than Cottage Lake Creek during the winter. The influence of Cold Creek on summer water temperature in Cottage Lake Creek was estimated by a simple mixing calculation summarized in the table below. The table summarizes what changes in temperature might occur as a result of a 0.5 cfs reduction in the flow at Cold Creek Springs. This 0.5 cfs flow reduction is an example only and intended to show, in general, how recharge reduction from increased development might affect water temperature in Cottage Lake Creek.

	Cold Creek (02K)[2]		Cottage Lake Ck (70C)[3]		Cottage Lake Ck (02L)[4]		Delta T[6]
	Q (cfs)	Temp C	Q (cfs)	Temp C	Q (cfs)	Temp C[5]	
Spring	4	8.5	8.0	12.5	12.0	11.17	
Spring[1]	3.5	8.5	8.0	12.5	11.5	11.28	0.12
Summer	4	8.5	2.0	25	6.0	14.00	
Summer[1]	3.5	8.5	2.0	25	5.5	14.50	0.50
Fall	4	8.5	2.0	16.5	6.0	11.17	
Fall[1]	3.5	8.5	2.0	16.5	5.5	11.41	0.24

Notes:
[1] Assumes hypothetical 0.5 cfs reduction in flow to Cold Creek
[2] Approximate values based on observed flows and temperatures (2000 -2005)
[3] Estimated values based on observed range of flows and temperatures at 02L gage during 2005
[4] Approximate values based on observed flows and temperatures (0ctober 2005 - May 2006 only)
[5] Calculated based on simple mixing equation:

$$T_{02L} = \frac{T_{o2K} * Q_{02K} + T_{70C} * Q_{70C}}{Q_{02K} + Q_{70C}}$$

[6] Change in temperature at 02L gage, calculated from hypothetical reduction in flow to Cold Creek of 0.5 cfs

The mixing calculation shows that Cold Creek does help moderate temperatures in Cottage Lake Creek below the inflow from Cottage Lake. A 10 to15% reduction in flow to Cold Creek from groundwater would be expected to result in a modest temperature increase of less than 1 degree C during the summer and less than 0.5 degrees C during the spring and fall.

The mixing calculation suggests that water temperatures below the confluence of Cold Creek and Cottage Lake Creek are affected by the groundwater discharge at Cold Creek Springs. Therefore, a reduction in groundwater discharge to Cold Creek Springs as a result of increased impervious surface could have downstream effects on Cottage Lake Creek outside of the R-1 area.

The magnitude of this effect is uncertain, but would be proportional to the amount of flow reduction.

2.2 Geologic Hazards

2.2.1 LIDAR Data

Golder reviewed the most recent geologic and topographic (LIDAR) mapping of the area, provided in a hard copy by the City of Woodinville. LIDAR is a relatively new technology that allows high

resolution imaging of the ground surface that previously may have been concealed by tree cover using conventional aerial photographic techniques. LIDAR is a particularly powerful tool to complete geomorphic analysis of landforms in heavily forested areas such as the Pacific Northwest. The tree canopy is digitally removed resulting in a "bare" earth image of the land surface resulting in an opportunity to evaluate geomorphic features that heretofore was not possible.

2.2.2 Geologic Setting

The geologic conditions in the Puget Sound Lowland area, including the Woodinville area, have been dominated by several glacial episodes. The most recent, the Vashon Stade of the Fraser Glaciation is responsible for most of the present day geologic and topographic conditions. As world wide sea levels lowered and the Puget lobe of the Cordilleran ice sheet advanced southward from British Columbia into the Puget Sound Lowland, deposits composed of heterogeneous deposits of proglacial lacustrine sediments, advance outwash, lodgment till, and recessional outwash were deposited upon either bedrock or older pre-Vashon sediments. The older Pre-Vashon deposits include predominantly glacial and nonglacial sediments deposited during repeated glaciations and interglacial periods during the past 2 million years. As the Puget Lobe of the Cordilleran ice sheet glacier retreated northward, it uncovered a sculpted landscape of elongate uplands, and intervening valleys and as sea levels rose, the Puget Sound Lowland was re-occupied by marine water form the Pacific Ocean. Post glacial deposits include: alluvium deposited within active stream channels, modern lacustrine deposits, organic silt and local peat deposits within kettle depressions, drainages, and outwash channels; volcanic mudflow deposits and landslide deposits. Many of these older landslide deposits are thought to have resulted from slumping of saturated, ice-marginal outwash deposits.

2.2.3 Geologic Conditions

The geologic conditions around the Woodinville have been mapped by Minard (1983, 1985) and more recently by the Pacific Northwest Center for Geologic Mapping Studies GEOMAP project (Troost, personal communication). The geology generally consists of sediments associated with the last glacial stade to affect the region known as the Vashon stade. The upland plateau area that encompasses the R-1 Area east of the Bear Creek drainage and the Sammamish River Valley is underlain by dense, Vashon lodgment till. The till overlies Vashon advance outwash deposits that are exposed along the side slopes of the Sammamish River Valley and the Bear Creek drainages, as well as the Woodinville-Duvall Road corridor between Lake Leota and Woodinville (Figure 4). The outwash deposits are typically dense, granular deposits of sand and gravel that were deposited in glacial waters in front of the advancing ice sheet and were subsequently over-ridden by the ice resulting in the dense nature of these deposits.

The advance outwash deposits overlie what has been mapped as pre-Fraser Transitional beds by Minard (1985). These deposits are exposed along the base of the east- and west- facing slopes of the Sammamish River Valley in the Woodinville area and generally consist of dense, thin bedded, clay, silt , and fine sand, organic rich silt and local accumulations of peat. This stratigraphic relationship, when combined with high groundwater seepage pressures, is a common cause of slope stability problems on the slopes in the Puget Sound Lowland due to the differences in permeability of the higher permeability advance outwash deposits and the underlying, lower permeability, pre-Fraser deposits.

2.3 Discussion

2.3.1 Groundwater

One important groundwater condition related to the R-1 zoning area and Litowitz test issue is the relationship between the groundwater and each of the three surrounding lakes (Lake Leota, Crystal Lake, and Cottage Lake). Lake Leota appears to be "perched" above the Qva aquifer, and has an elevation similar to Crystal Lake, while Cottage Lake is much lower than both Lake Leota and Crystal Lake and acts as a strong "sink" in the groundwater flow field. Figure 2 shows that the level of Lake Leota is clearly higher than the groundwater level in surrounding wells, with a hydraulic gradient to the east toward Cottage Lake. Figure 3 shows that groundwater levels generally decline from north to south and that Crystal Lake level falls into the regional gradient.

Additional water-level data are needed to confirm the groundwater flow directions suggested here. However it appears that most of the groundwater originating from the R-1 area will flow to the west, toward Little Bear Creek, rather than to the east toward Cottage Lake. This would suggest that recharge from the R-1 Area is less important than inflow from surrounding areas outside the R-1 Area in terms of maintaining flows to Cold Creek Springs. Lake Leota and the area just south of it may provide some infiltration that does reach Cold Creek Springs.

As described in the next section, discharge of groundwater toward Little Bear Creek has potential geotechnical implications.

2.3.2 Landslide Hazards

Based on our review of the background information, the existing Woodinville ordinance captures the majority of the potential landslide hazards within the city limits, with the following exceptions:

1. The current Landslide Hazard delineation is based on the earlier geologic mapping by Minard (1985). As a result, the west-facing slopes in the northern half of the City (generally those located east of 144th Avenue NE.) as well as most of the west facing slopes bordering the upland plateau area are not included in the Landslide Hazard delineation because these slopes do not meet the all of the criteria as outlined in 21.24.290 - specifically, these slopes are not underlain by the requisite stratigraphy referred to in item 2b (hillsides intersecting geologic contacts with relatively permeable sediment overlying a relatively impermeable sediment or bedrock). As mapped by Minard (1985), the Transitional Bed/Advance Outwash contact is located several thousand feet to the west, roughly parallel to Woodinville-Snohomish Rd NE. However, the more recent geologic map prepared by the GEOMAP project places the contact between the Vashon advance outwash deposits and the underlying Pre-Fraser deposits further to the east, closer to the base of the west-facing slope (Figure 4). This stratigraphic relationship, if combined with significant groundwater discharge in this area, may warrant revision to the Landslide Hazard area as delineated by the City of Woodinville. Groundwater discharge is reported in this area, but has not been confirmed in this investigation. The area of potential concern extends in a north-northwest direction from the vicinity of the intersection of NE 171st St/ 143rd Pl. NE at the south City Limits to the vicinity of the intersection of NE N. Woodinville Way and Woodinville-Snohomish Rd. NE.

   Additional geologic evaluation was completed to increase the understanding of the stratigraphic conditions in the vicinity of the west-facing hill slope drainage area.

Activities completed for the additional evaluation included: 1) a ground reconnaissance of the west-facing slope in the general area extending from the King/Snohomish County line to NE N. Woodinville Way; 2) review of several geotechnical reports completed for projects located in the general area between 140th Ave. NE and the base of the west-facing slope, and 3) excavation of two exploratory test pits in the vicinity of NE N. Woodinville Way and 140th Ave. NE. The results of these activities are that the current GEOMAP mapping by Troost and others appears to delineate the stratigraphic conditions accurately. Based on our evaluation, the west-facing slope appears to be underlain primarily by granular Vashon advance outwash deposits as mapped by Troost and others. Interstratified within the advance outwash are minor beds of compact finer grained lacustrine or quiet water deposits that locally perch groundwater forming springs where the phreatic surface of the groundwater intersects the slope. Evidence of such beds is located within the northernmost drainage located adjacent to the County Line where groundwater discharge was noted and evidence of small scale sloughing of the slopes was noted during the reconnaissance. These conditions appear to be confined to the north end of the slope. In addition, several small occurrences of remnant till pockets were noted elsewhere on the slope.

2. The main conclusion from the landslide slope hazard evaluation is that the main contact that is interpreted to drive the Landslide Hazard Ordinances (i.e. the contact between the hard, fine grained, low permeability Pre-Fraser deposits and the overlying granular, more permeable Vashon advance outwash deposits) is not exposed in the west-facing slope of the R-1 area. However, beds that are interpreted as minor fine grain beds within the granular outwash sediments appear to locally perch groundwater creating local springs. See Section 4 for conclusions and recommendations related to infiltration.

3. Several areas within the city limits exhibit geomorphic characteristics indicative of older landslides. Such evidence commonly includes: an arcuate, amphitheater shaped head scarp areas, hummocky topography, and dissected terrain. An example of such a geomorphic feature is the area located east of NE Woodinville Duvall Rd. and south of NE Woodinville Duvall Road. This area has the appearance of older, probably pre historic landslide but likely Holocene in age. Many of the older, pre-historic landslides are interpreted to have occurred during the recessional phase of the Vashon stade glaciation when saturated, ice-marginal deposits failed after the buttressing effect of the glacial ice was removed. These older landslide deposits have remained relatively stable under the present climatic conditions. However, these older landslide deposits may become destabilized when something is altered that affects the equilibrium of the slope. Such factors that could directly affect the equilibrium are ill-advised grading activities that include cuts made in the toe area of an old landslide mass or the placement of fill near the head of the landslide mass. Additionally, activities that alter the hydrogeologic regime such as increased infiltration or inappropriate storm water management practices can cause changes to the hydrogeologic conditions that result in destabilization and remobilization of an old landslide mass.

2.3.3 Erosion Hazards

Erosion hazard classification is based on a combination of two factors: slope angle and the type of soil mapped by the Natural Resource Conservation Service (formerly the Soil Conservation Service, USDA). The erosion hazard criteria follow that of King County as defined in the Sensitive Areas Map Folio (Dec. 1987). The west-facing slope located at the north end of the City is mapped as underlain by Alderwood gravely sandy loam (map symbol AgD), a common soil type derived from the glacial sediments in the region. Alderwood gravely sandy loam (AgD) is described by the SCS as Alderwood gravely sandy loam on 15 to 30 percent slopes as having a severe erosion hazard.

Considerations related to the erosion hazard areas and the higher density rezoning issues will be related to surface water drainage effects on erosion potential. Based on a cursory review of the existing R-1 conditions, it appears that surface water drainage is handled with open ditches and surface water infiltration ponds. The effect of future zoning decisions on surface water drainage and subsequent erosion hazard will depend on a number of factors. Surface water infiltration could change the timing and magnitude of recharge to the shallow aquifer and subsequent discharge to streams or seeps. Depending upon the local thickness of the dense, low permeable lodgment till that mantles most of the upland surface beneath the R-1 area, surface water infiltration may be problematic. Any infiltration pond will have to be deep enough to penetrate the thickness of till thus allowing surface water to infiltrate into the more permeable underlying advance outwash deposits.

3.0 SUSTAINABLE DESIGN OPPORTUNITIES

3.1 Stormwater Infiltration Approaches

As described in Section 2, the USGS estimates 15 inches/yr to 19 inches/yr of groundwater recharge in areas covered by till soils, and 20 to25 inches for areas covered by outwash soils. This is deep recharge and is not typically used for engineering or geotechnical designs of stormwater infiltration facilities. Engineering design is typically based on soil type and short-term infiltration rate testing.

Figure 9 is a map showing the soil coverage in the Woodinville area. The two main soil types that exist within the R-1 area are the Alderwood soils – represented by purple; and the Everett soils – represented by the light-olive green color. A description of these soil types and their infiltration rates are summarized below:

1. Alderwood (AgB, AgC, AgD)– This soil type is described as a gravelly sandy loam and is usually found in the glacial till (Qvt) plains of Snohomish and King County. The Natural Resources Conservation Service (NRCS, 2006) describes this soil type as being moderately well drained with slow to medium runoff potential. The Alderwood soils are classified in the Hydrologic Soils Group C and have a long-term infiltration rate of 0.05 in/hr to 0.15 in/hr when thoroughly wetted (NRCS, 1972, 1998). The equivalent King County Runoff Time Series (KRCTS) classification for this soil type is "till" (King County, 2005). Perched water tables often occur at depths of 18 to 36 inches, depending on the depth to the hardpan surface (range is typically 20 – 40 inches).
2. Everett (EvB, EvC, EvD, EwC) – This soil type is described as a gravelly sandy loam and is usually found in the areas of glacial outwash deposits (Qva). A typical depth for this soil type is about 60 inches. The NRCS classifies the Everett soils in Hydrologic Soil Group B, which has a typical long-term infiltration rate of 0.15 in/hr to 0.30 in/hr when thoroughly wetted (NRCS, 1972, 1998). The NRCS-equivalent KRCTS classification for this soil type is "outwash" (King County, 2005).

In 2004, Earth Consultants, Inc. dug several test pits in the vicinity of 156th Avenue NE and NE 205th Street in Woodinville. They found the common thickness of the Alderwood soil to be from 2 to 12 inches with an occasional thickness of 16 inches. All of the soil in the area is underlain by silty sand and dense glacial till (Qvt). Some of the test pits had iron oxide staining; an indication of seasonal fluctuation in groundwater seepage. This is consistent with the reports of perched groundwater tables by the NRCS. No infiltration rate testing was reported, but detention vaults were recommended with foundation depths at 10 to 15 feet below land surface (ECI, 2004).

The Washington Department of Ecology (WDOE) classifies the Everett soils in the Hydrologic Soil Group A and the Alderwood soils in the Hydrologic Soils Group C (WDOE, 2001). Group A is characterized by the NRCS as having a low runoff potential and a long-term infiltration rate greater than 0.30 in/hr (WDOE, 2001). Group C is characterized as having moderately high runoff potential and an infiltration rate in the range of 0.05 in/hr to 0.15 in/hr (WDOE, 2001).

The WDOE's 2001 Stormwater Management Manual for Western Washington reports recommended short-term and long-term infiltration rates for designing an infiltration facility (WDOE, 2001). The infiltration rates presented in the manual are for different soil types based on the USDA Soil Textural Classification. For a loamy sand, the short-term and long-term infiltration rates are 2 in/hr and 0.5 in/hr, respectively. For a sandy loam, the short-term and long-term infiltration rates are 1 in/hr

and 0.25 in/hr, respectively. The USDA grain size distribution test should be used in order to determine whether a soil is a sandy loam or a loamy sand (WDOE, 2001).

A soil infiltration study conducted by the Civil and Environmental Engineering Department at the University of Washington (Massman, 2001) compiled tested infiltration rates for different soils in King County and compared their values with similar soil infiltration rates reported by WDOE. The table below summarizes the test results compiled in King County. For Alderwood sandy loam, WDOE reports an infiltration rate of 0.6 in/hr, but Massman measured 1.18 in/hr. For the Everett gravelly sand loam, WDOE reports 10 in/hr, but Massman measured 7.2 in/hr to 14.4 in/hr.

SCS Soil Type	WDOE Rate (in/hr)	Reported Soil Type	Measured Infiltration Rate (in/hr)	Site Location	Testing Method
Everett gravelly sand loam	10	very gravelly coarse sand	7.2	Winterwood Estates	Single Ring Infiltrometer
Everett gravelly sand loam	10	very gravelly coarse sand	14.4	Winterwood Estates	Single Ring Infiltrometer
Sandy loam/cobble	4	Sandy loam/cobbles	59.2	Sno-Woodway Meadows Undis.	Double Ring Infiltrometer
Sandy loam	0.25	Sandy loam	16.7	Woodway Meadows Dist.	Double Ring Infiltrometer
Sandy loam/cobbles	4	Sandy loam/cobbles	14	Tall Timbers	Double Ring Infiltrometer
Sandy loam	10	Coarse-grained material	0.25	Issaquah Highlands	Stage
Sandy loam	10	Coarse-grained material	1.38	Issaquah Highlands	Stage
Alderwood sandy loam	0.6	Loamy sand	1.18	Union Hill TRENCH (roof runoff)	Stage
Silty sand loam	0.25	Silty sand loam	2.7	Cimarron Div. 1	Falling Head
Silty sand loam	0.25	Silty sand loam	3.75	Sunridge Estates	Falling Head
Gravel/coarse sand	10	Gravel to coarse sand	66	Beaver Lake	Falling Head
Gravel/coarse sand	4	Well graded f-c sand	0.96	Redmond Ridge	Falling Head
Gravel/coarse sand	4	Well graded f-c sand	4.62	Redmond Ridge	Falling Head
Gravel/coarse sand	4	poorly graded sand	21.6	Redmond Ridge	Falling Head

Source: Massman, 2000.

The feasibility of infiltrating stormwater in the R-1 Area will be based on a combination of site size and layout, engineering feasibility, and sub-surface conditions. For assessing groundwater impacts and opportunities, it is usually best to identify one or more options that are feasible from a planning and engineering standpoint, and then evaluate groundwater as part of a final site selection or design exercise. An important aspect of infiltration feasibility will also relate to geologic hazards along the western boundary of the R-1 area. Increased infiltration could increase the potential for slope instability; see Appendix C for more discussion.

3.2 Density Choices

Increases in housing density could have a negative impact on groundwater quantity by decreasing the amount of recharge the aquifer receives. This is caused by the construction of impervious surfaces in the form of buildings, roads, and parking lots. Declines in recharge on the R-1 area related to future development could reduce discharge to small streams that flow to Bear Creek. The overall consumptive use of groundwater also increases with housing density, which can lead to long-term water level declines if consumptive use exceeds recharge. Based on available information, a significant reduction in groundwater baseflow to Cold Creek Springs is not anticipated because of the configuration of the groundwater divide. However, additional water-level data is needed to confirm the interpretation of groundwater flow directions. Sustainable development approaches to stormwater management can be expected to minimize the effects of higher density on groundwater recharge. However, along the western portion of the R-1 area, infiltration of stormwater should address the potential for slope instability and erosion.

Negative impacts on groundwater quality could also result for the same reasons. Infiltration of run-off from lots, and buildings can lead to groundwater contamination by petroleum products, and heavy metals. Careful engineering design and treatment strategies for stormwater can be expected to minimize the effects of higher density on groundwater quality. The most important decision related to density in the R-1 area will be related to septic systems. If the R-1 area develops at a higher density (greater than 1 unit per acre) without connecting to sewer, there is a high likelihood that groundwater contamination will occur, possibly to levels that would exceed state drinking water standards. In some cases, specific areas could accommodate some additional development using on site septic systems without significant impacts to water quality. However, at the scale of the 1,100 acre R-1 area, densities of greater than 2 units per acre on septic would be expected to cause measurable groundwater quality degradation. Additional water-quality data and analysis would be needed to develop a baseline and project possible effects from various build out scenarios, or to evaluate specific sites.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Significant Findings – Groundwater

4.1.1 Cold Creek

The most significant finding related to groundwater is that the available hydrogeologic data do not suggest a clear relationship between zoning density in the R-1 area and the surrounding sensitive areas around Cold Creek and Lake Leota area. Groundwater effects from development in the R-1 area are most likely to impact areas to the west; though some impact to Cold Creek Springs is possible.

4.1.2 Aquifer Recharge

The R-1 Area does contain areas where an important aquifer is exposed near the ground surface, and impacts to groundwater quantity could result from increased density in the R-1 area. Increased impervious area could reduce groundwater recharge. Reduction in recharge from increased impervious surface can be minimized through management of stormwater that encourages infiltration. However, increased infiltration, particularly near the western margin of the R-1 area, could increase the risk of slope failure and should be reviewed on a site-by-site basis with additional data.

Increased population could place additional demands on the Woodinville Water District water supply, requiring the use of existing, but unused, groundwater wells in the R-1 zoning area. Potential impacts from reduced recharge and increased pumping, however, would likely occur in areas outside of the Lake Leota area and would be superimposed upon larger scale regional groundwater flows discharging along the eastern slope of the Bear Creek drainage.

4.1.3 Groundwater Quality

Impacts to groundwater quality will also result from increased density in the R-1 area. The magnitude of impacts to groundwater quality will be minimized by the use of sewers, rather than septic systems, for wastewater discharge. Similar to management of groundwater quantity water quality impacts can be minimized through management of stormwater, and development of spill response plans to address discharges of hazardous materials.

4.2 Significant Findings – Geologic Hazards

4.2.1 Landslides

The most recent geologic mapping by Troost (in progress) places an important geologic contact between the Vashon advance outwash deposits and the underlying Pre-Fraser deposits further to the east than mapped earlier by Minard (1985). The position of this contact affects the criteria used to classify landslide hazard areas. This stratigraphic relationship, if combined with groundwater discharge in this area, warrants revision to the Landslide Hazard area as delineated by the City of Woodinville. Groundwater discharge is reported in this area, and has been confirmed in this investigation, particularly in the Golf Course drainage. The position of this contact is one factor, but not the only factor that affects the criteria used to classify landslide hazard areas. Other factors are presented on page A-3 of Appendix A.

Based on our review of the available information, the field reconnaissance, and subsurface exploration, it is our opinion that the west-facing slopes located adjacent to the R-1 rezone area (the

Hillside Drainages and the Upper Woodin Creek Basin) should be classified as Landslide Hazard Areas. This is based on the following criteria:

1) Evidence of historic slope movements in the Golf Course drainage, and

2) Slopes steeper than 15 percent with local evidence of seepage, and minor interbeds of fine grain low permeability strata.

While it is our opinion that geologic conditions related to landslide hazards are rather localized in nature, they do exist in some areas of the Hillside Drainages and Upper Woodin Creek basin.

Several areas within the city limits exhibit geomorphic characteristics indicative of older landslides. Many of the older, pre-historic landslides are interpreted to have occurred thousands of years ago and have remained relatively stable under the present climatic conditions. However, these older landslide deposits may become destabilized when something is altered that affects the equilibrium of the slope. Activities that alter the hydrogeologic regime such as increased infiltration or inappropriate storm water management practices can cause changes to the hydrogeologic conditions that result in destabilization and remobilization of an old landslide mass. Appendix C contains a preliminary example of a geotechnical evaluation related to infiltration and slope stability. Based on conservative assumptions about stormwater infiltration, aquifer geometry, and geotechnical parameters related to slope stability, Appendix C of this report indicates that infiltration of stormwater at distances of 500 feet or more from the crest of the slope appear unlikely to cause a significant increase in the risk of slope failure in the Hillside drainages sub-basin. Infiltration at distances of 50 feet or less from the crest of the slope could increase the risk of slope failure, particularly for aquifer conditions with lower hydraulic conductivity, which causes higher mounding beneath an infiltration pond. Site-specific information on shallow aquifer properties, stratigraphy, groundwater flow direction, and infiltration capacity is needed to determine infiltration feasibility at specific locations greater than 50 feet from the slope.

4.2.2 Erosion

Surface water infiltration could change the timing and magnitude of recharge to the shallow aquifer and subsequent discharge to streams or seeps. Depending upon the local thickness of the dense, low permeable lodgment till that mantles most of the upland surface beneath the R-1 area, surface water infiltration may be problematic. Any infiltration pond will have to be deep enough to penetrate the thickness of till thus allowing surface water to infiltrate into the more permeable underlying advance outwash deposits.

4.3 Recommendations

- Regardless of the City's decision on zoning or density, protection of groundwater and geologically hazardous areas will continue pursuant to the City's existing critical areas requirements. Assuming that increases in residential development density will occur in conjunction with sewers, the primary issue will be associated with stormwater management (increased impervious surfaces). At higher density, the number and severity of potential issues increases, but they are not eliminated by a lower density alternative. We therefore recommend that the City provide adequate hydrogeological support to the City's Planning Department during permit review so that site specific conditions related to groundwater recharge and geologic hazards are adequately investigated and addressed keeping in mind the requirements indicating where infiltration is limited (see below).

- We recommend that the Hillside Drainages and slopes greater than 15% in the Upper Woodin Creek Basin be classified as Landslide Hazard Areas. We recommend that stormwater infiltration be limited or avoided within 50 feet of steep slopes, in the hillside basin, and that for areas between 50 and 500 feet additional geotechnical information be required. This recommendation is based on the geologic conditions in these sub-basins and the worst case infiltration and slope stability analysis conducted in this investigation. Site specific studies should be required to confirm or refute the presence and severity of hazards on a case-by-case basis.
- We recommend that the City revise the Critical Aquifer Recharge Area (CARA) map to reflect the updated geologic mapping identified in this study.
- Existing regulatory guidance, including Washington State Water Quality Standards (Chapter 173-200 WAC), Washington Department of Ecology Critical Aquifer Recharge Area Guidance (Ecology, 2001 and Ecology 2005), King County Groundwater Management Program (Chapter WAC 173-100), and King County Critical Aquifer Recharge Area (CARA) Designations and Best Available Science (BAS) documentation, should be used in managing permitted activities in CARA's.
- Additional hydrogeologic data would be unlikely to change general conclusions regarding the hydraulic relationship of the R-1 zone to Cold Creek Springs; and regarding geologic hazards along the western R-1 area. While additional precision regarding the extent of specific geologic strata or groundwater flowpaths would be "nice to have", we do not think additional data collection is necessary for the sake of supporting zoning decisions.
- We recommend that other drainage-related issues than those mentioned above and associated with groundwater and geologic hazards be addressed on a case-by-case basis or through the update to the stormwater management plan, assuming that conceptual level stormwater design alternatives and location information is included as a starting point.
- Over the longer term, we recommend collecting and/or compiling a database on the geology and hydrology in the R-1 Area to document and monitor hydrogeologic conditions within the R-1 area over time. Data from existing wells and test pits should be targeted first, followed by installation of new piezometers as needed.

5.0 REFERENCES

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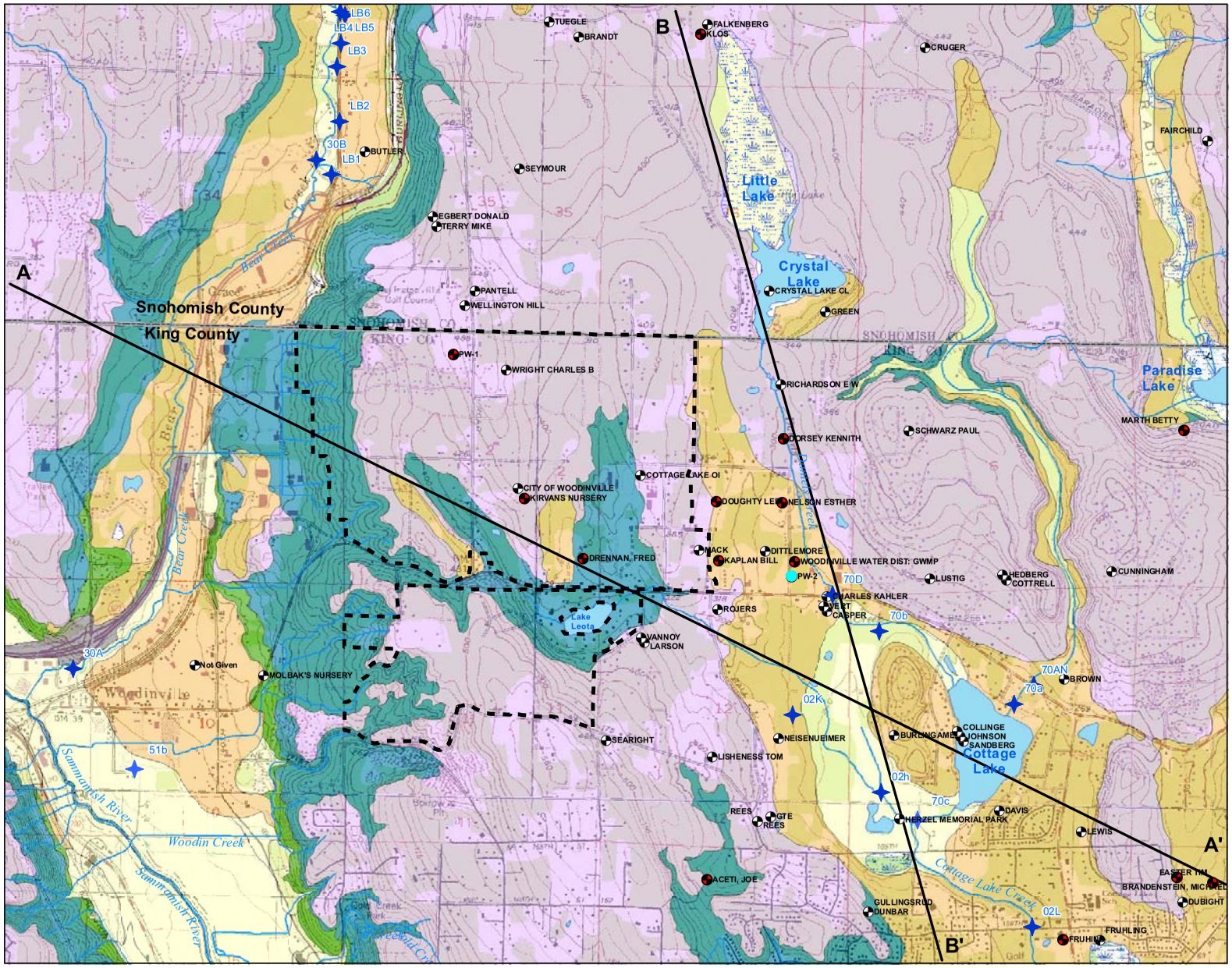
Washington Department of Ecology, 2005. Stormwater Management Manual for Western Washington, Prepared by Ecology Water Quality Program, February 2005. Ecology Publication Numbers 05-10-029 through 05-10-033.

FIGURES



LEGEND

- Active Stream Gage
- Inactive Stream Gage
- Well
- Well with Water Level Data
- Stream
- Cross Section
- Water Level Contours (FT AMSL)
- County Boundary
- City of Woodinville R-1 Zoning
- Lake or Pond
- Swamp or Marsh

Geologic Units

- Qal -Alluvium
- Qmw - Mass wasting deposits (landslides)
- Qpf - Pre-Fraser undifferentiated sediments
- Qva - Vashon advance glacial outwash
- Qvr - Vashon recessional glacial outwash
- Qvt - Vashon glacial till
- m - Modified land

0 2000
Scale in Feet

N

Map Projection:
Washington State Plane,
North Zone, NAD 83, Feet
Source: USGS, King County,
NHD, WSDNR

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **1**

GEOLOGIC MAP OF WOODINVILLE R-1 AREA

SA/WOODINVILLE HYDROGEO SVCS/WA

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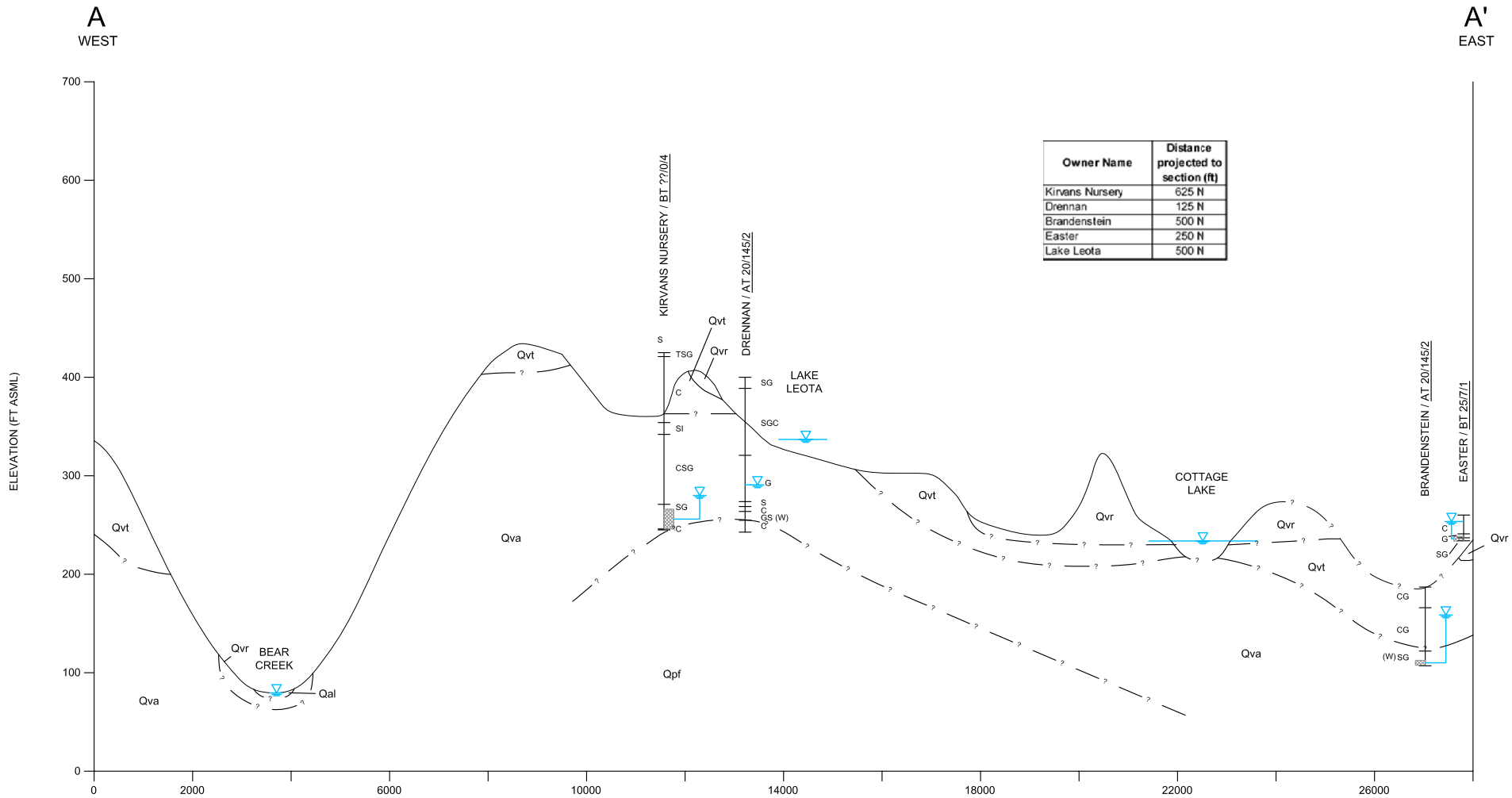
Golder Associates



Owner Name	Distance projected to section (ft)
Kirvans Nursery	625 N
Drennan	125 N
Brandenstein	500 N
Easter	250 N
Lake Leota	500 N

LEGEND

ESTHER — OWNER NAME
PT 10/44/4 — WELL TESTING RESULTS
C
CS — SOIL TEXTURE
WATER LEVEL
SCREENED INTERVAL

SOIL TEXTURE DESCRIPTIONS

B = BOULDERS
G = GRAVEL
S = SAND
SI = SILT
C = CLAY
T = TOP SOIL
(W) = WATER
(C) = CEMENTED
TILL = SAND, GRAVEL AND BOULDERS IN A MATRIX OF SILT AND SAND

WELL TESTING RESULTS

TEST TYPE:
PT= PUMP TEST
BT= BAILER TEST
AT= AIR TEST

PT 10/44/4
TEST FLOW (GPM)
*WELL DRAWDOWN (FT)
TEST DURATION (HRS)

*FOR AT : WELL DRAWDOWN = STEM SET (FT)

GEOLOGIC UNITS

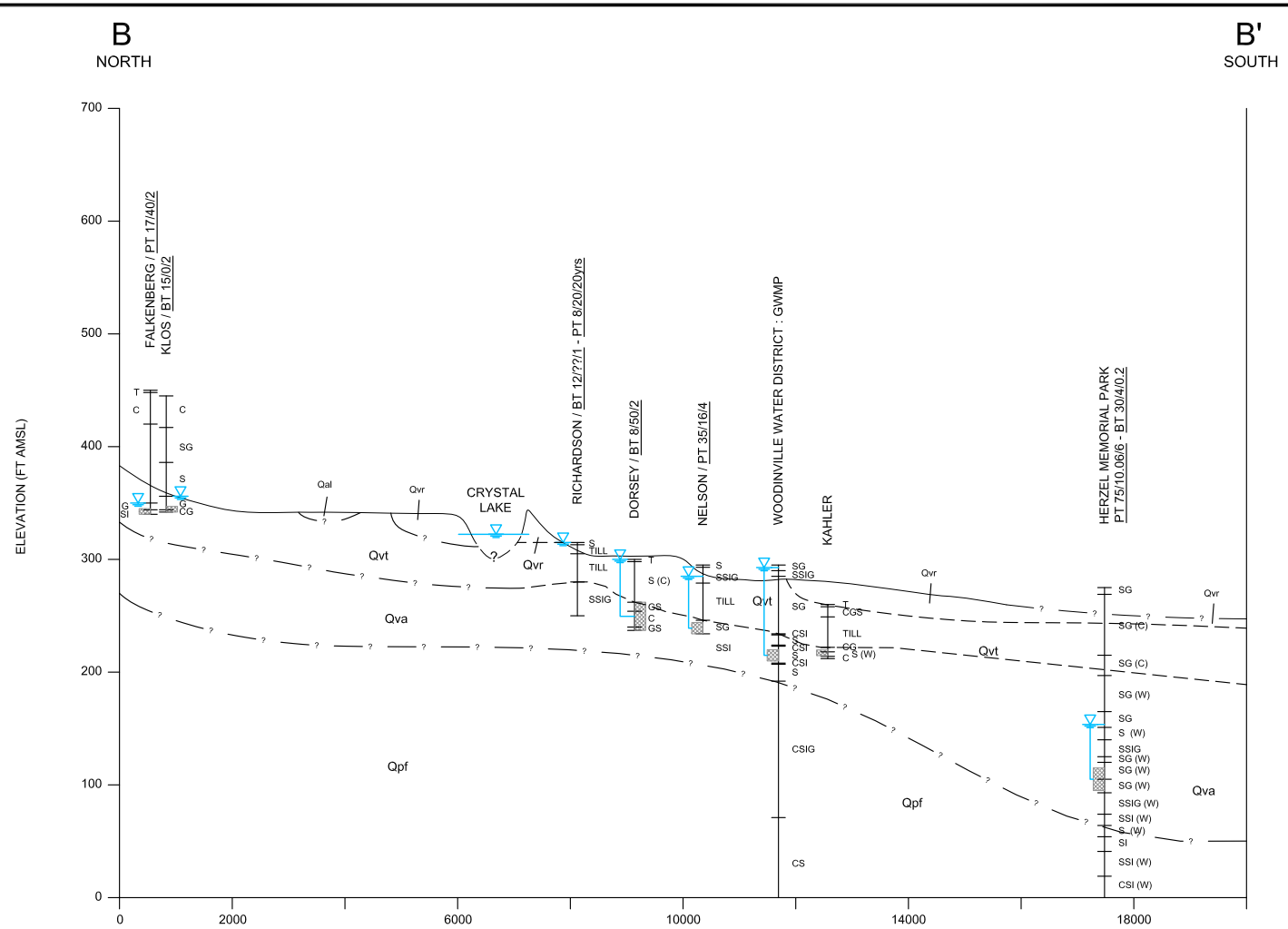
Qal = ALLUVIUM
Ovr = VASHON RECESSIONAL OUTWASH
Qvt = VASHON TILL
Qva = VASHON ADVANCE OUTWASH
Qpf = PRE-FRASER UNDIFFERENTIATED DEPOSITS

0 2000 4000
SCALE IN FEET
VERTICAL EXAGGERATION = 20x

FIGURE **2**
CROSS SECTION A-A'
S&A/WOODINVILLE HYDROGEO SVCS/WA

06312304F01.dwg | Layout: A-A' | Modified: 08/25/2006, 11:41 | Plotted: 09/13/2006, 14:21

Golder Associates



Owner Name	Distance Projected to Section (ft)
Falkenberg	500 E
Klos	375 E
Richardson	0
Dorsey	250 W
Nelson	625 W
Woodinville Water District: GWMP	750 W
Kahler	250 W
Herzel Memorial Park	0

LEGEND

ESTHER — OWNER NAME
PT 10/44/4 — WELL TESTING RESULTS
C
CS — SOIL TEXTURE
WATER LEVEL
SCREENED INTERVAL

SOIL TEXTURE DESCRIPTIONS

B = BOULDERS
G = GRAVEL
S = SAND
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C = CLAY
T = TOP SOIL
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AT= AIR TEST

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TEST FLOW (GPM)
*WELL DRAWDOWN (FT)
TEST DURATION (HRS)

*FOR AT : WELL DRAWDOWN = STEM SET (FT)

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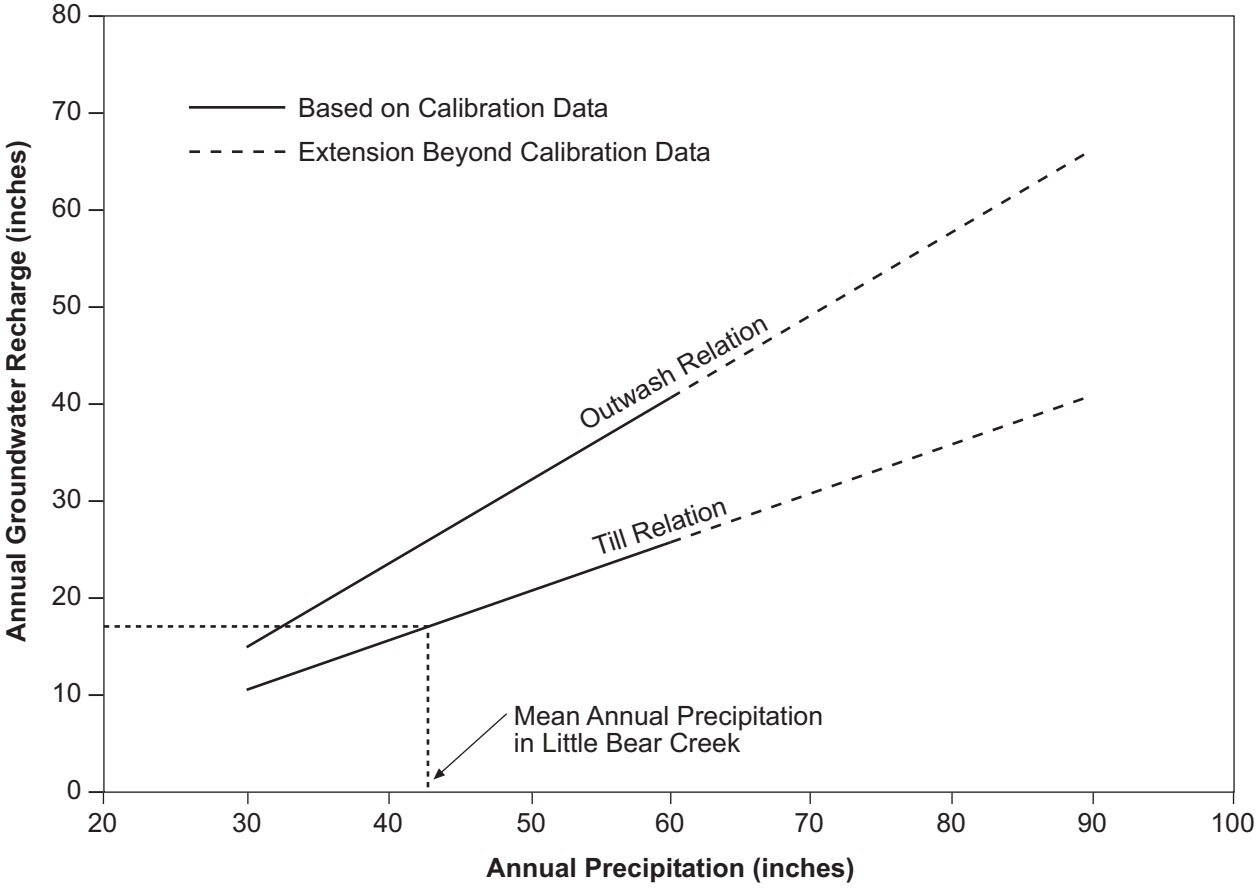
Qvt = VASHON TILL
Qva = VASHON ADVANCE OUTWASH
Qpf = PRE-FRASER UNDIFFERENTIATED DEPOSITS

0 2000 4000
SCALE IN FEET
VERTICAL EXAGGERATION = 20x

FIGURE 3
CROSS SECTION B-B'
S&A/WOODINVILLE HYDROGEO SVCS/WA

06312304F01.dwg | Layout: B-B' | Modified: 08/25/2006, 11:41 | Plotted: 09/13/2006, 14:22

Golder Associates



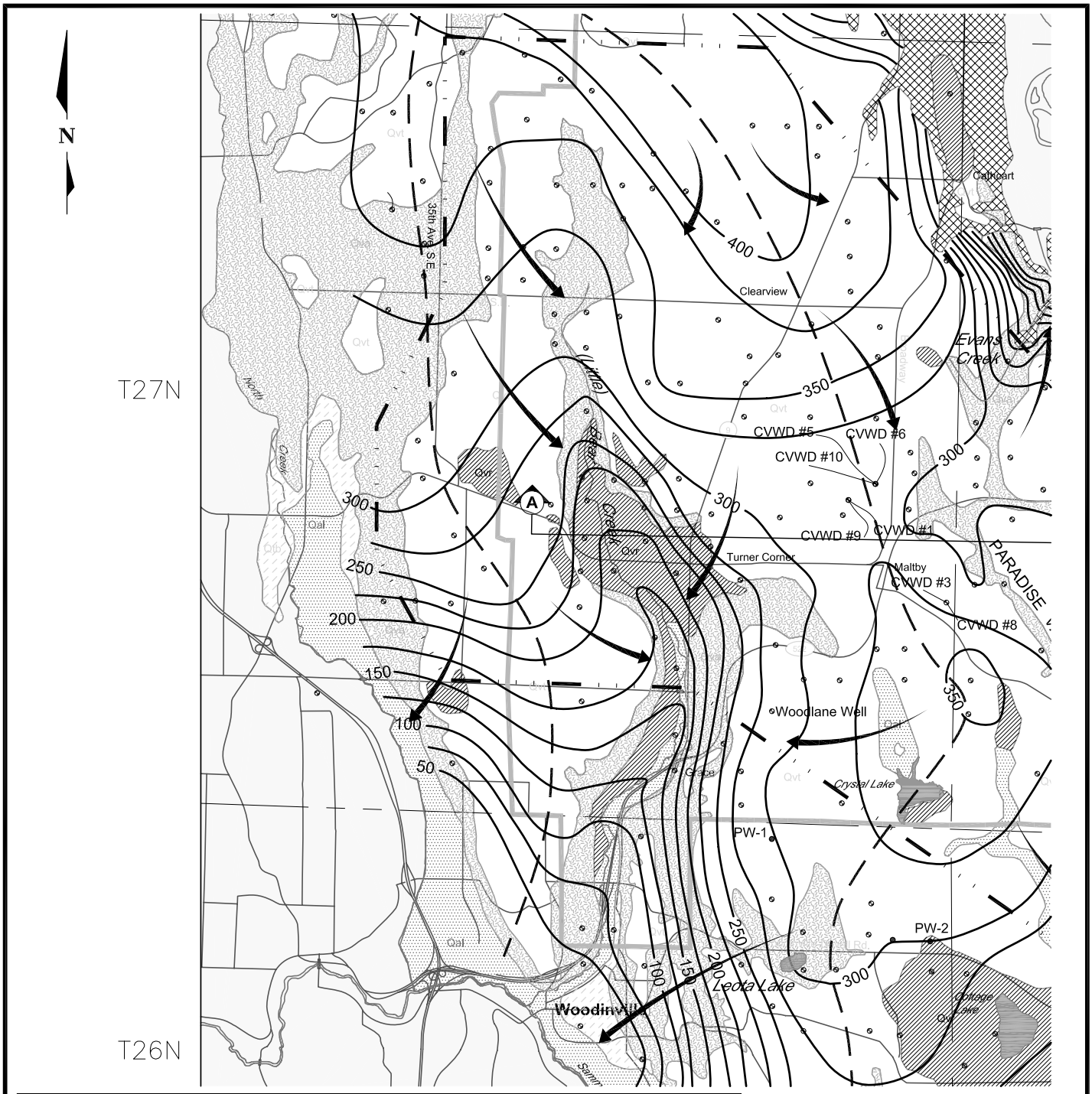
Source

USGS Water Resources Investigations
Report 96-4312, Thomas et al., 1997

FIGURE **4**

PRECIPITATION-RECHARGE RELATIONSHIPS FOR WESTERN SNOHOMISH COUNTY, WASHINGTON

S&A/WOODINVILLE HYDROGEO SVCS/WA



LEGEND:

- 200 — GROUNDWATER ELEVATION CONTOUR
- INFERRED GROUNDWATER FLOW DIRECTION IN THE CROSS VALLEY AQUIFER
- WATER WELL
- PW-1 — WOODINVILLE WATER DISTRICT WELL LOCATION AND DESIGNATION
- CVWD #1 — CROSS VALLEY WATER DISTRICT WELL LOCATION AND DESIGNATION
- A A — GEOLOGIC CROSS SECTION LOCATION
- CVWD SERVICE AREA BOUNDARY
- SOLE SOURCE AQUIFER BOUNDARY
- INTERPRETED GROUNDWATER DIVIDE

GEOLOGIC UNITS:

- ORGANIC DEPOSITS (Qm)
- ALLUVIUM (Qal)
- RECESSIONAL OUTWASH (Qvr)
- TILL (Qvt)
- ADVANCE OUTWASH (Qva)
- TRANSITIONAL BEDS (Qtb)
- UNDIFFERENTIATED DEPOSITS (Qu)
- BEDROCK (Tb)

OTHER SYMBOLS:

- WATER
- LAND OUTSIDE OF PROJECT AREA

NOTE:
This map was developed from existing maps prepared by the U.S. Geological Survey.

0 6000 1200
SCALE IN FEET

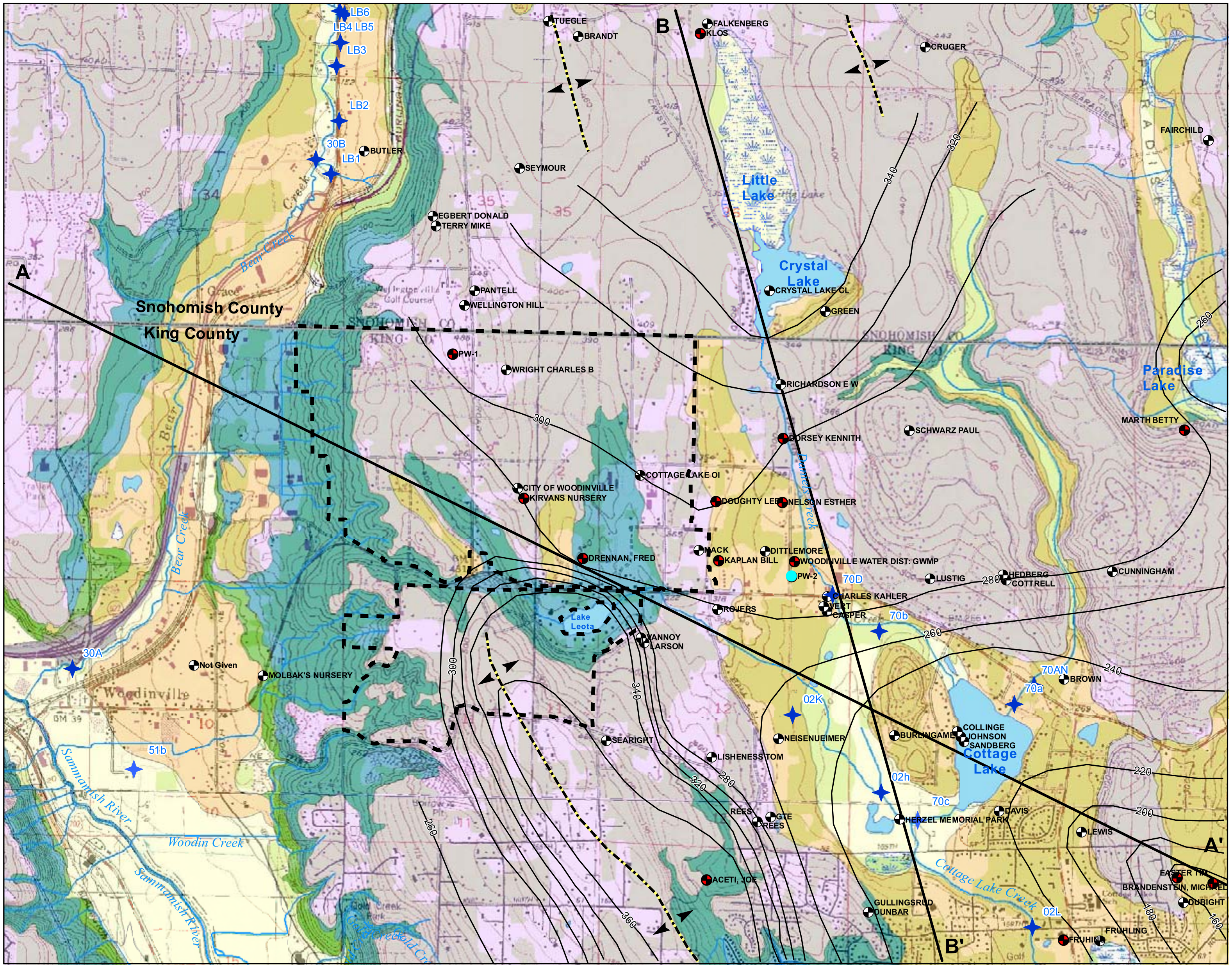
FIGURE **5**

GROUNDWATER FLOW IN THE CROSS Qva AQUIFER

SA/WOODINVILLE HYDROGEO

06312304F03.dwg | Layout1 | Mod: 10/19/2006, 10:56 | Plot: 10/19/2006, 10:57 | jruble

Golder Associates



LEGEND

- Active Stream Gage
- Inactive Stream Gage
- Well
- Well with Water Level Data
- Stream
- Cross Section
- Water Level Contours (FT AMSL)
- County Boundary
- City of Woodinville R-1 Zoning
- Lake or Pond
- Swamp or Marsh

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- Qpf - Pre-Fraser undifferentiated sediments
- Qva - Vashon advance glacial outwash
- Qvr - Vashon recessional glacial outwash
- Qvt - Vashon glacial till
- m - Modified land

0 2000
Scale in Feet

N

Map Projection:
Washington State Plane,
North Zone, NAD 83, Feet
Source: USGS, King County,
NHD, WSDNR

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE 6

GROUNDWATER CONTOUR MAP OF WOODINVILLE R-1 AREA

SA/WOODINVILLE HYDROGEO SVCS/WA

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Golder Associates

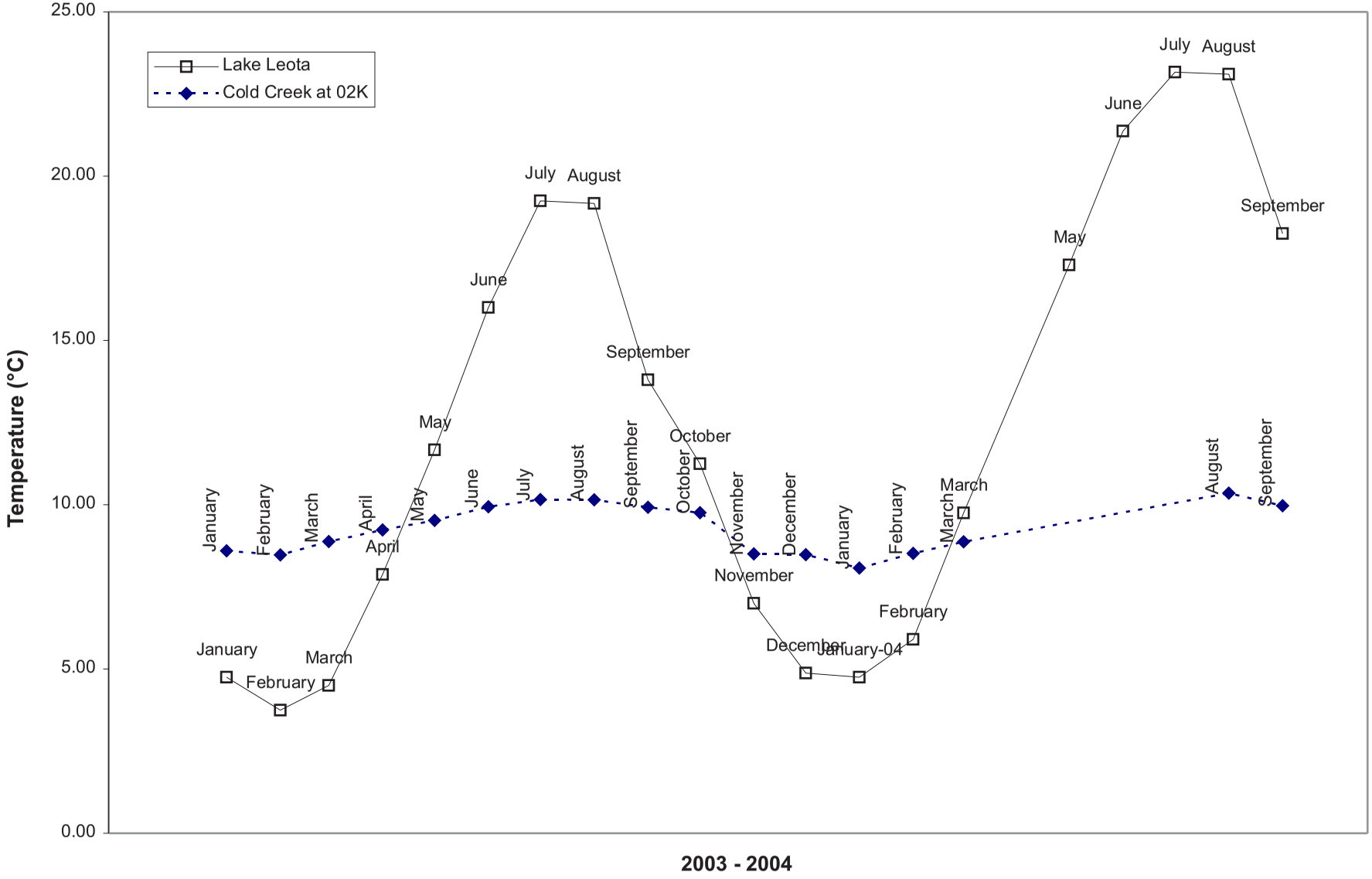

FIGURE 7

LAKE LEOTA & COLD CREEK HYDROGRAPH

S&A/WOODINVILLE HYDROGEO SVCS/WA

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Golder Associates

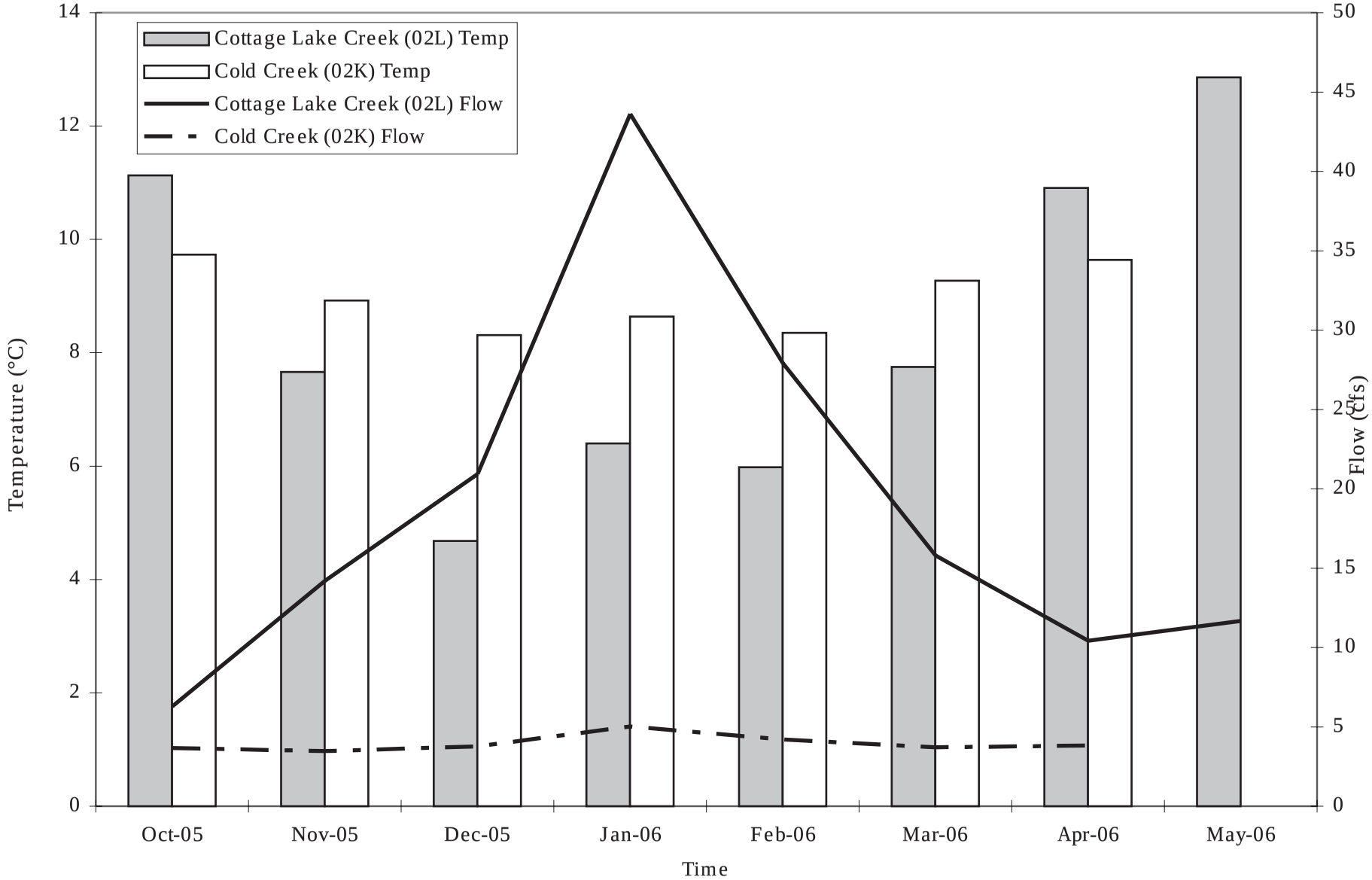
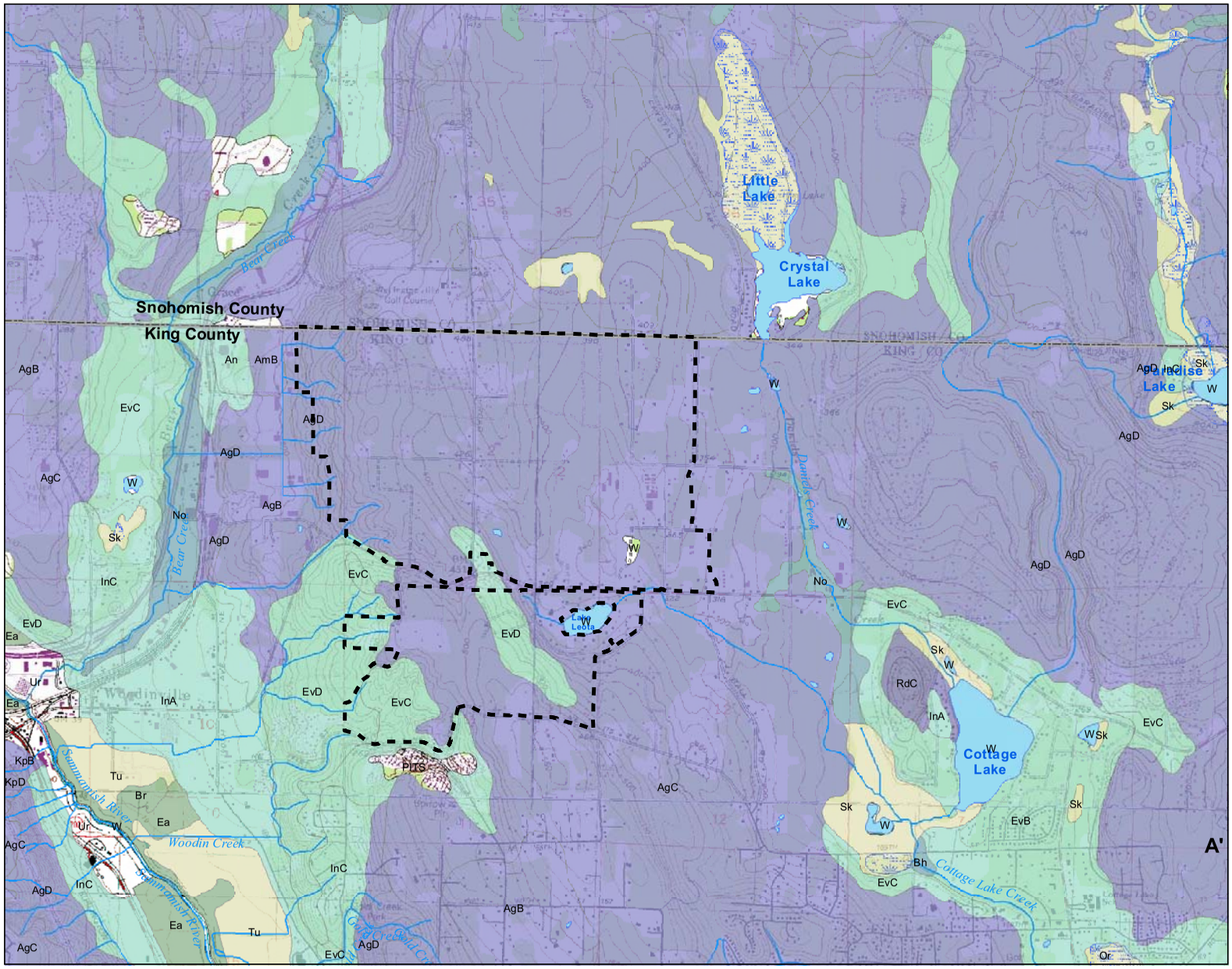


FIGURE 8
STREAM TEMPERATURE VS. FLOW
S&A/WOODINVILLE HYDROGEO SVCS/WA

06312304fig08.fh11 | Mod: 10/19/06 | JDD

Golder Associates



LEGEND

- Stream
- County Boundary
- City of Woodinville R-1 Zoning
- Lake or Pond
- Swamp or Marsh

Drainage Class

- No Data
- Moderately well drained
- Poorly drained
- Somewhat excessively drained
- Somewhat poorly drained
- Very poorly drained
- Well drained

Ag	Alderwood
AmB	Arents, Alderwood material
An	Arents, Everett material
Bh	Bellingham silt loam
Br	Briscot silt loam
Ea	Earlmont silt loam
Ev	Everett gravelly sandy loam
In	Indianola loamy fine sand
Kp	Kitsap silt loam
No	Norma sandy loam
Or	Orcas peat
PITS	Pits
RdC	Ragnar-Indianola association
Sk	Seattle muck
Tu	Tukwila muck
Ur	Urban land
W	Water

0 2000
Scale in Feet

N

Map Projection:
Washington State Plane,
North Zone, NAD 83, Feet
Source: USGS, King County,
NHD, WSDNR, NRCS

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **9**

SOIL COVERAGE MAP OF WOODINVILLE R-1 AREA

SA/WOODINVILLE HYDROGEO SVCS/WA

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Golder Associates

APPENDIX A

CURRENT WOODINVILLE CARA AND GEOLOGIC HAZARD ORDINANCES

Critical aquifer recharge areas

21.24.190 Critical aquifer recharge areas – Designation and rating.

(1) The map entitled King County Critical Recharge Areas, including any authorized updates to this map, is hereby adopted as the designation of critical aquifer recharge areas in the City of Woodinville. The designated critical aquifer recharge areas map may be updated from time to time as new information becomes available pursuant to WMC 21.24.080 and 21.24.090.
(2) Critical aquifer recharge areas are categorized as follows:
(a) Category I critical aquifer recharge areas include those areas designated on the critical aquifer recharge area map as highly susceptible to ground water contamination and that are located within a sole source aquifer or wellhead protection area.
(b) Category II critical aquifer recharge areas include those mapped areas designated that:
(i) Have a medium susceptibility to ground water contamination and are located in a sole source aquifer or wellhead protection area; or
(ii) Are highly susceptible to ground water contamination and are not located in a sole source aquifer or wellhead protection area.
(3) An applicant can request that the Planning Director declassify a specific area included in the map adopted under subsection (1) of this section. The request must be supported by a critical areas report that includes a hydro-geologic assessment. The request to declassify an area shall be reviewed by the Planning Director following the procedure in WMC 21.24.110. (Ord. 375 § 3, 2004)

21.24.200 Critical aquifer recharge areas – Development regulations.

(1) The following new uses or activities are not allowed in Category I critical aquifer recharge areas:
(a) Hazardous liquid transmission pipelines;
(b) Sand and gravel, and hard rock mining on land that is not zoned for mining as of December 1, 2004;
(c) Mining of any type below the ground water table;
(d) Processing, storage, and disposal of radioactive wastes;
(e) Hydrocarbon extraction;
(f) Commercial wood treatment facilities on permeable surfaces;
(g) Golf courses;
(h) Cemeteries;
(i) Wrecking yards;
(j) Landfills for hazardous waste, municipal solid waste, or special waste; and
(k) On-site septic systems on lots smaller than one acre without a treatment system that results in effluent nitrate-nitrogen concentrations below 10 milligrams per liter.
(2) The following new uses and activities are not allowed in a Category II critical aquifer recharge area:
(a) Mining of any type below the water table;
(b) Processing, storage, and disposal of radioactive substances;
(c) Hydrocarbon extraction;
(d) Commercial wood treatment facilities on permeable surfaces;
(e) Wrecking yards;
(f) Landfills for hazardous waste, municipal solid waste, or special waste; and
(g) On-site septic systems on lots smaller than one acre without a treatment system that results in effluent nitrate-nitrogen concentrations below 10 milligrams per liter.

(3) The following standards apply to any development proposal in a critical aquifer recharge area:

(a) All storage tanks proposed to be located in a critical aquifer recharge area must comply with local building code requirements and must conform to the International Fire Code requirements for secondary containment.

(b) Commercial vehicle repair and servicing must be conducted over impermeable pads and within a covered structure capable of withstanding normally expected weather conditions. Chemicals used in the process of vehicle repair and servicing must be stored in a manner that protects them from weather and provides containment should leaks occur.

(c) No dry wells shall be allowed in critical aquifer recharge areas on sites used for vehicle repair and servicing. Dry wells existing on the site prior to facility development must be abandoned using techniques approved by the Washington State Department of Ecology prior to commencement of the proposed activity.

(d) The activities listed below shall be conditioned in accordance with the applicable State and Federal regulations as necessary to protect critical aquifer recharge areas.

Activity	Applicable State and Federal Regulations
Above-ground storage tanks	WAC 173-303-640
Animal feedlots	Chapter 173-216 WAC, Chapter 173-220 WAC
Automobile washers	Chapter 173-216 WAC, Best Management Practices for Vehicle and Equipment Discharges (WDOE WQ-R-95-56)
Chemical treatment storage and disposal facilities	WAC 173-303-182
Hazardous waste generator (boat repair shops, biological research facility, dry cleaners, furniture stripping, motor vehicle service garages, photographic processing, printing and publishing shops, etc.)	Chapter 173-303 WAC
Injection wells	Federal 40 CFR Parts 144 and 146, Chapter 173-218 WAC
Junk yards and salvage yards	Chapter 173-304 WAC, Best Management Practices to Prevent Storm Water Pollution at Vehicles Recycler Facilities (WDOE 94-146)
Oil and gas drilling	WAC 332-12-450, Chapter 173-218 WAC
On-site sewage systems (large scale)	Chapter 173-240 WAC
On-site sewage systems (< 14,500 gal./day)	Chapter 246-272 WAC, Local Health Ordinances
Pesticide storage and use	Chapter 15.54 RCW, Chapter 17.21 RCW
Sawmills	Chapter 173-303 WAC, Chapter 173-304 WAC, Best Management Practices to Prevent Storm Water Pollution at Log Yards (WDOE 95-53)
Solid waste handling and recycling facilities	Chapter 173-304 WAC
Surface mining	WAC 332-18-015
Underground storage tanks	Chapter 173-360 WAC
Wastewater application to land surface	Chapter 173-216 WAC, Chapter 173-200 WAC, WDOE Land Application Guidelines, Best Management Practices for Irrigated Agriculture

(Ord. 375 § 3, 2004; Ord. 326 § 11, 2002; Ord. 175 § 1, 1997)

LANDSLIDE HAZARD AREAS

Landslide Hazard Areas are defined by the City of Woodinville 21.24.290 as:

Areas potentially subject to landslides based on a combination of geologic topographic and hydrologic factors. They include areas susceptible because of a combination of bedrock, soil, slop (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to the following:

1) Areas of historic failures, such as areas designated as Quaternary slumps, earth flows, mudflows, lahars, or landslides on maps published by the U.S. Geological Survey or Department of Natural Resources;

2) Areas with all three of the following characteristics:

a. slopes steeper than 15 percent;
b. Hillsides intersecting geologic contacts with relatively permeable sediment overlying a relatively impermeable sediment or bedrock,
c. Springs or groundwater seepage.

3) Areas that have shown movement during the Holocene (last 10,000 years ago to the present) or that are underlain or covered by mass wastage debris of that epoch.

4) Areas potentially unstable because of rapid stream incision, stream bank erosion, and undercutting by wave action.

5) Areas located in canyons or on an active alluvial fan presently or potentially subject to inundation by debris flows or catastrophic flooding, and

6) Any area with a slope of 40 per cent or steeper with a vertical relief of 10 or more feet except areas composed of consolidated rock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

Erosion Hazard Areas as defined by the City of Woodinville 21.24.290 are defined as:

"Erosion hazard areas are those areas identified by the U.S. Department of Agriculture's Natural Resources Conservation Service or identified by a critical area special study as having a severe to very severe erosion potential."

APPENDIX B

MISCELLANEOUS SUPPORTING TECHNICAL DATA

Preparation of the geologic and depth-to-water maps for the Redmond-Bear Creek area

Derek B. Booth
Pacific NW Center for Geologic Mapping Studies
University of Washington
January 18, 2006

Geologic Map

The geologic map was prepared from a combination of sources, particularly preexisting published mapping (Booth, 1987; Minard and Booth, 1988); unpublished mapping by K.Troost and D. Booth in 2002 and 2003, new field work in 2005, and the subsurface geodatabase acquired for this project. In the northwest corner of the study area, geologic investigations for the Brightwater wastewater treatment plant were consulted extensively, although not all of the interpretations presented in those documents were used verbatim. The appropriate scale for map use, interpretation, and display is 1:24,000 (1"= 2000').

Depth to Groundwater

This was determined for the expressed purpose of producing a final susceptibility map (see below), and so certain conventions were followed. Only unconfined water levels, or confined water levels where the confining layer was presumed to be of limited lateral extent (e.g., local silt lenses in alluvium), were included. Water levels produced as a result of confinement or whose deposits were capped by an extensive geologic layer of low permeability (e.g., till), whether or not a confining head was present, were excluded. This reflects the use of these data to highlight areas where contaminants have direct access to the water table.

Given the King County categories for "shallow" water tables (i.e., <25' and 25-75' depths), identification of potential shallow-water areas began by highlighting all wells with recorded water-level depths of 75 or less. Only 44 wells were so identified, and so the log of every such shallow-water well was inspected. Those that were unconfined and without significant overlying aquitards or aquicludes were highlighted (6 wells in total). Contours of shallow water-table depths could not be generalized from these data points, because they were so few in number and widely spaced. Therefore, geologic units and contacts between certain units were primarily used to determine plausible, albeit largely unconfirmed, depths to water. This followed a procedure similar to that used for the Vashon/Maury Island susceptibility mapping in 2004, one that is also consistent with the guidance of the 1995 King County aquifer-susceptibility document, *Mapping Aquifer Susceptibility to Contamination in King County,* for areas where well data are lacking. For this map, the following assumptions were used:

- All areas mapped Qal (modern river- and stream-valley alluvium) and adjacent Qvr (Vashon-age recessional outwash deposits) were assumed to have water-table depths of no more than 25 feet. All 5 of the wells showing unconfined water-table depths in this range were located in these units.
- All areas mapped Qoal and Qf (older stream-valley alluvium, generally on slightly elevated terraces, and alluvial fan deposits) were assumed to have water-table depths of

25-75 feet, except for one fan with large topographic relief in the southeast map area that was judged likely to have depths to water greater than 75 feet in its highest reaches.

- The basal contact of unit Qva (Vashon advance outwash), where exposed on sideslopes and overlying silt- or clay-dominated deposits (most commonly unit Qpf), was assumed to mark the location of a water table. Areas lying within 25' vertical elevation above this contact and not covered by overlying till were mapped in the "0-25 feet" zone; areas lying between 25 and 75 feet and not covered by till were mapped in the 25-75 feet" zone. Where groundwater is abundant this is an overly narrow assumption; where groundwater is limited this probably overstates its presence. In nearly every area there is insufficient well data to confirm or refute this approach, although field exposures commonly reveal abundant seeps and springs at and just above this contact.

REFERENCES

D. B. Booth, 1987, Geology of the Bear Creek Basin: chapter in Conditions Report, Bear Creek Basin Planning Area: King County Surface Water Management, Seattle, WA.

J. P. Minard and D. B. Booth, 1988, Geologic map of the Redmond quadrangle, King and Snohomish Counties, Washington: U.S. Geological Survey Miscellaneous Field Investigations Map MF-2016, scale 1:24,000.

Leota

Leota Overview

Volunteer monitoring began at Lake Leota in 1998 and continued through 2004. Recent data suggested that this city lake (Woodinville) was moderate in primary productivity (mesotrophic) with good water quality. Productivity appeared to be higher in 1998 – 2001.

Lake Leota has no public access points, though residents should keep an eye on aquatic plants growing nearshore to catch early infestations of Eurasian milfoil, Brazilian elodea or other noxious aquatic weeds. Lake Leota has recently experienced aggressive growth by a milfoil identified as native, *Myriophyllum verticillatum*.

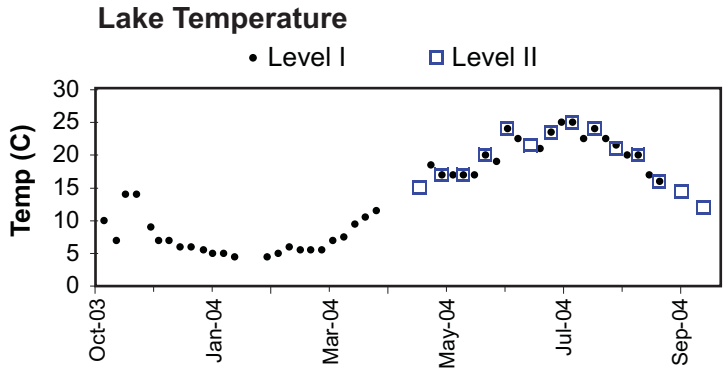
Physical Parameters

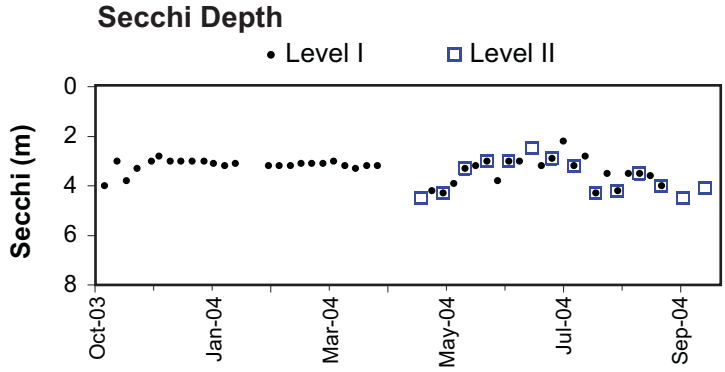
Secchi transparency ranged between 2.2 and 4.5 m through the year. The summer average was 3.6 m, which was in the upper middle range for all the small lakes monitored in 2004. Annual water temperatures ranged from 4.5 to 25.0 degrees Celsius. The maximum recorded was in the mid range for the lakes that were tracked.

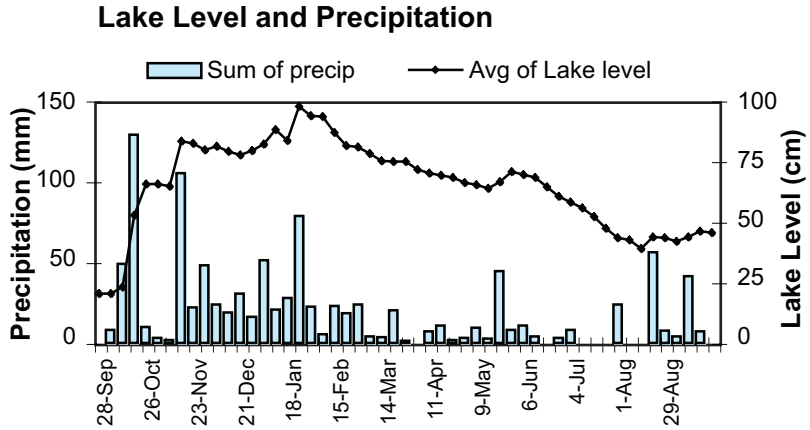
Excellent precipitation and water level records were compiled for the year. Water levels were consistent with the regional pattern of winter-high levels, dropping slowly through the summer to a low stand in early fall.

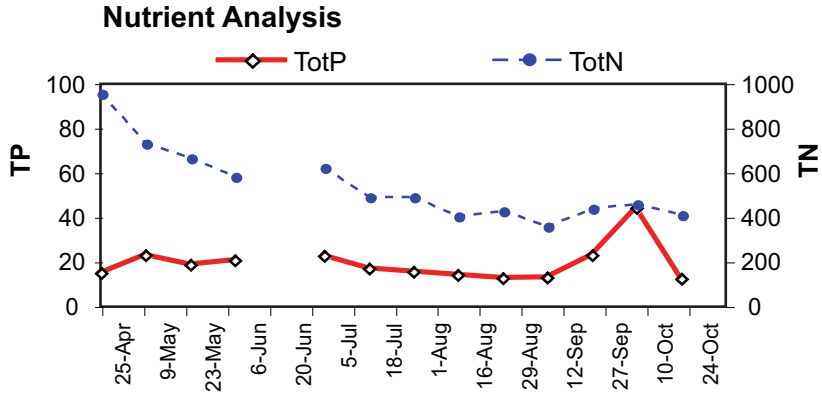
Nutrient Analysis and TSI Ratings

Total nitrogen generally decreased through the period, while phosphorus remained steady until mid October when there was an abnormally high value recorded. Aside from this date, the N:P ratio ranged from 19 to 65, averaging 47 which suggested









generally poor conditions for nuisance bluegreen growth.

Profile data indicate that thermal stratification was present early in the season and persisted through the summer. Relatively high concentrations of phosphorus were found in the deep water, suggesting there was some release from the sediments. Chlorophyll data indicated that algae were higher in abundance in the surface water than in middle of the water column.

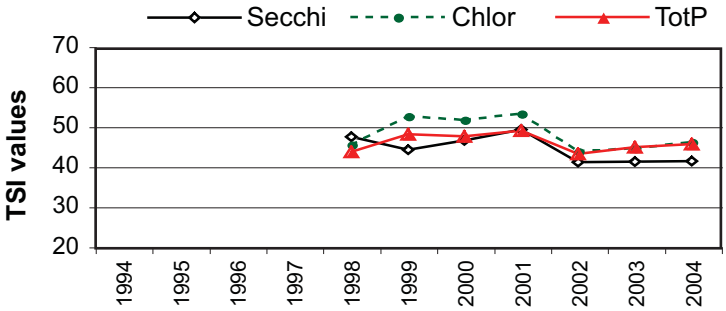
The 2004 TSI values were fairly close to each other in the mesotrophic range, with TSI-Secchi somewhat lower than the other two indicators, similar to 2003.

Chlorophyll Concentrations and Algae

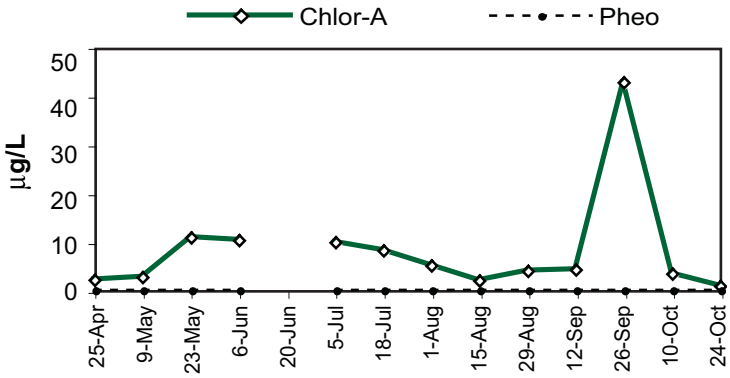
Chlorophyll remained fairly low through the sampling period until mid October when it spiked in late September, two weeks before the high phosphorus value. Commonly found algae in spring and summer included an unidentified chrysophyte species, *Synura*, and *Dinobryon*. The high peak in late September was due to a bloom of the dinoflagellate *Ceratium hirundinella*.

Date	Secchi	depth-m	degC	Chlor-A	TP µg/L	TN µg/L
5/23/04	3.3	1	17.0	10.90	18.5	670
		3	12.0	9.29	18.6	867
		6	6.5		114.0	1130
8/29/04	4.2	1	21.0	4.00	12.3	430
		3	17.5	1.40	9.5	328
		6	9.5		86.5	969

TSI Ratings



Chlorophyll a Concentrations (ug/L)



Common Algae

	Group
Dinobryon spp	Chrysophyta
Unidentified cells	Chrysophyta
Ceratium hirundinella	Dinophyta

Leota

2004 Level I Data

Daily Data Summary

Week of	Sum of precip. (mm)	# of days	Avg of lake level (cm)	# of days
28-Sep-03	0.0	4	20.5	4
5-Oct-03	8.0	6	20.4	7
12-Oct-03	49.0	6	23.0	7
19-Oct-03	129.0	7	52.7	7
26-Oct-03	10.0	5	65.7	7
2-Nov-03	3.0	6	65.4	7
9-Nov-03	2.0	6	64.6	7
16-Nov-03	105.0	7	83.3	7
23-Nov-03	22.0	5	82.4	5
30-Nov-03	48.0	6	79.7	6
7-Dec-03	24.0	6	81.1	7
14-Dec-03	19.0	6	79.1	7
21-Dec-03	30.5	7	77.6	7
28-Dec-03	16.0	7	79.4	7
4-Jan-04	51.0	6	82.0	7
11-Jan-04	20.5	6	88.1	7
18-Jan-04	28.0	7	83.4	7
25-Jan-04	78.5	6	97.7	7
1-Feb-04	22.5	7	93.9	7
8-Feb-04	5.5	7	93.3	7
15-Feb-04	23.0	7	86.7	7
22-Feb-04	18.5	7	81.6	7
29-Feb-04	24.0	7	80.7	7
7-Mar-04	4.0	7	78.0	7
14-Mar-04	3.5	6	75.1	7
21-Mar-04	20.0	7	74.7	7
28-Mar-04	1.5	5	75.0	7
4-Apr-04	0.0	7	71.6	7
11-Apr-04	7.0	6	70.0	7
18-Apr-04	11.0	5	69.1	7
25-Apr-04	2.0	7	68.3	7
2-May-04	3.0	7	66.1	7
9-May-04	9.5	6	65.3	7
16-May-04	2.5	5	63.9	7
23-May-04	44.5	7	66.6	5
30-May-04	8.0	7	70.7	7
6-Jun-04	11.0	7	69.6	7
13-Jun-04	4.0	7	68.1	7
20-Jun-04	0.0	6	64.4	7
27-Jun-04	3.0	7	60.6	7
4-Jul-04	8.0	6	58.0	7
11-Jul-04	0.0	7	55.7	7
18-Jul-04	0.0	6	52.0	7
25-Jul-04	0.0	7	47.4	7
1-Aug-04	24.0	6	43.4	7
8-Aug-04	0.0	6	42.4	7
15-Aug-04	0.0	7	38.9	7
22-Aug-04	56.0	7	43.9	7
29-Aug-04	7.5	7	43.3	7
5-Sep-04	4.0	5	41.9	7
12-Sep-04	41.5	6	43.9	7
19-Sep-04	7.0	6	46.0	7
26-Sep-04	0.0	5	45.4	5
Min	0.0		20.4	
Max	129.0		97.7	
Total	1019.5			

Weekly Data Summary

Sample date	Sample time	Secchi (m)	Temp (°C)	Algae* (Shore)	Algae* (at site)	Goose Count*
5-Oct-03	15:00	4.0	10.0	P1	P1	
13-Oct-03	17:00	3.0	7.0	P1	P1	
19-Oct-03	16:30	3.8	14.0	P1	P1	
26-Oct-03	16:00	3.3	14.0	P2	P2	
4-Nov-03	14:00	3.0	9.0	P1	P1	
9-Nov-03	13:00	2.8	7.0	P1	P1	
16-Nov-03	16:00	3.0	7.0	P2	P2	
23-Nov-03	14:00	3.0	6.0	P2	P2	
30-Nov-03	14:00	3.0	6.0	P1	P1	
8-Dec-03	15:00	3.0	5.5	P2	P2	
14-Dec-03	12:30	3.1	5.0	P1	P1	
21-Dec-03	13:30	3.2	5.0	P1	P1	
28-Dec-03	14:00	3.1	4.5	P1	P1	
18-Jan-04	12:30	3.2	4.5	P1	P1	
25-Jan-04	13:30	3.2	5.0	P1	P1	
1-Feb-04	12:00	3.2	6.0	P1	P1	
8-Feb-04	14:30	3.1	5.5	P1	P1	
15-Feb-04	14:00	3.1	5.5	P1	P1	
22-Feb-04	13:00	3.1	5.5	P1	P1	
29-Feb-04	16:00	3.0	7.0	P1	P1	
7-Mar-04	13:00	3.2	7.5	P1	P1	
14-Mar-04	17:00	3.3	9.5	P1	P1	
21-Mar-04	14:30	3.2	10.5	P1	P1	
28-Mar-04	13:00	3.2	11.5	P1	P1	
2-May-04	14:00	4.2	18.5	P1	P1	
9-May-04	15:30	4.3	17.0	P1	P1	
16-May-04	16:00	3.9	17.0	P1	P1	
23-May-04	13:00	3.3	17.0	P1	P1	
30-May-04	13:30	3.2	17.0	P1	P1	
6-Jun-04	13:30	3.0	20.0	P1	P1	
13-Jun-04	15:30	3.8	19.0	P1	P1	
20-Jun-04	17:00	3.0	24.0	P1	P1	
27-Jun-04	15:00	3.0	22.5	P1	P1	
11-Jul-04	15:00	3.2	21.0	P1	P1	
18-Jul-04	15:30	2.9	23.5	P1	P1	
25-Jul-04	15:00	2.2	25.0	P1	P1	
1-Aug-04	14:00	3.2	25.0	P1	P1	
8-Aug-04	17:00	2.8	22.5	P1	P1	
15-Aug-04	16:00	4.3	24.0	P1	P1	
22-Aug-04	15:00	3.5	22.5	P1	P1	
29-Aug-04	14:30	4.2	21.5	P1	P1	
5-Sep-04	8:30	3.5	20.0	P1	P1	
12-Sep-04	10:30	3.5	20.0	P1	P1	
19-Sep-04	12:50	3.6	17.0	P1	P1	
26-Sep-04	14:30	4.0	16.0	P1	P1	
	Min	2.2	4.5			
	Max	4.3	25.0			

* See introduction for discussion of algae assessment and goose count methods.

2004 Level II Data

Date (2004)	Temp (°C)	Secchi (m)	Chl-*a* (µg/l)	TP (µg/l)	TN (µg/l)	Algae Obsv.	N:P	Calculated TSI Secc	Calculated TSI chl-a	Calculated TSI TP
25-Apr	15.0	4.5	2.08	14.8	959	1	65	38.3	37.8	43.0
9-May	17.0	4.3	2.72	22.7	735	1	32	39.0	40.4	49.2
23-May	17.0	3.3	10.90	18.5	670	1	36	42.8	54.0	46.2
6-Jun	20.0	3.0	10.40	20.4	586	1	29	44.1	53.5	47.7
20-Jun	24.0	3.0						44.1		
5-Jul	21.5	2.5	9.93	22.4	626	1	28	46.8	53.1	49.0
18-Jul	23.5	2.9	8.17	16.6	493	1	30	44.6	51.2	44.7
1-Aug	25.0	3.2	5.13	15.4	492	1	32	43.2	46.6	43.6
15-Aug	24.0	4.3	2.00	13.7	406	1	30	39.0	37.4	41.9
29-Aug	21.0	4.2	4.01	12.3	430	1	35	39.3	44.2	40.4
12-Sep	20.0	3.5	4.27	12.8	360	1	28	41.9	44.8	40.9
26-Sep	16.0	4.0	43.10	22.9	442	1	19	40.0	67.5	49.3
10-Oct	14.5	4.5	3.47	44.0	461	1	10	38.3	42.8	58.7
24-Oct	12.0	4.1	0.90	12.0	411	1	34	39.6	29.5	40.0

	Temp (°C)	Secchi (m)	Chl-*a* (µg/l)	TP (µg/l)	TN (µg/l)	Algae	N:P	Calculated TSI Secc	Calculated TSI chl-a	Calculated TSI TP
Mean	19.3	3.7	8.2	19.1	543.9	1.0	31	41.5	46.4	45.7
Median	20.0	3.8	4.3	16.6	492.0	1	30	41.0	44.8	44.7
Min	12.0	2.5	0.9	12.0	360.0	1	10	38.3	29.5	40.0
Max	25.0	4.5	43.1	44.0	959.0	1	65	46.8	67.5	58.7
Count	14	14	13	13	13	13	13	14	13	13

TSI Average = 44.5

Cottage

Cottage Overview

Volunteer monitoring began at Cottage Lake in 1995 and continued through 2004. The data indicate this lake is relatively high in primary productivity (eutrophic) with fair water quality. Enhancement of productivity through human impacts was verified in the lake management plan (King County, 1996).

Cottage Lake has no public access boat ramp, but car top boats may be launched through the county park. Residents should monitor aquatic plants growing near-shore to catch early infestations of Eurasian milfoil, Brazilian elodea, or other noxious aquatic weeds.

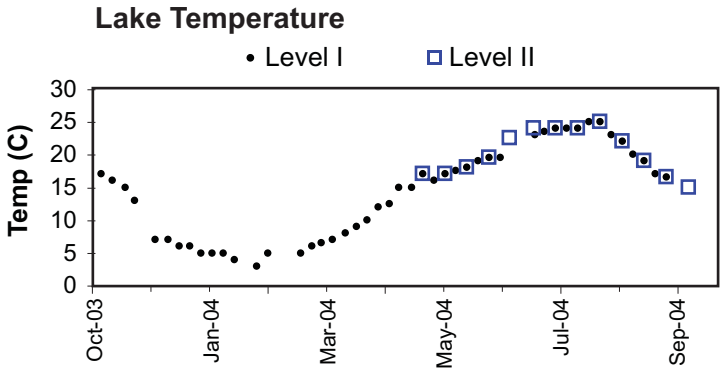
Physical Parameters

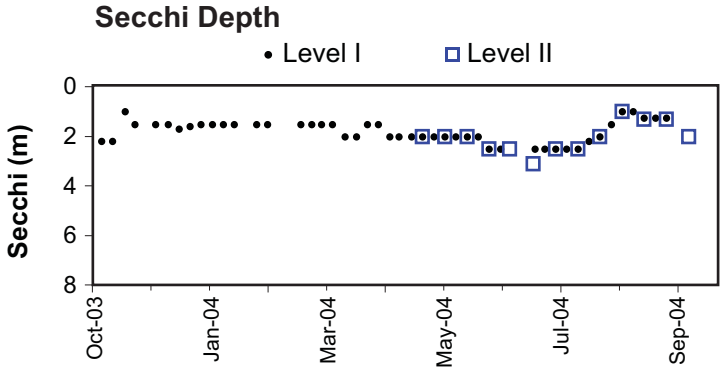
Secchi transparency ranged between 1.0 and 3.1 m during the year. The summer average was 2.1 m which placed it in the lower end of small lakes monitored in 2004. Surface water temperatures ranged from 3.0 to 25.0 degrees Celsius, putting it in the mid range for the group.

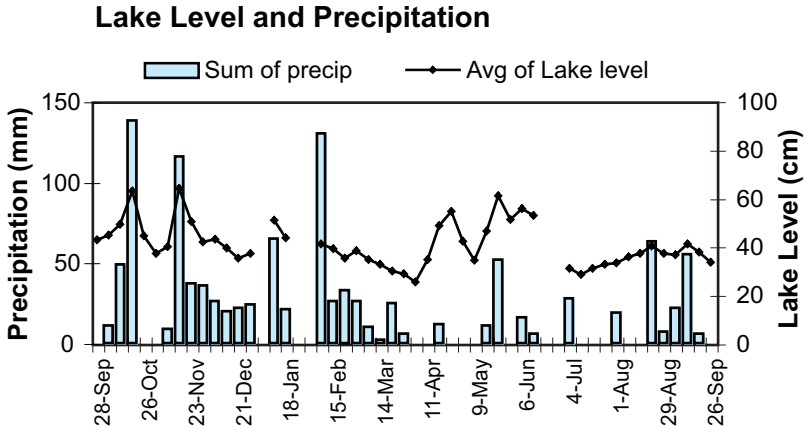
Excellent local precipitation and water level records were available for the year, showing that the lake level varied erratically through most of the year, relating to rainfall events in winter, but also remaining at high levels in summer, likely affected by both beaver and human activities.

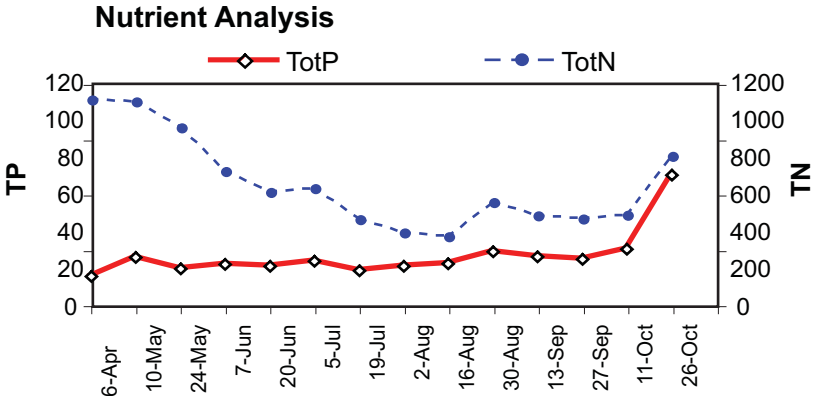
Nutrient Analysis and TSI Ratings

Total nitrogen declined through the spring, varied a little in summer, and increased in late October. Total phosphorus remained fairly steady until late October, when it also began to increase. The N:P ratio ranged from 12 to 70, averaging 28, with good conditions for nuisance bluegreen growth indicated beginning in August.









Profile data indicate that thermal stratification was present early in the season and persisted through the summer. High concentrations of phosphorus were found in the deep water in August, suggesting that anoxia could have triggered a release from the sediments. Chlorophyll data indicated that algae were higher in abundance in the middle of the water column, possibly around the thermocline.

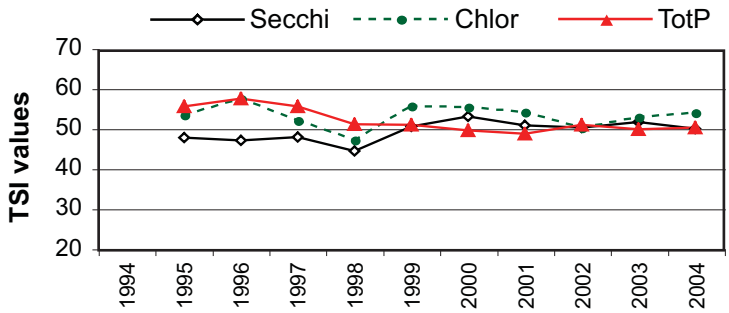
In 2004 TSI values for the three indicators were close to each other, above the threshold for eutrophic conditions, similar to recent years.

Chlorophyll Concentrations and Algae

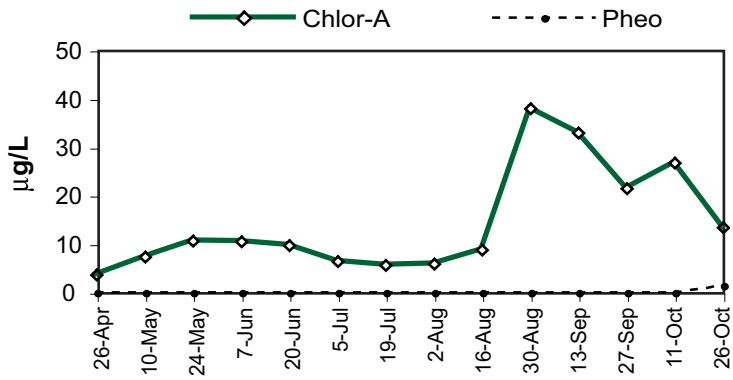
Chlorophyll content decreased from a minor increase in late May to low values that remained steady through summer and then increased greatly in late August, shortly after the drop in N:P ratios. For most of the sample season, the phytoplankton was dominated by the bluegreen *Aphanizomenon flos-aquae.* The diatoms *Tabellaria fenestrata*, *Asterionella formosa*, and *Fragilaria crotonensis* were also commonly found, in addition to a variety of cryptophyte and chrysophyte species.

Date	Secchi	depth-m	degC	Chlor-A	TP µg/L	TN µg/L
5/24/04	2.0	1	18.0	10.70	20.1	961
		3	15.0	17.80	24.5	1030
		6.5	8.0	13.60	54.9	644
8/30/04	1.0	1	22.0	38.00	29.2	562
		3	20.0	57.70	40.5	509
		6.5	11.0	34.30	561.0	2510

TSI Ratings



Chlorophyll a Concentrations (ug/L)



Common Algae

	Group
Aphanizomenon flos-aquae	Cyanobacteria
Tabellaria fenestrata	Bacillariophyta
Fragilaria crotonensis	Bacillariophyta

Cottage

2004 Level I Data

Daily Data Summary

Week of	Sum of precip. (mm)	# of days	Avg of lake level (cm)	# of days
28-Sep-03	0	5	42.8	5
5-Oct-03	11	7	44.9	7
12-Oct-03	53	7	50.9	7
19-Oct-03	134	7	61.0	7
26-Oct-03	0	5	44.8	5
2-Nov-03	0	4	37.3	4
9-Nov-03	17	7	40.9	7
16-Nov-03	108	7	66.3	7
23-Nov-03	37	7	47.9	7
30-Nov-03	38	7	41.9	7
7-Dec-03	29	7	42.7	7
14-Dec-03	16	7	38.4	7
21-Dec-03	31	7	35.7	7
28-Dec-03	14	5	36.4	5
4-Jan-04	40	1		1
11-Jan-04	30	7	49.4	7
18-Jan-04	16	5	43.4	5
25-Jan-04	0	0		0
1-Feb-04	126	1		1
8-Feb-04	9	7	40.3	6
15-Feb-04	21	7	38.7	7
22-Feb-04	33	7	35.3	7
29-Feb-04	29	7	37.9	7
7-Mar-04	7	7	34.0	7
14-Mar-04	2	7	32.3	7
21-Mar-04	25	7	29.4	7
28-Mar-04	6	7	28.4	7
4-Apr-04	0	7	25.0	7
11-Apr-04	0	7	36.9	7
18-Apr-04	12	7	50.4	7
25-Apr-04	0	7	53.1	7
2-May-04	0	7	40.4	7
9-May-04	3	7	35.1	7
16-May-04	8	7	48.3	7
23-May-04	52	7	63.0	7
30-May-04	0	6	48.3	7
6-Jun-04	22	7	57.7	7
13-Jun-04	0	3	49.3	3
20-Jun-04	0	0		0
27-Jun-04	0	0		0
4-Jul-04	28	7	30.7	6
11-Jul-04	0	7	28.3	7
18-Jul-04	0	7	31.7	7
25-Jul-04	0	7	32.4	7
1-Aug-04	19	7	33.6	7
8-Aug-04	0	7	36.0	7
15-Aug-04	44	7	37.9	7
22-Aug-04	19	7	39.6	7
29-Aug-04	7	7	37.0	7
5-Sep-04	28	7	36.9	7
12-Sep-04	51	7	41.1	7
19-Sep-04	4	7	36.9	7
26-Sep-04	0	4	33.0	4
Min	0.0		25.0	
Max	134.0		66.3	
Total	1129.0			

Weekly Data Summary

Sample date	Sample time	Secchi (m)	Temp (°C)	Algae* (Shore)	Algae* (at site)	Goose Count*
7-Oct-02	13:00	1.0	15.0	C3	C3	
14-Oct-02	13:00	1.0	13.0	C3	C3	
21-Oct-02	13:00	1.0	13.0	C3	C3	
28-Oct-02	13:00	2.0	12.0	C1	C1	
4-Nov-02	12:30	2.0	9.0	C1	C1	
12-Nov-02	12:30	2.0	9.0	C1	C1	
18-Nov-02	13:00	2.0	9.0	C1	C1	
25-Nov-02	13:00	2.0	8.0	C1	C1	
2-Dec-02	13:00	2.0	7.0			
9-Dec-02	13:00	2.0	7.0			
16-Dec-02	13:00	1.0	7.0			
23-Dec-02	13:00	1.5	6.0			
30-Dec-02	13:00	2.0	5.0			
6-Jan-03	13:00	1.5	5.0			
12-Jan-03	13:00	1.5	5.0			
20-Jan-03	13:00	1.5	6.0			
27-Jan-03	12:00	1.5	6.0			
3-Feb-03	13:00	1.5	5.5			
10-Feb-03	13:00	1.5	5.0			
17-Feb-03	13:00	1.8	5.5			
24-Feb-03	12:30	2.0	6.0			
3-Mar-03	13:00	1.5	6.0			
9-Mar-03	13:00	1.5	7.0			
17-Mar-03	13:00	1.5	9.0			
7-Apr-03	14:00	1.0	11.0	P1	P1	
13-Apr-03	14:30	1.0	11.5	P1	P1	
21-Apr-03	14:00	1.0	13.0	P1	P1	
28-Apr-03	12:30	1.5	14.0	P1	P1	
4-May-03	13:00	1.8	14.0	P1	P1	
12-May-03	13:00	1.5	17.0	P1	P1	
19-May-03	12:00	1.5	16.0	P1	P1	
27-May-03	13:00	1.5	18.0	P1	P1	
2-Jun-03	13:00	2.0	19.0	P1	P1	
9-Jun-03	13:00	2.0	23.0	P1	P1	
16-Jun-03	13:30	2.0	21.5	P1	P1	
23-Jun-03	13:00	2.0	18.0	P2	P2	
29-Jun-03	11:45	2.8	23.0	P2	P1	
7-Jul-03	13:30	2.5	23.0	P2	P1	
14-Jul-03	13:00	2.3	23.0	P2	P1	
21-Jul-03	14:00	2.5	25.0	P3	P1	
28-Jul-03	15:00	2.7	25.0	P3	P1	
4-Aug-03	14:00	2.7	25.0	P3	P1	
10-Aug-03	15:00	2.2	24.5	P3	P1	
18-Aug-03	13:00	1.5	23.0	P3	P2	
25-Aug-03	12:00	1.3	22.0	P3	P2	
1-Sep-03	12:00	1.2	22.0	P3	P2	
8-Sep-03	13:00	1.2	21.0	P3	P2	
15-Sep-03	13:00	1.2	18.0	P3	P2	
22-Sep-03	14:00	1.0	18.0	P3	P3	
29-Sep-03	12:00	1.3	18.0	P3	P3	
	Min	1.0	5.0			
	Max	2.8	25.0			

* See introduction for discussion of algae assessment and goose count methods.

2004 Level II Data

Date (2004)	Temp (°C)	Secchi (m)	Chl-*a* (µg/l)	TP (µg/l)	TN (µg/l)	Algae Obsv.	N:P	Calculated TSI Secc	Calculated TSI chl-a	Calculated TSI TP
26-Apr	17.0	2.0	3.68	16.0	1110	2	69	50.0	43.4	44.1
10-May	17.0	2.0	7.37	26.3	1100	2	42	50.0	50.2	51.3
24-May	18.0	2.0	10.70	20.1	961	2	48	50.0	53.8	47.4
7-Jun	19.5	2.5	10.60	22.6	727	2	32	46.8	53.7	49.1
20-Jun	22.5	2.5	9.77	21.3	615		29	46.8	52.9	48.3
5-Jul	24.0	3.1	6.41	24.0	635		26	43.7	48.8	50.0
19-Jul	24.0	2.5	5.61	19.1	468	2	25	46.8	47.5	46.7
2-Aug	24.0	2.5	5.93	21.3	398	2	19	46.8	48.0	48.3
16-Aug	25.0	2.0	8.81	22.8	379	2	17	50.0	51.9	49.3
30-Aug	23.0	1.0	38.00	29.2	562	2	19	60.0	66.3	52.8
13-Sep	19.0	1.3	33.00	26.6	490	2	18	56.2	64.9	51.5
27-Sep	16.5	1.3	21.50	25.3	471	2	19	56.2	60.7	50.8
11-Oct	15.0	2.0	26.80	30.5	494	2	16	50.0	62.8	53.5
25-Oct	NR	NR	13.50	70.3	809		12		56.1	65.5

	Temp (°C)	Secchi (m)	Chl-*a* (µg/l)	TP (µg/l)	TN (µg/l)	Algae	N:P	Calculated TSI Secc	Calculated TSI chl-a	Calculated TSI TP
Mean	20.3	2.1	14.4	26.8	658.5	2.0	28	50.2	54.4	50.6
Median	19.5	2.0	10.2	23.4	588.5	2	22	50.0	53.3	49.6
Min	15.0	1.0	3.7	16.0	379.0	2	12	43.7	43.4	44.1
Max	25.0	3.1	38.0	70.3	1110.0	2	69	60.0	66.3	65.5
Count	13	13	14	14	14	11	14	13	14	14

TSI Average = 51.7

Data Access Procedure and Policy

*The Pacific Northwest Center for Geologic Mapping Studies (GeoMapNW) has an **open-door policy** for access to borehole data. The borehole database, one of the products from on-going grant-supported data collection, is continually enhanced by data contributions from the geologic and geotechnical community.*

Web Access to Borehole Data and Maps
The borehole data, borehole metadata, subsurface layer data, geologic maps, and some recent publications can be downloaded from our website (http://geomapnw.ess.washington.edu). Geologic maps are posted on our website as when they are appropriate final drafts. We welcome information that will improve our maps and database, ktroost@u.washington.edu.

Hard Copy and Assisted Access
The borehole data (over 60,000 exploration points) can be accessed in our computer lab and the hard copies can be reviewed by making an appointment. We can help you navigate through the Arcview database system. A few draft geologic maps can also be viewed by making an appointment. Please respect that we do not have funding to make copies for you via phone requests, make maps, or provide digital copies of data. While in our computer lab, you'll be able to print a screen shot showing the locations of borings in your area of interest. We are in the process of **scanning** all of the boring logs and site plans in our database and will have the pdf's available online as soon as possible.

Appointments
Please contact Aaron Wisher at 206-685-2821 or wisher@u.washington.edu (best method) to schedule an appointment. Please try to schedule your visit between 9 am and 3 pm Monday though Thursday, and try to limit your visit to an hour, to accommodate our workload patterns and computer use. Please give Aaron an idea of your area of interest and a phone number in case we need to reach you before your appointment.

CopiesCredit
Be sure to credit "GeoMapNW at the University of Washington" as the source of data you collect from us. This center's ability to provide data and new geologic maps is dependent upon continued funding, and citations are an important element for measuring progress.

Finding Us
The Pacific Northwest Center for Geologic Mapping Studies (GeoMapNW), part of the Department of Earth & Space Sciences, is located in the old Oceanography Building (room 316) in the South Campus Area of the University of Washington in Seattle. A campus map can be found at http://www.washington.edu/home/maps/. Enter

campus going south on 15th Ave NE from NE Pacific Street, and then follow the road around to the East (left) to behind the Medical Center. At the parking kiosk, ask for parking in Lot S-1. From S-1, walk through the South Campus Center, exiting on the south side on the lower floor so that you are facing the canal. Turn left and you'll see the "old" Oceanography Building, a small 3-story, 1931 brick building. It is located between the Marine Science and Fisheries buildings. If you need special accommodations for accessing the 3rd floor, please contact Aaron so that we can operate the freight elevator for you. For loading/unloading or handicap access, as for temporary parking adjacent to our building, in Lot S-8, off of San Jaun Ave., along the canal.

General Policy

The data and maps have been compiled and/or prepared by the University of Washington's GeoMapNW, a cooperative project sponsored jointly by the U.S. Geological Survey, the City of Seattle, King County, and the Center for Water and Watershed Studies, as part of an ongoing effort to develop and deliver regional geologic data in a geographic information systems (GIS) database format for the Puget Sound region. The data should not be used for purposes of site-specific land-use planning or site-specific hazard, geologic, or geotechnical evaluations. Although the digital form of the data removes the constraint imposed by the scale of the original site plans, the detail and accuracy issues inherent in map scale limitations are also present in the digital data.

GeoMapNW and the UW do not guarantee the precision or accuracy of project and field exploration locations, any data contained on exploration logs, or any entries in the database. The quality of the data is varied. The user accepts these data with all faults, and assumes all responsibility for use thereof, and agrees to hold the GeoMapNW (and the former SGMP), the UW, King County, and the City of Seattle harmless from and against any damage, loss, or liability arising from any use of these data. You must credit use of data to the GeoMapNW on all printed or digital products that have made use of these data.

Arrangements can be made to make photocopies onsite for fewer than 50 pages. Copies of more than 50 pages of originals can be made at one of many nearby locations. We do not have funds to cover copying or to make copies for you. Any materials taken off site for copying will have to be signed out and returned on the same day as many of us make use of the hard copies through the day. Please limit your copying to less than 100 documents per visit (each document averages 6 borings or test pits).

Health Sciences A-206 206-543-6059	Kinko's Inc. 206-524-6629 (3042 NE 45th St)
Health Sciences I-146 206-543-8696	Kinko's Inc. 206-545-7218 (810 Northeast 45th St)
UW Medical Center NW-079 206-598-4019	many copy centers on the "ave"

Credit
Be sure to credit “GeoMapNW at the University of Washington” as the source of data you collect from us. This center’s ability to provide data and new geologic maps is dependent upon continued funding, and citations are an important element for measuring progress.

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Dated June 26, 2004

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. [redacted]
26/5/13C
Water Right Permit No.

(1) OWNER: Name Joe Aceti Address 17326 - NE 152 ND Woodinville

(2) LOCATION OF WELL: County King NE ¼ NW ¼ Sec. 13 T. 26 N., R. 5 W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) SAme

(3) PROPOSED USE: ☐ Domestic ☒ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☐ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled feet. Depth of completed well ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from +1 ft. to 265' ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☐ " Diam. from ft. to ft.
Threaded ☐
Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Model No.
Diam. 5" Slot size 15 from 275 ft. to 270 ft.
Diam. 56 Slot size 15 from 270 ft. to 265 ft.
Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.
Surface seal: Yes ☒ No ☐ To what depth? 20 ft.
Material used in seal Bentonite Clay
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Flint + Walling
Type: Sub H.P. 5hp

(8) WATER LEVELS: Land-surface elevation above mean sea level 210 ft.
Static level 130 ft. below top of well Date 9-19 92
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Driller
Yield: 22 gal./min. with 12 ft. drawdown after 1 hrs.
" " " "
" " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 20 gal./min. with 25' ft. drawdown after 3 hrs.
Airlift gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Glacier Till	0	35
Sand (Non-Water Bearing)	35	200
Sand (Non Water Bearing)	200	265
Sand Gravel Water Bearing	265	273

RECEIVED
NOV 30 1992
DEPT. OF ECOLOGY

Work started Sept 19, 19. Completed Oct 21, 19 92

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME J K A Enterprises (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 21203-195th SE Monroe
(Signed) [signature] (WELL DRILLER) License No. 1606
Contractor's Registration No. JKAENOI01LD Date 10-23, 19 92

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329- 3

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26/6/17C
Permit No. 26/6/17C

(1) OWNER: Name Tim Easter Address 12951 NE BELRED Rd BELLEVUE

(2) LOCATION OF WELL: County King NE ¼ NW ¼ Sec 17 T 26 N., R 6E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)....

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 26 ft. Depth of completed well 26 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 21 ft.

Threaded ☐ " Diam. from ft. to ft.

Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

Screens: Yes ☒ No ☐ JOHNSON

Manufacturer's Name

Type STAINLESS Model No.

Diam. 6 Slot size 012 from 21 ft. to 26 ft.

Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:

Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal Bentonite

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name

Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level.... ft.

Static level 6 ft. below top of well Date 10/6/80

Artesian pressure lbs. per square inch Date

Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 25 gal./min. with 7 ft. drawdown after 1 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
BROWN CLAYEY H.P.	0	19
GRAVEL	19	23
BLUE SAND & GRAVEL	23	26

RECEIVED OCT 22 1980 DEPT. OF ECOLOGY

Work started 10/3, 19 80. Completed 10/6, 19 80

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME (Person, firm, or corporation) (Type or print)

Address

[Signed] Lawrence Johnson (Well Driller)

License No. 0220 Date 10/8, 19 80

(USE ADDITIONAL SHEETS IF NECESSARY)

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. 26/16 - 17C
Permit No.

(1) OWNER: Name Jim Easter Address 12951 NE Bel Red Rd Bellevue

(2) LOCATION OF WELL: County King — NE ¼ NW ¼ Sec. 17 T. 26 N., R. 6E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 26 ft. Depth of completed well 26 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 21 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐ JOHNSON
Manufacturer's Name
Type STAINLESS Model No.
Diam. 6 Slot size 012 from 21 ft. to 26 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 6 ft. below top of well Date 10/6/80
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 25 gal./min. with 7 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
BROWN CLAYEY H.P.	0	19
GRAVEL	19	23
BLUE SAND & GRAVEL	23	26

OCT 22 1980
DEPT. OF ECOLOGY

Work started 10/3, 1980 Completed 10/6, 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME (Person, firm, or corporation) (Type or print)

Address

[Signed] Lawrence Johnson (Well Driller)

License No. 0220 Date 10/8, 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

26/6E/17D

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W 09713
Unique Well I.D. #
Water Right Permit No.

(1) OWNER: Name BRANDENSTEIN, MICHAEL Address 14822 204TH PLACE N E WOODINVILLE, WA 98072-

(2) LOCATION OF WELL: County KING - NW 1/4 NW 1/4 Sec 17 T 26 N., R 6 WM
(2a) STREET ADDRESS OF WELL (or nearest address) 14822 204TH PLACE N E, WOODINVILLE

(3) PROPOSED USE: DOMESTIC

(4) TYPE OF WORK: Owner's Number of well (If more than one)
NEW WELL Method: ROTARY

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 79 ft. Depth of completed well 79 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Dia. from 0 ft. to 74 ft.
WELDED " Dia. from ft. to ft.
" Dia. from ft. to ft.

Perforations: NO
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: YES
Manufacturer's Name
Type STAINLESS STEEL Model No. TELESCOPING
Diam. 6 slot size 10 from 74 ft. to 79 ft.
Diam. slot size from ft. to ft.

Gravel packed: NO Size of gravel
Gravel placed from ft. to ft.

Surface seal: YES To what depth? 18 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? NO
Type of water? Depth of strata ft.
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ... ft.
Static level 28 ft. below top of well Date 11/02/93
Artesian Pressure lbs. per square inch Date
Artesian water controlled by

(10) WELL LOG

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

MATERIAL	FROM	TO
BROWN CLAY & GRAVEL	0	21
BLUE CLAY & GRAVEL	21	65
WATER FINE SAND & LITTLE GRAVEL	65	80

RECEIVED
NOV 16 1993
DEPT. OF ECOLOGY

Work started 11/01/93 Completed 11/02/93

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.

Recovery data

Time	Water Level	Time	Water Level	Time	Water Level

Date of test / /
Bailer test gal/min. 43 ft. drawdown after hrs.
Air test 12 gal/min. w/ stem set at 73 ft. for 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made?

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME DAHLMAN PUMP & WELL DRILL
(Person, firm, or corporation) (Type or print)

ADDRESS PO BOX 422,BURLINGTON, WA

[SIGNED] Ralph W. Dahlman License No. 2043

Contractor's Registration No. DAHLMPW123LC Date 11/04/93

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

ENTERED 126842

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 11796
UNIQUE WELL I.D. # ABF589
Water Right Permit No. G1-27396A

(1) OWNER: Name Herzel Memorial Park Address 16601-11 Dayton Avenue North

(2) LOCATION OF WELL: County King SW ¼ SW ¼ Sec 7 T 26 N., R 6E W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) 16601-11 Dayton Avenue North 26/6/7N

(3) PROPOSED USE: ☐ Domestic ☒ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 8 inches.
Drilled 294 feet. Depth of completed well 190 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 8 " Diam. from 0 ft to 160 ft
Welded ☒ Liner installed ☐ Threaded ☐ " Diam. from ft. to ft.
" Diam from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in
perforations from ft. to ft
perforations from ft to ft.
perforations from ft to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type 304 Stainless Model No.
Diam 5 Slot size 0.030 from 160 ft. to 180 ft.
Diam. Slot size from ft to ft.

Gravel packed: Yes ☒ No ☐ Size of gravel 8-12
Gravel placed from 150 ft to 190 ft.

Surface seal: Yes ☒ No ☐ To what depth? 32 ft.
Material used in seal Cement
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Flint & Walling, Inc.
Type Submersible H.P. 5

(8) WATER LEVELS: Land-surface elevation above mean sea level Approx. 420 ft.
Static level 121.35 ft below top of well Date 5/10/94
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? AGI
Yield 75 gal./min. with 10.06 ft drawdown after 6 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
1	119.35	9	121.39	40	121.35
2	120.33	20	121.38	50	121.35
5	121.41	30	121.36		

Date of test 5/11/94
Bailer test 30 gal./min with 4 ft drawdown after 2 hrs
Airtest gal./min. with stem set at ft for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☒ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Silty sand w/gravel, dk brn	0	6
Cemented sand & grvl, tight	6	60
Cemented sand & grvl, gry-brn	60	78
Sand, grvl, water, gry-brn	78	110
Sand, gravel, dirty, dry	110	124
Sand, fine, water, brown	124	135
Sand, fine, gravel, silt,brn	135	150
Sand, fine, grvl, w-b, brn	150	155
Sand, fine, grvl, w-b, brn	155	170
Sand, fine, grvl, w-b, brn	170	182
Sand, fine, silty, grvl, wb	182	200
Sand, fine, silty, wood, wb	200	210
Sand, fine, w-b, blue	210	220
Silt, tight, dry, dark gray	220	233
Sand, silty, w-b, blue-gray	233	256
Clay, silty, sticky, w-b	256	294

RECEIVED
MAY 31 1994
DEPT. OF ECOLOGY

Work started 4/20/94, 19 Completed 5/13, 19 94

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Hokkaido Drilling & Development, Inc
(PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)

Address P.O. Box 100, Graham, WA 98338

(Signed) [signature] (WELL DRILLER) License No. 1146

Contractor's Registration No. HOKKADD178D3 Date 5-19, 19 94

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329-

26-- 12- G

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WATER WELL REPORT
STATE OF WASHINGTON

Start Card No. [redacted]
Water Right Permit No.

(1) OWNER: Name GTE Address 2312 W CASINO ROAD EVERETT, WA 98201-

(2) LOCATION OF WELL: County KING - SW 1/4 SE 1/4 Sec 12 T 26 N., R 5 WM
(2a) STREET ADDRESS OF WELL (or nearest address) NE 172ND OFF ROCKER ROAD

(3) PROPOSED USE: ANODE

(4) TYPE OF WORK: Owner's Number of well (If more than one) 1
NEW WELL Method: ROTARY

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 200 ft. Depth of completed well 200 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Dia. from 0 ft. to 200 ft.
WELDED " Dia. from ft. to ft.
" Dia. from ft. to ft.

Perforations: NO
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: NO
Manufacturer's Name
Type Model No.
Diam. slot size from ft. to ft.
Diam. slot size from ft. to ft.

Gravel packed: NO Size of gravel
Gravel placed from ft. to ft.

Surface seal: YES To what depth? 18 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? NO
Type of water? Depth of strata ft.
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ... ft.
Static level ft. below top of well Date
Artesian Pressure lbs. per square inch Date
Artesian water controlled by

(10) WELL LOG

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

MATERIAL	FROM	TO
BROWN CLAY & GRAVEL	0	15
SAND	15	20
BROWN CLAY & GRAVEL	20	80
WATER & GRAVEL	80	100
BLUE CLAY & GRAVEL	100	118
WATER & GRAVEL	118	124
BLUE CLAY	124	200

Work started 04/10/02 Completed 04/13/92

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.
Was a pump test made? If yes, by whom?
Yield: gal./min with ft. drawdown after hrs.

Recovery data
Time Water Level Time Water Level Time Water Level

Date of test / /
Bailer test gal/min. ft. drawdown after hrs.
Air test gal/min. w/ stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made?

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME DAHLMAN PUMP & WELL DRILL
(Person, firm, or corporation) (Type or print)

ADDRESS PO BOX 422, BURLINGTON, WA

[SIGNED] Ted Ruckers License No. 0623

Contractor's Registration No. DAHLMPW123LC Date 04/14/92

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APR 24 1992
DEPT. OF ECOLOGY

26/5 - 1 1

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 015307

Water Right Permit No. _____

(1) OWNER: Name Tom Siekoness Address P.O. Box 1072 Woodinville, Wa, 98072

(2) LOCATION OF WELL: County King NE ¼ SW ¼ Sec 12 T. 26 N., R. 5 E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) 17708-126 Ave NE Woodinville, Wa. 98072

(3) PROPOSED USE: [X] Domestic [ ] Irrigation [ ] DeWater Industrial [ ] Test Well [ ] Municipal [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) _____
Abandoned [ ] New well [X] Deepened [ ] Reconditioned [ ]
Method: Dug [ ] Cable [X] Rotary [ ] Bored [ ] Driven [ ] Jetted [ ]

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 31 feet. Depth of completed well 31 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from 0 ft. to 25 ft.
Welded [X] " Diam. from _____ ft. to _____ ft.
Liner installed [ ] Threaded [ ] " Diam. from _____ ft. to _____ ft.

Perforations: Yes [ ] No [X]
Type of perforator used _____
SIZE of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

Screens: Yes [X] No [ ]
Manufacturer's Name Johnson
Type Stainless Model No. _____
Diam. 6 Slot size .015 from 26 ft. to 31 ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes [ ] No [X] Size of gravel _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes [X] No [ ] To what depth? 20 ft.
Material used in seal Cement
Did any strata contain unusable water? Yes [ ] No [X]
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level flowing ft.
Static level flowing ft. below top of well Date 10/24/88
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by Cap & valve (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes [X] No [ ] If yes, by whom? Driller
Yield: 18 gal./min. with 20 ft. drawdown after 3½ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
0	20	1 min	8	3½	flowing

Date of test 10/24/88

Bailer test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest _____ gal./min. with stem set at _____ ft. for _____ hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water 50° Was a chemical analysis made? Yes [X] No [ ]

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Topsoil	0	3
Grey sandy clay	3	18
Grey Till (Hardpan)	18	25
Coarse sand & water	25	31

RECEIVED
NOV 14 1988
DEPARTMENT OF ECOLOGY
NORTHWEST REGION

Work started _____, 19__ Completed _____, 19__

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Morris Drilling Co. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 7215-122 Ave SE Renton, Wa 98056
(Signed) Thomas J. Morris (WELL DRILLER) License No. 0327
Contractor's Registration No. MORRIDC181P5 Date 10/25, 1988

(USE ADDITIONAL SHEETS IF NECESSARY)

EGY 050-1-20 (10/87) -1328-

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Unrecorded

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

WELL LOG

Record by Driller
Source Well Report

Location State of WASHINGTON
County King
Area
Map
NE 1/4 SE 1/4 sec 8 T 26 N R 6 E/W

Diagram of Section

Drilling Co H O Mayer (98033)
Address 6424 Lake Washington Blvd Kirkland Wa
Method of Drilling Cable Date 9-25-72 19
Owner Ron Verschuyl 11046 2nd Av N W
Address Seattle Wa 98177
Land surface datum — ft above/below —
SWL 0' Date 9-25-72 19 Dims 6" x 62'

File number 26/6E 8J

Correlation	Domestic Material	From (feet)	To (feet)
	Topsoil, sandy	0	3
	Hardpan & cobbles	3	12
	gravel, hardpan + boulders		
	large boulders 6-12'	12	14'
	Hardpan	14	33'
	Hardpan w/ cobbles	33	40'
	Hardpan w/ cobbles	40	49'
	Sand & cobbles	49	52'
	Sand, silty w/ gravel	52	55'
	Sand, gravel & water-bearing	55	62'
	Casing - 6	0	57'
	Screen Johnson 6 Stainless - 14		
		57'	62'
	Surface seal - Impervious clay	—	—
	Bailer Test - 7 gpm w/ 50' DD @ 2 hrs		

(Transcribe driller's terminology literally but paraphrase as necessary in parentheses. If material water bearing so state and record static level if reported. Give depths in feet below land surface datum unless otherwise indicated. Correlate with stratigraphic column if feasible. Following log of materials list all casings perforations screens etc.)

Turn up Sheet of sheets

26/06-8G

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Paul Watson Address 20642 NE 175th Woodinville, Wa. 98072

(2) LOCATION OF WELL: County King — SW ¼ NE ¼ Sec 8 T 26 N., R 6 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 60 ft. Depth of completed well 60 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 56 ft.

Threaded ☐ " Diam. from ft. to ft.

Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒

Type of perforator used .....

SIZE of perforations ..... in. by ..... in.

..... perforations from ..... ft. to ..... ft.

..... perforations from ..... ft. to ..... ft.

..... perforations from ..... ft. to ..... ft.

Screens: Yes ☒ No ☐

Manufacturer's Name Johnson

Type stainless Model No. .....

Diam. 5 Slot size .08 from 55 ft. to 60 ft.

Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....

Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal Bentonite

Did any strata contain unusable water? Yes ☐ No ☒

Type of water? ..... Depth of strata .....

Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....

Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.

Static level 12 ft. below top of well Date 4/22/85

Artesian pressure ..... lbs. per square inch Date .....

Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☐ If yes, by whom? .....

Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....

Bailer test 10 gal./min. with 30 ft. drawdown after 2 hrs.

Artesian flow ..... g.p.m. Date .....

Temperature of water 47° Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Gravel	0	3
Red Till Rocks	3	19
Gravel & some water	19	21
Red Gravelly Till	21	34
Gray sand & Gravel rocks	34	60

RECEIVED SEP 11 1985 DEPARTMENT OF ECOLOGY NORTHWEST REGION

Work started 4/17, 1985 Completed 4/22, 1985

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Morris Drilling Co. (Person, firm, or corporation) (Type or print)

Address 7215-122 S.E. Renton, Wa. 98056

[Signed] Thomas J. Morris (Well Driller)

License No. 0327 Date 5/2, 1985

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start ~~Card~~ No. 46IC0096
7/29/93
Water Right Permit No. WO21056

(1) OWNER: Name Fisher Shaw Address 21213 N.E 186th ST. Woodinville

(2) LOCATION OF WELL: County King. N½ NW¼ NE¼ Sec. 8 T. 26 N., R. 6E W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) 21213 NE 186th ST. Woodinville 26/6E/8B

(3) PROPOSED USE: ☑ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☑ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☑ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 45 feet. Depth of completed well 45 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from +1½ ft. to 45 ft.
Welded ☑ 6" Diam. from ft. to ft.
Liner installed ☐
Threaded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? 19 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Flint + Walling
Type: Submersible H.P. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 6 ft. below top of well Date 12-2-93.
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☑ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 7 gal./min. with 23 ft. drawdown after 2 hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☑ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Dark Brown Clay Till with Boulders	0	6
Brown Till	6	23
Gray Till	23	27
Brown Till	27	39
Brown washed Gravel with some Sand mix	39	45

RECEIVED
DEC - 8 1993
DEPT. OF ECOLOGY

Work started 11-23-93, 19. Completed 12-2-93, 19.

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Burns Drilling Co (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 1519 Dayton Ct. N.E Renton
(Signed) Jon Burns (WELL DRILLER) License No. 0698
Contractor's Registration No. BURNS 121KP Date 12-6-93, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329-

3 Micro Biological + Nitrate

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start ~~Card~~ No. 46IC0096
7/29/93
Water Right Permit No. WO21056

(1) OWNER: Name Fisher Shaw Address 21213 N.E 186th ST. Woodinville

(2) LOCATION OF WELL: County King. N½ NW¼ NE¼ Sec. 8 T. 26 N., R. 6E W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) 21213 NE 186th ST. Woodinville 26/6E/8B

(3) PROPOSED USE: ☑ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☑ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☑ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 45 feet. Depth of completed well 45 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from +1½ ft. to 45 ft.
Welded ☑ 6" Diam. from ft. to ft.
Liner installed ☐
Threaded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? 19 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Flint + Walling
Type: Submersible H.P. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 6 ft. below top of well Date 12-2-93.
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☑ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 7 gal./min. with 23 ft. drawdown after 2 hrs.
Airtest gal./min. with stem set at ft. for hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☑ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Dark Brown Clay Till with Boulders	0	6
Brown Till	6	23
Gray Till	23	27
Brown Till	27	39
Brown washed Gravel with some Sand mix	39	45

RECEIVED
DEC - 8 1993
DEPT. OF ECOLOGY

Work started 11-23-93, 19. Completed 12-2-93, 19.

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Burns Drilling Co (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 1519 Dayton Ct. N.E Renton
(Signed) Jon Burns (WELL DRILLER) License No. 0698
Contractor's Registration No. BURNS 121KP Date 12-6-93, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329-

3 Micro Biological + Nitrate

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warrant the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy -- Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

26/05-12A

Application No. None

STATE OF WASHINGTON

Permit No. ....

(1) OWNER: Name Charles Miller 26/5E/12/A Address 18006-176 Ave N.E. Woodinville, Wash

(2) LOCATION OF WELL: County King Th Portion of S½ of S½ of S½ of NE¼ of NW¼ Sec. 12 T. 26 N., R. 5E W.M.

Bearing and distance from section or subdivision corner 2. NE COR of S½ of S½ - N88°52'22"W 4 2 2050.33835

(3) PROPOSED USE: Domestic ☑ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 48 ft. Depth of completed well 46 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: ....." Diam. from .... ft. to .... ft.
Threaded ☐ ....." Diam. from .... ft. to .... ft.
Welded ☑ 6" Diam. from +2 ft. to 40 ft.

Perforations: Yes ☐ No ☑
Type of perforator used .....
SIZE of perforations .... in. by .... in.
.... perforations from .... ft. to .... ft.
.... perforations from .... ft. to .... ft.
.... perforations from .... ft. to .... ft.

Screens: Yes ☑ No ☐ With 28" Riser
Manufacturer's Name U.P.O. Johnson
Type Stainless Steel Model No. .....
Diam. 14 Slot size .... from 41 ft. to 46 ft.
Diam. .... Slot size .... from .... ft. to .... ft.

Gravel packed: Yes ☐ No ☑ Size of gravel: .....
Gravel placed from .... ft. to .... ft.

Surface seal: Yes ☑ No ☐ To what depth? 22 ft.
Material used in seal .....
Did any strata contain unusable water? Yes ☐ No ☑
Type of water? .... Depth of strata .....
Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....
Type: .... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ft.
Static level .... ft. below top of well Date .....
Artesian pressure 8 lbs. per square inch Date 10-26
Artesian water is controlled by .... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☑ If yes, by whom? .....
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....
Bailer test .... gal./min. with .... ft. drawdown after .... hrs.
Artesian flow 20 g.p.m. Date 10-26
Temperature of water .... Was a chemical analysis made? Yes ☐ No ☑

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Top Soil & Muck	0	2
Clay yellow with gravel & sand	2	11
Gray Till	11	38
Gray Clay	38	43
Hard Pan with Gravel Mixture	38	42
Fine sand Artesian Water	42	46
Brown Sand	46	48
Clay	48	48
Just off of Woodinville Duvall Road		

Work started 10-15, 1975 Completed 10-26, 1975

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME H.D. Meyer Drilling Co. (Person, firm, or corporation) (Type or print)

Address 6420 Lake Wa. Blvd N.E. Kirkland, Wash. 98033

[Signed] H. D. Meyer (Well Driller)

License No. 0308 Date 11-14, 1975

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

26/5/2K

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. [redacted]

Water Right Permit No. 98072

(1) OWNER: Name Fred Drennan Address 18712 160th Ave, Woodinville

(2) LOCATION OF WELL: County King SE ¼ SE ¼ Sec 2 T. 26 N., R. 5 W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) (Same)

(3) PROPOSED USE: ☐ Domestic ☒ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 158 feet. Depth of completed well 158 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from 0 ft. to 158 ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☐ " Diam. from ft. to ft.
Threaded ☐

Perforations: Yes ☒ No ☐
Type of perforator used star wheel
SIZE of perforations 1/8 in. by 2 in.
80 perforations from 137 ft. to 146 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal puddling clay
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 110 ft. below top of well Date 6-30-92
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest 20 gal./min. with stem set at 145 ft. for 2 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Brown sand-gravel	0	12
Tan sand-gravel-clay	12	80
Gray gravel	80	127
Gray sand	127	132
Tan clay	132	137
Tan gravel-sand-water	137	146
Green clay	146	158

RECEIVED
JUL 02 1992
DEPT. OF ECOLOGY

Work started 6-24, 19. Completed 6-30, 19 92

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Johnson Drilling Co. Inc. (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 19415 108th Ave SE Renton 98055
(Signed) [signature] (WELL DRILLER) License No. 0233
Contractor's Registration No. JOHNSDC207GM Date 6-30, 1992

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329- 3

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26/05 — 01K

Permit No.

(1) OWNER: Name Esther Nelson Address 11704 196th Ave N.E. Redmond WA 98052

(2) LOCATION OF WELL: County King — NW ¼ SE ¼ Sec. 1 T. 25 N., R. 5E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.
Drilled 61 ft. Depth of completed well 61 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 51 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Model No.
Diam. 6" Slot size 30 from 51 ft. to 61 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Westerol
Type: Sub HP 1 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 10 ft. below top of well Date 12/30/80
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Statewide
Yield: 35 gal./min. with 16 ft. drawdown after 4 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 30 gal./min. with 12 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Brown Loamy Sand	0	2
Brown Silty, Sandy, Gravel	2	16
Gray Till	16	49
Gray Med to Coarse Sand & Med to Coarse Gravel	49	61
Gray Silty Clayey Sand	61	—

JUN 12 1981

Work started 12/23, 1980 Completed 12/31, 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Statewide Drilling Co. (Person, firm, or corporation) (Type or print)

Address 1333 Barton Way So. Renton

[Signed] David R. Yerla (Well Driller)

License No. C541 Date 1/19, 1981

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26/05-015

Permit No. ....

(1) OWNER: Name Lee Doughty Address 14840 NE 191st Woodinville 98072

(2) LOCATION OF WELL: County King 30' N of PR, 320' East of Lake Leota NE ¼ SW ¼ Sec. 1 T. 26 N., R. 5 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ....
New well ☐ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☑ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 68 ft. Depth of completed well 68 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 68 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☑ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☑
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☑
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☑ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☑ No ☐ To what depth? ft.
Material used in seal Bentonite Used
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? Depth of strata
Method of sealing strata off

But No Explanation

(7) PUMP: Manufacturer's Name Sears Jet
Type: H.P. 3/4

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 50 ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 20 gal./min. with 1.5 ft. drawdown after 44 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☑

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Dug well w. tile	0	55
Sand & Sediment	55	58
Hard pan	58	62
Clean washed gravel	62	68

Well had been fairly productive many years - But Pulls Cracks or Separations Considerable Silt Had Washed in
Water had always tested O.K.

We Put in 1 Sack Mixed Bentonite When we Started to drill - we Blowed Cutting Back into Hole.
Then I instructed owner to have 8 yards of sand fill (clean) Put into hole & gravel firm 2 more Sacks of Bentonite to Mix with The Sand.

Advised him that it should be Filled to the top, But that present Procedure should be Satisfactory

FEB 28 1980
DEPT. OF ECOLOGY

Work started 2-15 19 80, Completed 2-17, 19

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME H.O. Meyer Drilling Co. (Person, firm, or corporation) (Type or print)

Address 6424 Lake W. Blvd SE - Kirkland, Wa.

[Signed] H.O. Meyer (Well Driller)

License No. 0308 Date Feb. 26, 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

26/05-02K

Application No.

Permit No.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

(1) OWNER: Name Kit Vans Nursery Address 19208 156th NE Woodinville

(2) LOCATION OF WELL: County King — NW ¼ SE ¼ Sec. 2 T. 26 N., R. 5E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 180' ft. Depth of completed well 179 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from +1 ft. to 154 ft.
Threaded ☐ 5" Diam. from 150.5 ft. to 154 ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Johnson
Type Stainless Model No.
Diam. 5 Slot size 25 from 154 ft. to 179 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18' ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 145 ft. below top of well Date 5-26-87
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test unknown gal./min. with 0 ft. drawdown after 9 hrs.
Artesian flow g.p.m. Date
Temperature of water 47° Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Top soil, Sand and large gravel	0	4
Grey clay pan	4	71
silt	71	83
Grey clay pan - Sandy, gravelly	83	154
Med. sand - coarse - large gravel	154	179
grey clay	179	180

Work started 4-27, 1987 Completed 5-20, 1987

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Alpine Drill Co. Inc. (Person, firm, or corporation) (Type or print)

Address P.O. Box 717 Carnation

[Signed] (Well Driller)

License No. 1454 Date 5-26, 1987

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Entered

Start Card No. W 39843 ~~10317~~

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

UNIQUE WELL I.D. #

Water Right Permit No. 26/5/2K

(1) OWNER: Name City of Woodinville Address

(2) LOCATION OF WELL: County King - NW 1/4 SE 1/4 Sec 2 T. 26 N. R. SE W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) 156th + 203rd Pl

(3) PROPOSED USE: ☐ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☒ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐ Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 190 feet. Depth of completed well 178 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from +2 ft. to 165 ft.
Welded ☒ " Diam. from ft. to ft.
Liner installed ☐ Threaded ☐ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Smith
Type S.S. 6" Pole Model No.
Diam. Slot size .020 from 168 ft. to 178 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite Chips
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 101' ft. below top of well Date
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest 70 gal./min. with stem set at 160 ft. for 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
OR SILTY TOPSOIL	0	2
TAN BROWN SAND MOIST	2	6
GRAY SILTY SANDY GRAVEL COMPACT DRY	6	34
TAN GRAY SILTY SAND & GRAVEL MOIST	34	47
GRAY SILTY SAND DENSE COARSE TO MED MOIST	47	58
GRAY BROWN LOOSE MED SAND "	58	67
GRAY TAN GRAVEL & SAND	67	69
TAN BROWN SAND COMPACT	69	77
BROWN ~~GRAY~~ FINE TO COARSE SAND	77	97
LOOSE MOIST BROWN SAND	97	106
GRAY WET FINE TO MED SAND	106	125
GRAY WET SANDY GRAVEL	125	130
LOOSE GRAY SAND	130	133
GRAY WET GRAVELLY SAND	133	152
GRAY BROWN SL SILTY SANDY GRAVEL	152	155
GRAY WET SANDY GRAVEL	155	180
GRAY WET W GRAVELLY FINE SAND	180	190

RECEIVED
FEB 23 1994
DEPT. OF ECOLOGY

Work Started 1-6, 19. Completed 1-7, 19 94

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME HTI (PERSON, FIRM OR CORPORATION) (TYPE OR PRINT)

Address 10621 Todd Rd E

(Signed) [signature] (WELL DRILLER) License No. 1672

Contractor's Registration No. HOLTTIW087OJ Date 1-7, 19 94

(USE ADDITIONAL SHEETS IF NECESSARY)

ECL 050-1-20 (2/93)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

20/06-6E

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name Paul Schwarz Address 805 Evergreen Dr. E. Sumner, Wa. 98390

(2) LOCATION OF WELL: County King — SW ¼ NW ¼ Sec. 6 T. 20 N., R. 6 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☐ Driven ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 93 ft. Depth of completed well 93 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 93 ft.

Threaded ☐ ....." Diam. from ..... ft. to ..... ft.

Welded ☒ ....." Diam. from ..... ft. to ..... ft.

Perforations: Yes ☐ No ☒

Type of perforator used .....

SIZE of perforations ..... in. by ..... in.

..... perforations from ..... ft. to ..... ft.

..... perforations from ..... ft. to ..... ft.

..... perforations from ..... ft. to ..... ft.

Screens: Yes ☐ No ☒

Manufacturer's Name .....

Type ..... Model No. .....

Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Diam. ..... Slot size ..... from ..... ft. to ..... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....

Gravel placed from ..... ft. to ..... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal Bentonite & Cement

Did any strata contain unusable water? Yes ☐ No ☒

Type of water? ..... Depth of strata .....

Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....

Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.

Static level 36 ft. below top of well Date 10-29-84

Artesian pressure ..... lbs. per square inch Date .....

Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom? .....

Yield: ..... gal./min. with ..... ft. drawdown after ..... hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....

Bailer test 15 gal./min. with 30 ft. drawdown after 1 hrs.

Artesian flow ..... g.p.m. Date .....

Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Topsoil	0	3
Brn. Silty Sand	3	22
Brn. Till	22	64
Blue Till	64	69
Brn. Till	69	87
Water Bearing Sand & Gravel	87	93

Work started 10-26-84, 19.... Completed 10-29-84, 19....

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME NW Pump & Drilling Co. (Person, firm, or corporation) (Type or print)

Address 3245 Auburn Way South

[Signed] R. D. Delamont (Well Driller)

License No. 0097 Date 11-2-84, 19....

NORTHWEST REGION

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

2C/06-05E

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name MARTH, BETTY Address .....

(2) LOCATION OF WELL: County KING — SW¼ NW¼ Sec. 5 T. 26 N., R. 6E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....

New well ☐ Deepened ☒ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☐ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.

Drilled 101 ft. Depth of completed well 80 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 80 ft.

Threaded ☐ ..." Diam. from ... ft. to ... ft.

Welded ☒ ..." Diam. from ... ft. to ... ft.

Perforations: Yes ☒ No ☐

Type of perforator used WHEEL

SIZE of perforations 1/8 in. by 3/8 in.

5 ROWS perforations from 18 ft. to 35 ft.

..... perforations from 50 ft. to 78 ft.

..... perforations from ... ft. to ... ft.

Screens: Yes ☐ No ☒

Manufacturer's Name .....

Type ..... Model No. .....

Diam. ..... Slot size ..... from ... ft. to ... ft.

Diam. ..... Slot size ..... from ... ft. to ... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....

Gravel placed from ... ft. to ... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal BENTONITE

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? ..... Depth of strata .....

Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....

Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.

Static level 10 ft. below top of well Date MAY 10, 80

Artesian pressure ..... lbs. per square inch Date .....

Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom? .....

Yield: ... gal./min. with ... ft. drawdown after ... hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....

Bailer test 15 gal./min. with 30 ft. drawdown after 3 hrs.

Artesian flow ..... g.p.m. Date .....

Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
EXISTING WELL	0	18
GREY TILL WITH LENSES OF W.B. SAND	18	35
GREY TILL	35	50
GREY SA GVL	50	80
BOULDER	80	87
GREY SA GVL	87	98
BOULDER	98	101

1980

Work started ....., 19.... Completed MAY 10, 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME AXELSEN DRILLING (Person, firm, or corporation) (Type or print)

Address 18802 - 92 NE BOTHELL

[Signed] A. Axelsen (Well Driller)

License No. 0008 Date MAY 10, 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 1156—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26[illegible]-C-B

Permit No.

(1) OWNER: Name F. W. RICHARDSON Address 20103-174TH AVE NE WOODINVILLE

(2) LOCATION OF WELL: County KING — NW ¼ NE ¼ Sec. 1 T. 26 N., R. 5E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☐ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.
Drilled ft. Depth of completed well ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 65 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☒ To what depth? ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name DEMING
Type: JET H.P. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 0 ft. below top of well Date 1958
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? E. E. AKELSEN
Yield: 9 gal./min. with 23 ft. drawdown after 20 YEARS
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 12 gal./min. with ft. drawdown after 1 hrs.
Artesian flow 125 g.p.m. Date 1958
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
BRN SANDY LOAM	0	2
BRN TILL	2	10
GREY TILL	10	35
BRN SILTY SAND W/OCC GVL	35	60

MAY 1 5 1980

Work started 19 Completed 1958

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME AKELSEN DRILLING (Person, firm, or corporation) (Type or print)

Address 18802-92 NE, BOTHELL WA. 98011

[Signed] [illegible] (Well Driller)

License No. 0008 Date 8 AUG 1978

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7350—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

2C/06-05E

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. .....

Permit No. .....

(1) OWNER: Name MARTH, BETTY Address .....

(2) LOCATION OF WELL: County KING — SW¼ NW¼ Sec. 5 T. 26 N., R. 6E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) .....

New well ☐ Deepened ☒ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☐ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.

Drilled 101 ft. Depth of completed well 80 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 80 ft.

Threaded ☐ ..." Diam. from ... ft. to ... ft.

Welded ☒ ..." Diam. from ... ft. to ... ft.

Perforations: Yes ☒ No ☐

Type of perforator used WHEEL

SIZE of perforations 1/8 in. by 3/8 in.

5 ROWS perforations from 18 ft. to 35 ft.

..... perforations from 50 ft. to 78 ft.

..... perforations from ... ft. to ... ft.

Screens: Yes ☐ No ☒

Manufacturer's Name .....

Type ..... Model No. .....

Diam. ..... Slot size ..... from ... ft. to ... ft.

Diam. ..... Slot size ..... from ... ft. to ... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: .....

Gravel placed from ... ft. to ... ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal BENTONITE

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? ..... Depth of strata .....

Method of sealing strata off .....

(7) PUMP: Manufacturer's Name .....

Type: ..... H.P. .....

(8) WATER LEVELS: Land-surface elevation above mean sea level ..... ft.

Static level 10 ft. below top of well Date MAY 10, 80

Artesian pressure ..... lbs. per square inch Date .....

Artesian water is controlled by ..... (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom? .....

Yield: ... gal./min. with ... ft. drawdown after ... hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test .....

Bailer test 15 gal./min. with 30 ft. drawdown after 3 hrs.

Artesian flow ..... g.p.m. Date .....

Temperature of water ..... Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
EXISTING WELL	0	18
GREY TILL WITH LENSES OF W.B. SAND	18	35
GREY TILL	35	50
GREY SA GVL	50	80
BOULDER	80	87
GREY SA GVL	87	98
BOULDER	98	101

1980

Work started ....., 19.... Completed MAY 10, 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME AXELSEN DRILLING (Person, firm, or corporation) (Type or print)

Address 18802 - 92 NE BOTHELL

[Signed] A. Axelsen (Well Driller)

License No. 0008 Date MAY 10, 1980

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 1156—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26[illegible]-C-B

Permit No.

(1) OWNER: Name F. W. RICHARDSON Address 20103-174TH AVE NE WOODINVILLE

(2) LOCATION OF WELL: County KING — NW ¼ NE ¼ Sec. 1 T. 26 N., R. 5E W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☐ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.
Drilled ft. Depth of completed well ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 65 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☐ No ☒ To what depth? ft.
Material used in seal
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name DEMING
Type: JET H.P. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 0 ft. below top of well Date 1958
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? E. E. AKELSEN
Yield: 9 gal./min. with 23 ft. drawdown after 20 YEARS
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test 12 gal./min. with ft. drawdown after 1 hrs.
Artesian flow 125 g.p.m. Date 1958
Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
BRN SANDY LOAM	0	2
BRN TILL	2	10
GREY TILL	10	35
BRN SILTY SAND W/OCC GVL	35	60

MAY 1 5 1980

Work started 19 Completed 1958

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME AKELSEN DRILLING (Person, firm, or corporation) (Type or print)

Address 18802-92 NE, BOTHELL WA. 98011

[Signed] [illegible] (Well Driller)

License No. 0008 Date 8 AUG 1978

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7350—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 26,000-L

Permit No. ....

(1) OWNER: Name KENNITH B. DORSEY Address 19920-174 AL NE WOODINVILLE WA

(2) LOCATION OF WELL: County KING WA NW¼ NW¼ NW¼ — SW ¼ NE ¼ Sec. 1 T. 26 N., R. 5 W.M.

Bearing and distance from section or subdivision corner

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) ONE

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 64 ft. Depth of completed well ..... ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from 0 ft. to 58 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐ JOHNSONS
Manufacturer's Name
Type STAINLESS STEEL Model No.
Diam. 5 Slot size 40 from 38 ft. to 63 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? GOOD Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name PIONEER
Type: SUB H.P. 1/2

(8) WATER LEVELS: Land-surface elevation above mean sea level .... ft.
Static level 0 ft. below top of well Date 6-13-84
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 6-12-84
Bailer test 8 gal./min. with 50 ft. drawdown after 2 hrs.
Artesian flow g.p.m. Date
Temperature of water 48 Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
TOP SOIL BR	0	2
SAND STONE BR	2	38
GRAVEL & SAND GR DRY	38	46
CONGLOMATED ROCK GR	46	60
GRAVEL & SAND GR	60	63

RECEIVED OCT 1984 DEPARTMENT OF ECOLOGY NORTHWEST REGION

Work started ....., 19.... Completed ....., 19....

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME RAY'S WELL DRILLING (Person, firm, or corporation) (Type or print)

Address O. R. Filipini

[Signed] 12420-208 AVE NE REDMOND WA. (Well Driller)

License No. 1195 Date 6-29-, 1984

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

27/5E/25/P

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 27/05-25P

Permit No.

(1) OWNER: Name David C. Falkenberg Address 9034-45th. N.E. Seattle, Wa. 98115

(2) LOCATION OF WELL: County Snohomish - the No. 165' of the SE ¼ SW ¼ Sec. 25 T. 27 N., R. 5E W.M.

Bearing and distance from section or subdivision corner So. 330', Lot 26, Maltby 5 A. Tracts, Vol. 7 of Plats, Pg. 40.

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" inches.
Drilled 110' ft. Depth of completed well 110 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 100'2" ft.
Threaded ☐ 5" Diam. from 100'2" ft. to 105 ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Cook
Type Stainless Steel Model No.
Diam. 5" Slot size 30 from 105 ft. to 110 ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite slurry
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name Sears
Type: H.P. 3/4

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 100 ft. below top of well Date 4/4/74
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom?
Yield: 17 gal./min. with 40 ft. drawdown after 2 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 4/3/74
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Top soil	0	2'
Clay	2	30'
Glacial till	30	100'
Pea gravel	100	106'
Silt	106	110'

Work started 3/19, 1974. Completed 4/4, 1974

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME J & S Drilling Co., Inc. (Person, firm, or corporation) (Type or print)

Address P.O. Bx. 1065 Everett Wa 98206

[Signed] A. H. Bakeng (Well Driller)

License No. 0024 Date 4/16, 1974

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy 27/5E/25/P

WATER WELL REPORT

STATE OF WASHINGTON

Application No. 27/05-25P

Permit No.

(1) OWNER: Name Willi E. Klos Address 17140-33rd Ave N.E., Seattle, Wa 98155

(2) LOCATION OF WELL: County Snohomish - SE ¼ SW ¼ Sec. 25 T 27 N., R 5E W.M.

Bearing and distance from section or subdivision corner Maltby 5 A Tracts; Blk 000-D-0-2; Lots-25-26, less S 330'.

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Deepened ☐ Reconditioned ☐

Method: Dug ☐ Bored ☐ Cable ☒ Driven ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.

Drilled 103 ft. Depth of completed well 103 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6" Diam. from 0 ft. to 95'6" ft.

Threaded ☐ 5" Diam. from 95'6" ft. to 98 ft.

Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

perforations from ft. to ft.

Screens: Yes ☒ No ☐

Manufacturer's Name Cook

Type Stainless steel Model No.

Diam. 5" Slot size 20 from 98 ft. to 103 ft.

Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☐ Size of gravel:

Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal Bentonite slurry

Did any strata contain unusable water? Yes ☐ No ☒

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name

Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.

Static level 89 ft. below top of well Date

Artesian pressure lbs. per square inch Date

Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

" " " "

" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test 15 gal./min. with 0 ft. drawdown after 2 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Clay	0	28'
Sand & gravel	28	59'
Sand	59	89'
Gravel	89	101'
Clay & gravel	101	103'

Work started 6-10, 1974 Completed 6-24, 1974

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME J & S Drilling Co., Inc. (Person, firm, or corporation) (Type or print)

Address P.O. Box 1065, Everett, Wa 98206

[Signed] A H Baking (Well Driller)

License No. 0024 Date 7-11, 1974

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

APPENDIX C

PRELIMINARY GEOTECHNICAL EVALUATION

TECHNICAL MEMORANDUM

TO:	Cindy Baker, City of Woodinville	**DATE:**	February 13, 2007
FR:	Bob Anderson, Dave Findley	**OUR REF:**	063-1230
RE:	Preliminary Assessment of Hillside Drainages Infiltration		

This memorandum summarizes the a preliminary assessment of the possible effects of stormwater infiltration on the Hillside Drainages sub-basin, located on the western margin of the R-1 zoning area. This memorandum is a preliminary assessment and examines idealized conditions in the area based on limited information. It is intended as a supplement to the Sustainable Development project and the hydrogeologic assessment conducted by Golder Associates Inc. as part of that project.

METHODOLOGY

The analysis of the relationship between stormwater infiltration and slope stability in the Hillside drainages sub-basin was conducted using a series of calculations based on an idealized geometry and input parameters for hydrogeologic and slope stability conditions. Slope stability was examined using a factor of safety approach, as calculated from the slope stability program Slide[1]. The Slide program includes water-level as an input to determine factor of safety of the assumed slope configurations. A second series of calculations was made to determine what water-level changes might occur as a result of stormwater infiltration volumes. These water-level changes were then used to relate stormwater infiltration volumes to slope stability in the Hillside drainages sub-basin.

RESULTS

Two idealized cross-sectional profiles were generated using slope stability software. The two cross-sections included a 30-degree and 40-degree slope, combined with a perching clay layer at elevation 320 and a water table of 340 feet 50-feet behind the crest of the slope. Using Slide, these two base case sections produced a factor of safety (FOS) of 1.66 and 1.18 respectively, where FOS is the ratio of forces resisting slope movement to forces driving slope movement. Slopes with FOS greater than 1.0 are mathematically stable. Due to variability in subsurface conditions and slope geometry, and FOS of 1.3 is a generally accepted target for design purposes. The schematic cross-sections and model output are provided in Attachment A. The water table behind the crest of the slope was then increased at 1–foot intervals and the factor of safety was recalculated for each cross-section. Table 1 shows the results of the factor of safety calculations. The change in the factor of safety associated with higher groundwater levels is related, in a relative sense, to the increase in risk of shallow landslides resulting from infiltration that increases seepage pressures at the crest of the slope. Without considering what volumes of stormwater infiltration might occur under R-4 zoning designation, the table shows that the FOS decreases as a result of increased groundwater-levels. Therefore, any infiltration of stormwater on the Hillside drainage basin increases the risk of slope failure to some degree.

[1] Slide – Version 5.025, Rocscience Inc.

TABLE 1

Slide Slope Stability Results

Groundwater Elevation	30 degree slope Factor of Safety	40 degree slope Factor of Safety
340	1.66	1.18
341	1.65	1.18
342	1.65	1.17
343	1.65	1.17
344	1.64	1.17
345	1.64	1.17
346	1.64	1.17
347	1.63	1.16
350	1.61	1.16
355	1.55	1.14
360	1.49	1.12
365	1.40	1.08
370	1.32	1.03
375	1.23	0.97
380	1.20	
385	1.11	
390	1.02	
395	0.97	

(See attachment for assumed cross-sectional geometry)

In order to determine how infiltration of stormwater might increase groundwater levels at the crest of the slope, a groundwater flow calculation was made using a method described in Finnemore[2]. An idealized infiltration pond geometry of 100' x 200' was assigned to calculate the mounding of groundwater beneath the pond from a design inflow rate based on the 24-hour storm event example presented in the Ecology Stormwater Manual[3]. The design flowrate for a 10-acre site, with 39% impervious area was used to determine representative total infiltration volumes over a 1-day, 3-day

[2] Finnemore, E.J., 1995. MOUNDHT Version 1.1. Groundwater Vol 33, No. 1, pp 139-143.
[3] Ecology, 2001. Stormwater Manual for Western Washington. Table 2.7, page 2-36.

and 7-day period. Inflow rates ranged between 400,000 and 600,000 gallons per day. The volumes were infiltrated into an aquifer with 20-feet of saturated thickness and hydraulic conductivities of 10 ft/day and 50 ft/day. These inflow and hydrogeologic parameters are considered representative of conditions in the Hillside Drainage and a typical stormwater infiltration facility. Actual conditions will vary. In general, the predicted rise of groundwater levels below the pond ranged from 10 to 15 feet at the higher hydraulic conductivity, and between 25 and 30 feet at the lower hydraulic conductivity. The idealized pond was placed a distances of 50, 100 and 500 feet from the crest of the slope and the head changes beneath the pond were then projected from the pond to the slope using an unconfined aquifer flow calculation using the Dupuit Forcheimer equation. The equation calculates the groundwater level along a profile that includes an unconfined seepage face on a slope based on the following equation:

- $H = \sqrt{(h_1^2 - h_2^2)} * x/L$ where

  L = Distance to pond
  x = 50 feet behind crest of slope)
  h_1 = Head change at pond
  h_2 = 0 (free surface seepage at confining layer)

The predicted change in groundwater level at the crest of the slope was translated into a change in the factor of safety (FOS), as predicted by Slide. The results are shown on Table 2. The table shows that for higher hydraulic conductivities, the change in FOS is as high as 6% at a distance of 50 feet from the crest of the slope. For lower hydraulic conductivities, FOS could increase by 10% or more at distances of less than 100 feet from the crest of the slope. At distances of 500 feet from the crest of the slope, FOS is less than 3% for both low and high hydraulic conductivity.

TABLE 2

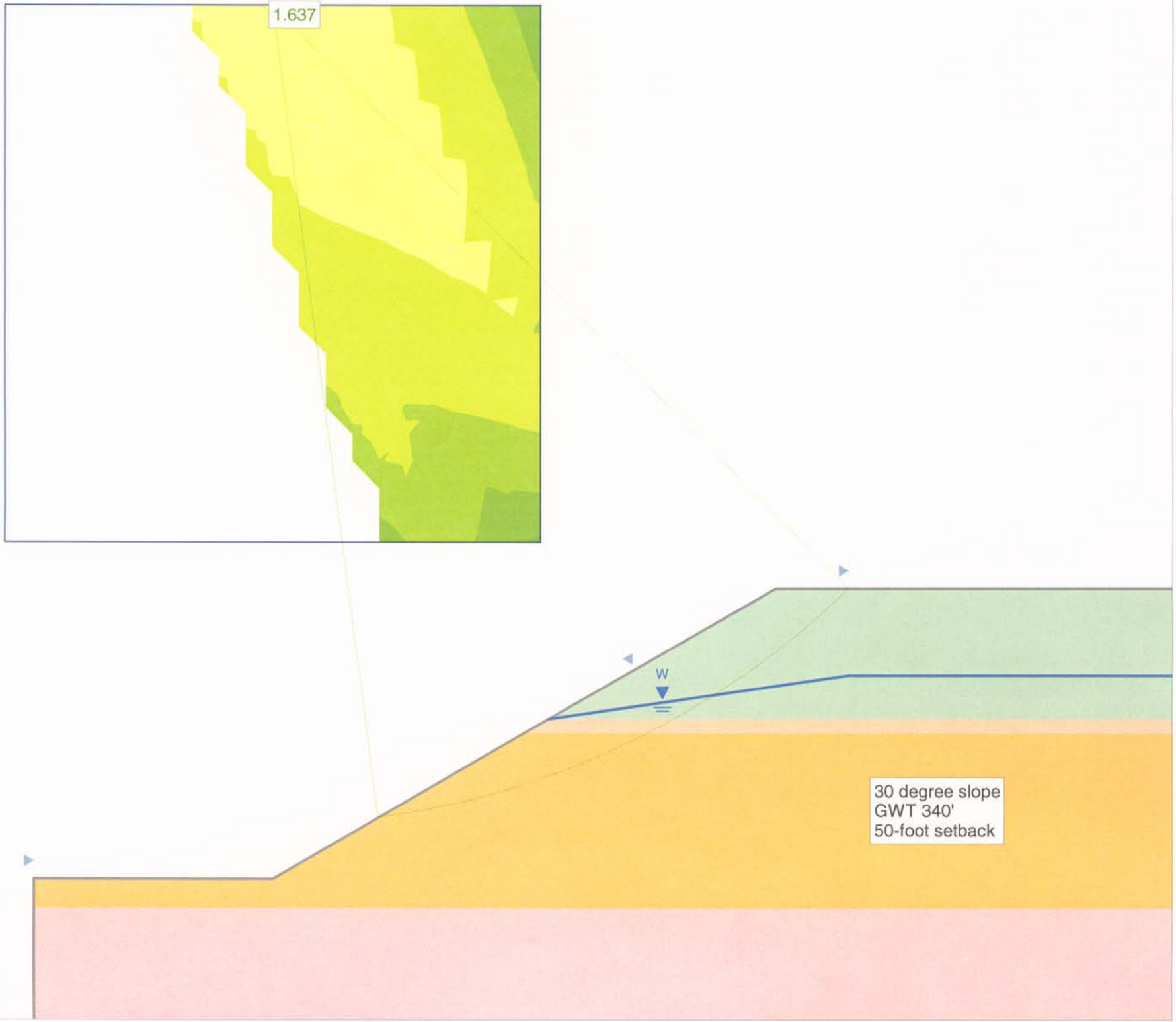
Estimated Seepage Pressure Changes

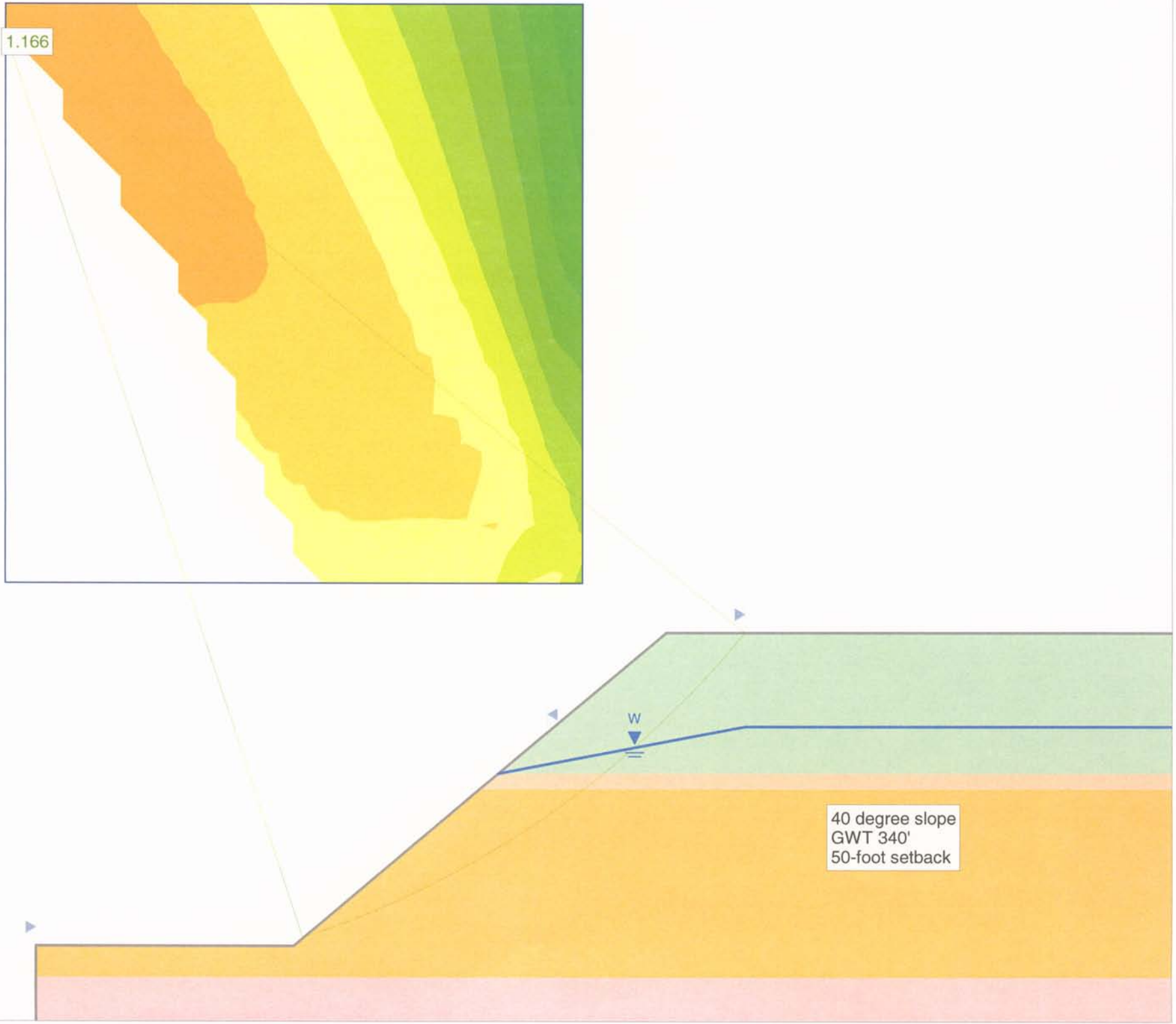
Pond Geometry[1]		Groundwater Level Change[2]		Stability Change[3]			
Aquifer Hydraulic Conductivity	Distance from Crest of Slope	at Pond	at slope crest	30-degree slope[4]	Percent change	40-degree slope[4]	Percent change
(ft/day)	(ft)	(ft)	(ft)	(FOS)	%	(FOS)	%
50	50	15	15	-0.10	-6%	-0.04	-3%
50	100	15	10	-0.05	-3%	-0.02	-2%
50	500	15	6	-0.02	-1%	-0.01	-1%
10	50	30	30	-0.33	-20%	-0.15	-13%
10	100	30	21	-0.17	-10%	-0.05	-5%
10	500	30	9	-0.05	-3%	-0.02	-2%

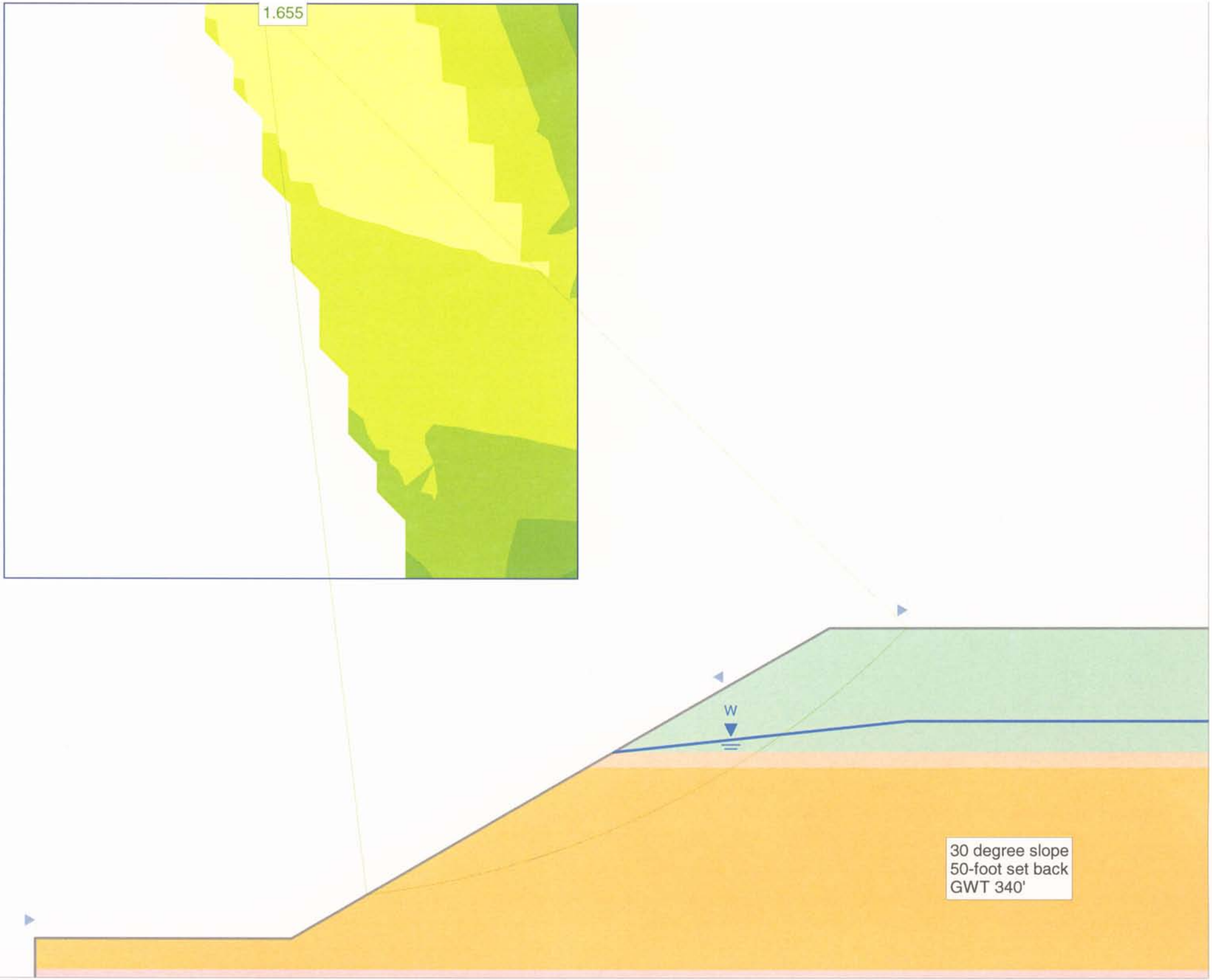
1 Assumes 100'x200' pond, with a 20-foot aquifer saturated thickness, and 0.1 storage coefficient
2 Calculated based on Finnemore (1995)
3 Calculated based on SLIDE calculations (see attachment)
4 Initial FOS = 1.66
5 Initial FOS = 1.18

CONCLUSION

Based on the results of the analysis, infiltration of stormwater at distances of 500 feet or more from the crest of the slope appear unlikely to cause a significant increase in the risk of slope failure in the Hillside drainages sub-basin. Infiltration at distances of 50 feet or less from the crest of the slope could increase the risk of slope failure, particularly for aquifer conditions with lower hydraulic conductivity, which causes higher mounding beneath an infiltration pond. The analysis described above contains a number of assumptions and an idealized geometry of stormwater infiltration, aquifer geometry, and geotechnical parameters related to slope stability. As such, a "setback distance" of 500 feet for infiltration should be considered a guide, and may not be technically defensible under site specific circumstances. Site specific information on shallow aquifer properties, stratigraphy, groundwater flow direction, and infiltration capacity is needed to determine infiltration feasibility at specific locations in the Hillside drainages.


1.637
W
30 degree slope
GWT 340'
50-foot setback


1.166
W
40 degree slope
GWT 340'
50-foot setback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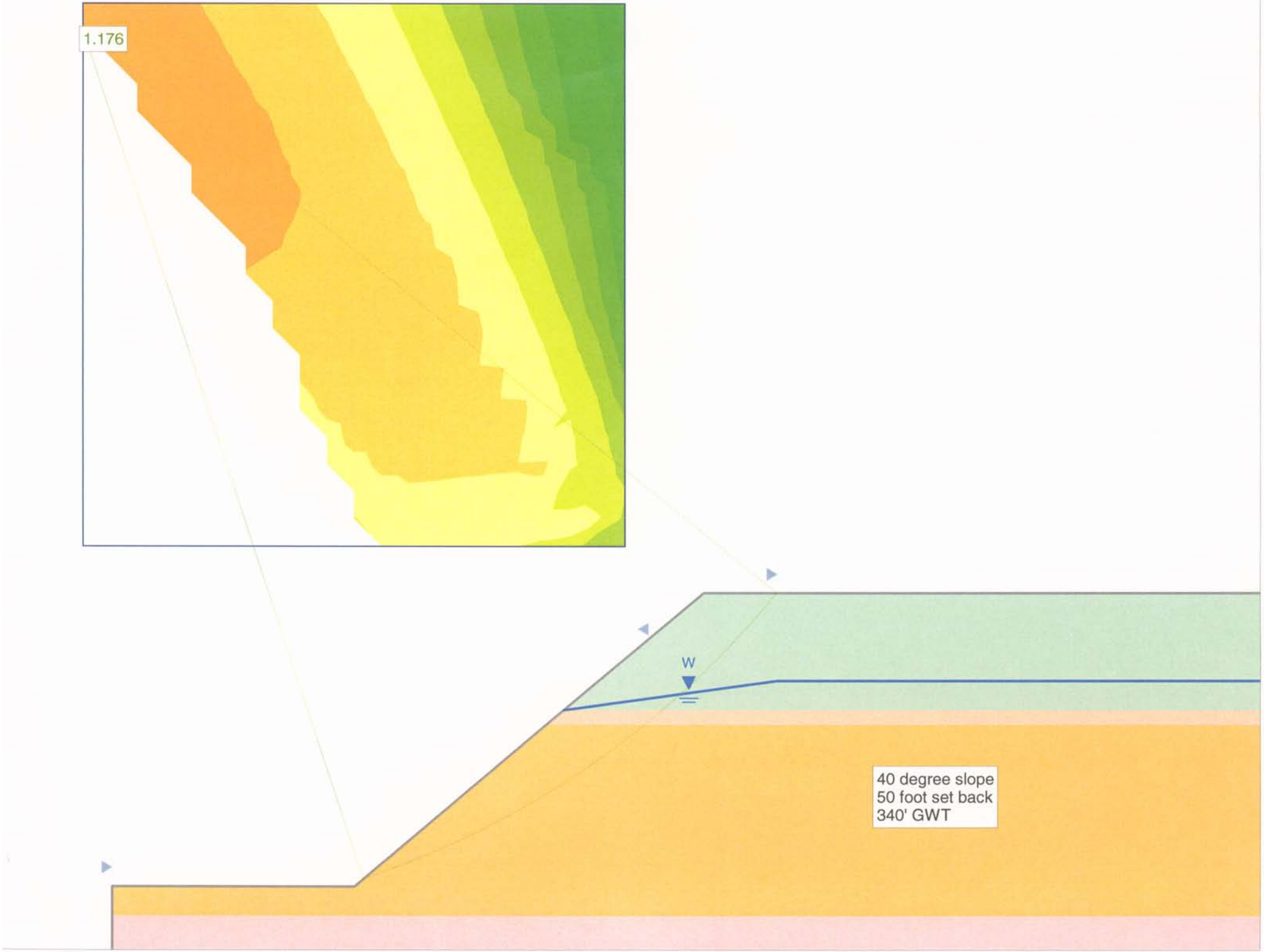
W
30 degree slope
50-foot set back
GWT 340'


1.176
W
40 degree slope
50 foot set back
340' GWT

Appendix B.

Lake Leota Analysis for City of Woodinville Sustainable Development Program, C. Michael Falter

LAKE LEOTA ANALYSIS

FOR

CITY OF WOODINVILLE

SUSTAINABLE DEVELOPMENT PROGRAM

Submitted to:

Steward and Associates
120 Avenue A, Suite D
Snohomish, WA 98290

Submitted by:

C. Michael Falter, Ph.D.
Limnology/Aquatic Ecology
736 Homestead Place
Moscow, ID 83843-3241
208-882-3676
cmfalter@moscow.com

February 2007

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1.0 INTRODUCTION

This sub-report reviews the limnology of Lake Leota, emphasizing its physical and chemical aspects, plant communities, and apparent environmental controlling factors in the watershed. The lake's trophic status is then discussed with respect to the above controlling factors. Future analysis would address changes in lake condition in response to possible management alternatives. An evaluation of Lake Leota with respect to the Litowitz criteria follows. This sub-report is a component of a larger technical study by Steward and Associates that examines controlling issues in the watershed relevant to present and future land management in the city of Woodinville. This larger study explores the role of development density in the R-1 zone on critical issues to determine relevance to the Litowitz criteria, namely whether they are large in scope, have complex structures and functions, and a high rank order (following). Lake Leota is the critical area that is the focus of this sub-report.

2.0 CRITICAL AREA REVIEW

2.1 Setting of Lake Leota

2.1.1 Geology and Soils

Lake Leota is located near the southeastern corner of Woodinville, Washington, in King County, approximately 1.3 mile south of the Snohomish/King County line. The lake basin, like neighboring lake basins and stream channels, was formed in the undulating terrain of irregularly deposited glacial outwash left by southward flowing glacial melt waters. Vashon advance glacial outwash gravels underlie soils in the immediate vicinity of the lake. These materials extend slightly more than a mile up gentle flowages to the northwest and north (App. A to the Environmental Report, Figure 4) of the lake basin. These slopes contain the northwest and northern tributary channels to the lake. From 60 – 100 ft. above the lake extending further upward in elevation, Vashon glacial till underlies soils. A pocket of alluvium underlies soils approximately 0.3 mile north-northwest of the lake.

The peaty soil on the very flat slopes of land immediately adjacent to the lake are most likely wetland meadows formed by the process of lake aging where productive littoral (nearshore) aquatic plant communities gradually replace shallow water with dense emergent vegetation -filled shallow contours around the lake. Wet, peat-filled meadows eventually resulted. The present ring of vegetation-rich littoral (shallow, where light penetrates to the bottom) waters around the lake is a continuation of this aging process (Photograph 1). In the early phases of its history after basin formation some 11,000 years ago, Lake Leota would have been 3 – 4 times its present area and much deeper. The basin shape is indicative of a kettle lake basin, one left behind after blocks of erratic ice buried in the glacial outwash melted and left behind a recession in the gravels that would become the lake basin.

Soils near the lake are basically a dark sandy loam with prominent distinct redoximorphic accumulations (App. C to the Environmental Report). Wetlands are common along the northwest tributary channel and predominant around the lake in a nearly continuous band. Although wetlands are common around the lakeshore, with a few extending up tributary channels and swales, present wetlands are but a small remnant of pre-settlement wetlands. Their earlier presence, however, is important for the soils left behind. These old wetland soils are wet with high organic content. This type of soil tends to be oxygen-deficient, the low redox potential facilitating de-nitrification (nitrogen loss) and soluble phosphorus release from chemically bound states in the soils. These soils, therefore, have low phosphorus binding capacity rendering them poor substrate for septic drain fields. Much of the discharged phosphorus in sanitary systems around Lake Leota will rapidly saturate subsoil groundwater and flow to the lake.

The 506-acre watershed is steepest away from the lake. As described above, lands close to the lake slope more gradually and flatten out close to the water. There were no eroding soils or cut banks at the shoreline seen on my two visits to the lake in June and July 2006.

2.1.2 Watershed Vegetation

Vegetation cover in the watershed and around the lake tends toward the coastal climax forest, which once dominated these near-ocean hills. Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) remain the dominant large trees with western yew (*Taxus brevifolia*) and Sitka spruce (*Picea sitchensis*) common co-dominants. In the old growth stands, larger trees exceeded 250 ft in height and 12 ft diameter. Although species composition is similar to climax stands, present second or third growth trees tend to be considerably smaller and sporadic in small clumps or individual trees. Cedar, Douglas fir, and hemlock dominate the remaining second growth timber around the lake. Native understory was bracken fern, sword fern, salal, elderberry, black alder, big-leaf maple, and devil's club. Present understory plant communities are similar but spotty and may be dominated by the exotic shrubs blackberry and Scotch broom in sunny areas.

Shoreline vegetation composition and pattern is described in Appendix C of the environmental report. In general, however, the lake shoreline is nearly100% vegetated, either with the wetland communities described by Cooke or by lawns on the nearly flat lower slopes near the lake. Much of these lower lawn areas are developed from or built over the original wetlands, which surrounded the lake (Lake Leota Community Club, 2006).

2.1.3 Lakeshore Development Around Lake Leota

The watershed of Lake Leota was first platted and settled by newcomers to the Pacific Northwest in 1891 with a deed of surrounding lands to a Clinton West from the federal government. In 1902, Edward Brady, a lawyer prominent in the rebuilding of Seattle after the 1889 fire, acquired the land around Summit Lake (as Lake Leota was named at the time) and developed a cedar shake mill on its northeastern shore. Several other sawmills soon developed in the lake's watershed as the extensive cedar stands were harvested. By the mid-1920s, the watershed had been clearcut with the result that some of the stump lands were sold for taxes. As surrounding brush fields developed, Summit Lake became a destination for recreation trips but it was considered "still a seep lake, bog, and brush [sic]"(Leota Community Club 2000). In the 1932 original plat of Lake Leota Farms, the lake was first recorded as Lake Leota, named after Brady's wife. Restrictive covenants were in the original deeds restricting uses to recreational and residential only with specific prohibition of "any sewer drainage into the lake or any pollution of the water". Any use for manufacturing or public amusement was also prohibited by those original documents.

Twenty-eight platted tracts within a rectangle formed by the outer boundaries now surround the lake. All but 4 of the tracts extend to the water's edge. The seasonal cabins of the 1940s and 1950s have since developed into year-round homes on most of the properties. Tract development preceded incorporation into the City of Woodinville so individual, active septic systems surround the lake. Land use throughout the watershed is suburban low density residential with one small urban shopping area located to the northwest.

2.2 Limnology of Lake Leota

2.2.1 Basin Shape and Volume

The morphometric map of Lake Leota (Figure 1 below) depicts bottom contours and scale. These data are necessary for water, sediment, and nutrient loading estimates as well as zonal water and sediment volumes for lake rehabilitation work.

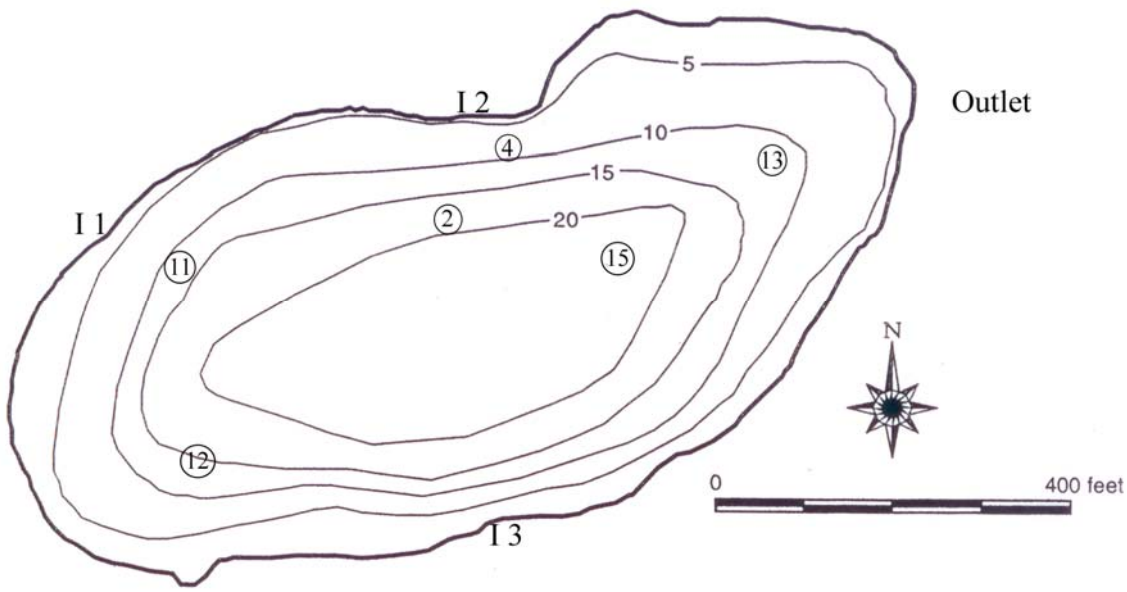


Figure 1. Morphometry of Lake Leota (Washington Dept. of Ecology, 1976). I1, I2, and I3 refer to lake inlet channels. Circled numbers refer to benthic sampling points, July 2006.

Table 1. Morphometric data calculated from the Lake Leota map (Falter 2006).

Measure	English	Metric
Maximum Length	1,100 ft	335 m
Maximum Width	520 ft	158 m
Watershed Area	506 Ac	202 ha
Lake Area at summer pool	10.44 Ac	4.2 ha
Maximum Depth	23.0 ft	7.0 m
Mean Depth	12.4 ft	3.8 m
Relative Depth (Mean Depth/Maximum Depth)	0.54	0.54
Mean Bottom Slope	6.0%	6.0%
Lake Volume	129.9 Ac ft 5,657,000 ft^3	 160,180 m^3
Area of lake when filled to the -2.5 ft contour*	12.34 Ac ft	4.9 ha
Area of lake when filled to the -5.0 ft contour	14.60 Ac ft	5.8 ha
Volume of 0 to -2.5 ft stratum	1,238,000 ft^3	35,083 m^3
Volume of 0 to –5.0 ft stratum	1,465,000 ft^3	41,515 m^3

* Using an estimated –2.5 ft contour line from the topographic map supplied by Appendix A to the environmental report.

The surface area of Lake Leota at summer water level is 10.4 acres (4.2 ha) or 2.1% of the watershed area. Since the lake has been observed to raise 2.5 ft following precipitation events, I calculated the lake area to be 12.34 acres if the lake rose 2.5 ft over typical mid-summer level. Maximum depth of that normal summer pool is 23.0 ft (7.0 m) while mean depth of the lake is 12.4 ft (3.8 m). Mean depth is 54% of the maximum depth. This moderately high relative depth suggests a greater tendency for water stratification in summer, freezing in winter, and relative isolation of deeper water and sediments from the unlimited light and oxygen available at the surface.

Mean slope of the lake bottom from shore to the deep point is 6.0%. Lake water volume is 129.9 AcFt; volume of the 0 to –2.5 ft stratum is 1,238,000 ft^3 or 22% of the lake at typical summer pool level. A 2.5 ft raise in lake surface elevation with a runoff event into the lake would then represent an approximate 22% increase in lake water volume. This large increase in lake volume with a small surface elevation occurs because of the very flat gradient of shoreline above the 0 depth contour.

2.2.2 Hydrology

Inflows to the Lake. Residents and King County Volunteer Lake Monitoring Program (KCVLMP) reports have long described Lake Leota as a seepage lake. It has three surface tributary channels, but is considered to receive most of its inflowing water *via* groundwater seepage (King County 1998-2005). These surface channels enter the lake from the northwest, north, and south slopes of the lake basin. The *northwest* channel,

although draining the largest land area (~291 acres), was the least scoured above the lake and had most heavily vegetated channel to its mouth at the lake. Its watershed has the gentlest slopes adjacent to the surface channel of Lake Leota's three sub-watersheds. Thus it is the most stable of the three tributary channels (Photograph 2). There is one stormwater retention facility about half way up that channel. On some maps, this northwest channel is designated as "Cold Creek" even though still upstream of the lake.

The *north* channel drains a higher density housing development on the north side of Woodinville-Duvall road as well as a length of that heavily trafficked road. Draining some 100 acres, this north channel shows some evidence of channel scouring. A lakeshore resident (J.D. White) who lives along lower reaches of the north channel reports past out-channel flooding of this channel as flows through a braided, but still heavily vegetated reach just above the lake.

The *south* channel drains approximately 115 acres. This channel shows recent severe scour and bank cutting in its lower reaches just above the lake (Photograph 5). This south sub-watershed is the steepest of the three Lake Leota sub-watersheds. Out-of-channel flows have resulted from culvert clogging at NE 180th St. just above the lake (Personal Communication, Rosie Paulgen). At the point of entry to the lake, all three tributary channels are very low gradient with thickly vegetated stream mouths (Photographs 2, 3, and 4).

Since the early 1990's, the KCVLMP has maintained at least weekly precipitation and lake level records on the lake. The lake surface elevation varies from annual lows in late summer/fall to highs late in winter and early spring (January to April). The annual range of fluctuation is commonly 2.5 ft (0.75 m) but has been up to 3.2 ft (~1.0 m). These records show a fairly rapid (within a week) response in lake level to precipitation events although the absence of tributary flow volumes and flow rates of groundwater seepage prohibits parsing the relative contributions of the varied water sources to the lake. The weekly resolution of precipitation and lake level data does not permit a fine analysis of lake response to precipitation but the data do commonly show a rise in lake level elevation of 10-15 cm in the week following a 4-6 cm precipitation event. In late December 1996 following a record very heavy snowfall (~2 wet feet) the lake rose 60 cm rise over the following week. We cannot tell how fast the lake rose within the week given the data resolution. Differences in lake response to comparable precipitation events over a year are most likely due to intensity of the precipitation and whether it occurred as rain or snow.

Outflows from the Lake. Lake Leota is "perched" above the Qva aquifer (Appendix A to the environmental report); perched lakes commonly lose most of their outflow as seepage, a common phenomenon in glaciated lands across the northern states. In lower valleys, the lake basins are on glacial alluvium and/or till with water retained in the lake by a relatively thin layer of muck. This "seal" may only be a few meters thick, permitting significant or all water loss from the lake as seepage to groundwater. The King County lake monitoring reports have stated that nearly all outflowing water leaves Lake Leota *via* groundwater flow. This is an important point and will be discussed later

in Section 2.3. Inspection of the lake outlet channel on July 19, 2006 showed the lake level was about 40 cm below the level necessary to deliver surface flow to the channel (Photograph 6). Vegetation development in the meandering outflow channel suggested that no surface outflow had occurred at least since the previous winter.

Surface outflows down the lake's single eastside surface outlet probably do occur most years in winter months but because of seepage outflows, not as often as inflow channels bring water into the lake. Seepage probably occurs mostly through the outflow sill. Surface outflows from the Lake Leota can be regulated by a drop board structure if flows are high enough. Lake Leota's surface outflow is commonly accepted as the beginning of Cold Creek even though still an intermittent stream at this point. These intermittent surface outflows are not gauged until the Cold Creek stream gage (02K) maintained by King County (App. A) about 1 mile below Lake Leota. Initial intermittent flows below Lake Leota gradually increase downstream from spring seepage until the stream has year-round flow by Gage 02K. Flows at the gage vary little around the year, averaging 3.5 – 4.0 cfs over all seasons (five-year record 2000-2005). Stream temperature at the gage also varied little with a 8 – 11 degree Celsius range (App. A) while Lake Leota surface temperatures showed a ~20 C temperature range over the year (King County Volunteer Lake Monitoring Reports 1998-2005).

It is clear that nearly all the water delivered downstream from Lake Leota to Cold Creek is as sub-surface seepage. Flow through the glacial gravels to surface springs in the downstream Cold Creek wetlands is sufficiently buffered by intra-gravel storage so that the seepage yield to Cold Creek is nearly constant in flow volume and temperature year-round. Anderson concluded that a 10-15% reduction in seepage to Cold Creek would result in a summer temperature increase of 0.5-1.0 C even in Cottage Lake Creek downstream of Cold Creek. Temperature impacts to Cold Creek *per se* have apparently not been estimated.

Lake hydraulic retention time (HRT) could be estimated if inflow rates were available. There is, however, no estimate of either surface or seepage inflow volumes per unit time. The implications of variable HRT, therefore, especially in relation to USRO (urban storm runoff) can only be estimated. Lake volume, necessary for evaluating sensitivity to nutrient loading, can be calculated, however. Given the weekly lake level change measurements published, we can roughly estimate lake volume change to some storm events. At this point, we can say that a 60 cm rise in lake level from a moderate 5-7 cm precipitation event can cause a ~20% increase in lake water volume. This increase is undoubtedly from a combination of surface and groundwater (seepage) flow but mostly surface flow since median hydraulic conductivity of the underlying Qvt and Qva materials is estimated at 53-86 ft/day. If watershed areas had hydraulic conductivities near the maximum range of those materials (1,000-3,056 ft/day), a significant proportion of flows to the lake as seepage within a week is possible after a precipitation event. This, however, is unlikely. At this point, we conclude that lake level rises following precipitation often occur within a week, are mostly due to surface inputs, and over a year's time can contribute a significant proportion of the lake's volume. Lake Leota HRT is probably less than 2 years. More important than the proportion of water

delivered to the lake, however, is the loading of sediments, nutrients, and heavy metals delivered to the lake (Section 2.4.2).

2.2.3 Physical-Chemical Aspects and Trophic Status of Lake Leota

Lake Leota is a shallow, mesotrophic, slightly colored (yellow in mid-summer; brown in late fall, winter, and early spring) lake with both its sediments and water dominated by watershed runoff (a combination of surface and seepage inflows).

Temperature and Thermal Stratification. The lake thermally stratifies in summer with surface temperatures ~23-25 C; 4-5 m water temperatures ~13-16 C; and 6-7 m temperatures ~8 C. Winter low temperatures in the water column are ~2-5 C cooling slightly near the surface towards ~ 0 C in an inverse stratification. Ice formation may occur along shorelines in some years; total ice cover occasionally occurs for a few weeks but is rare. Summer stratification is probably stable most years through summer into fall because of the basin's protection from wind-driven summer overturn of the water column. The resulting isolation of deep waters and sediments from surface water through the summer limits the strength and duration of warm season algae blooms as phytoplankton uptake depletes nutrients from surface layers. Phytoplankton in late summer-early fall should be very responsive to occasional runoff events resupplying needed nutrients during the long stratification period.

If surface outflow were to occur during stratification, it would be warm, certainly above 20 C. But since lake outflow at that time is as seepage, the temperature of summer water delivered to Cold Creek is closer to 10 C. Such seepage through the summer dry spells is further indicated by the steady decline in lake surface elevation.

Dissolved Oxygen. Levels of dissolved oxygen have not been included in the KCVLMP so we cannot calculate summer oxygen deficits of the deep-water layer over recent decades. Some surface oxygen data are available from the early '70s (Lake Leota Community Club files) but the inherent variability of surface oxygen data according to time of day, weather patterns, and water depth of samples sheds little light on lake dynamics. With thermal stratification through the summer-fall, we expect gradual oxygen depletion in deeper waters under the thermocline (zone of rapid temperature decline with depth creating a density gradient). With elevated phytoplankton growth in surface waters during algae blooms late in summer and fall, large amounts of organic matter settle into deep waters following senescence and death of the algae thereby depleting deep water oxygen, even to zero. The oxygen deficit may extend down into the sediments reducing oxygen levels there to zero also. This phenomenon becomes more intense and lasts for longer time periods as the lake progresses into eutrophy (sustained high levels of phytoplankton production). A self-sustaining cycle will develop as oxygen-depleted sediments release soluble phosphorus to the water column, sustaining continuance of phytoplankton blooms in warm, well-lit surface waters through fall overturn.

When zero oxygen levels in sediments cause reducing conditions, black deposits of heavy

metal sulfides (mostly FeS, MnS, PbS, CuS, and ZnS) may form in the sediments. These black layers (varves) will persist in the sediments as a permanent record of past periods of deoxygenation. In most lakes, these periods will be restricted to summer and winter stratification. Deepwater Lake Leota sediments we sampled on July 19, 2006 showed some black lenses of past metallic sulfide deposition (Photograph 8). Sediment odor and predominant brown color indicated oxygen-depleted, but likely not zero oxygen sediments at that time. It's likely that dissolved oxygen in the overlying water column on that day was present down through the entire water column to the lake bottom, *albeit* in very low concentrations towards the bottom.

Lake Monitoring and Lake Trophic Status. A very limited amount of Level I data (temperature, and water transparency) with occasional water chemistry and chlorophyll *a* data points are available in Lake Leota Community Club files. The absence of sampling and laboratory protocols for much of those data, however, prevents their inclusion in the long-term water quality trend comparison.

The KCVLMP managed a Level I sampling effort over the WY 95 to present period. The Level II data gathering level of effort managed by the KCVLMP from WY 98 to present adds water Secchi depth transparency, total nitrogen, total phosphorus, and chlorophyll *a* (a measure of phytoplankton production) in the water column over the lake's deep point. This level of sampling has produced a data record from WY 1994 (WY 94 = Oct. 1, 1993 - Sept. 30, 1994; WY 95 = Oct. 1, 1994 – Sept. 30, 1995; etc.) to the most recent published report for WY 2004. Resident volunteers carry out both Level I and II sampling efforts with samples sent to King County Water and Land Resources laboratories for analysis. KCVLMP believes the resulting data is reliable because they train the volunteers in water sampling and sample handling, analyze the data, and prepare data summaries. Annual mean values for these Level II parameters are presented in Table 2.

Table 2. Mean summer level II monitoring values for Secchi transparency, total nitrogen, total phosphorus, N:P ratios, and chlorophyll *a* from Lake Leota (KCVLMP data and selected files of the Lake Leota Community Club).

Water Year WY	**Secchi Transparency m**	**Total Phosphorus µg/l**	**Total Nitrogen µg/l**	**TN:TP Ratio**	**Chloro-phyll *a* µg/l**	**Precipi-tation at Everett Inches**
95-97 Mean	2.4					
1998	2.4	15.6	418	27	4.6	35.2
1999	2.8	21.3	669	31	18.6	47.9
2000	2.6	20.0	540	27	12.3	39.3
2001	2.0	22.0	540	23	15.7	29.9
2002	4.0	17.0	610	36	5.0	36.9
2003	3.7	18.1	463	27	4.9	25.2
2004	3.7	19.1	544	31	8.2	40.4

Water Year WY	Secchi Transparency m	Total Phosphorus µg/l	Total Nitrogen µg/l	TN:TP Ratio	Chlorophyll *a* µg/l	Precipitation at Everett Inches
98-04 Mean	**3.0 m**	**19.0 µg/l**	**540.6 µg/l**	**28.9**	**9.9 µg/l**	**36.4**

Secchi transparency is a measure of water transparency, the maximum depth that a standardized disk can be seen when lowered in the water column. Average summer water transparency in Lake Leota over the seven recent summer periods was 3.0 m, a value in the middle of the mesotrophic range of productivity. Transparency on individual days has ranged from observed highs of 4.5 m down to 1.25 m. Residents report that the lake may turn brown and very turbid with low transparency after precipitation events. The data in Table 2 show a marked increase in water transparency in 2002-2004 compared to 1999-2001 (3.8 m compared to 2.5 m), concurrent with a pronounced lower 3-year trend in plankton chlorophyll (6.0 µg/l in 2002-2004 compared to 15.5 µg/l in 1999-2001). Rainfall was lower in the 3-year high transparency/low chlorophyll period, averaging 34.2 inches in those water years *vs.* 39.0 inches in the 3 low transparency/high chlorophyll water years (Western Regional Climate Center 2006).

Figure 2. TP vs. Precipitation, WY 1998-2004.

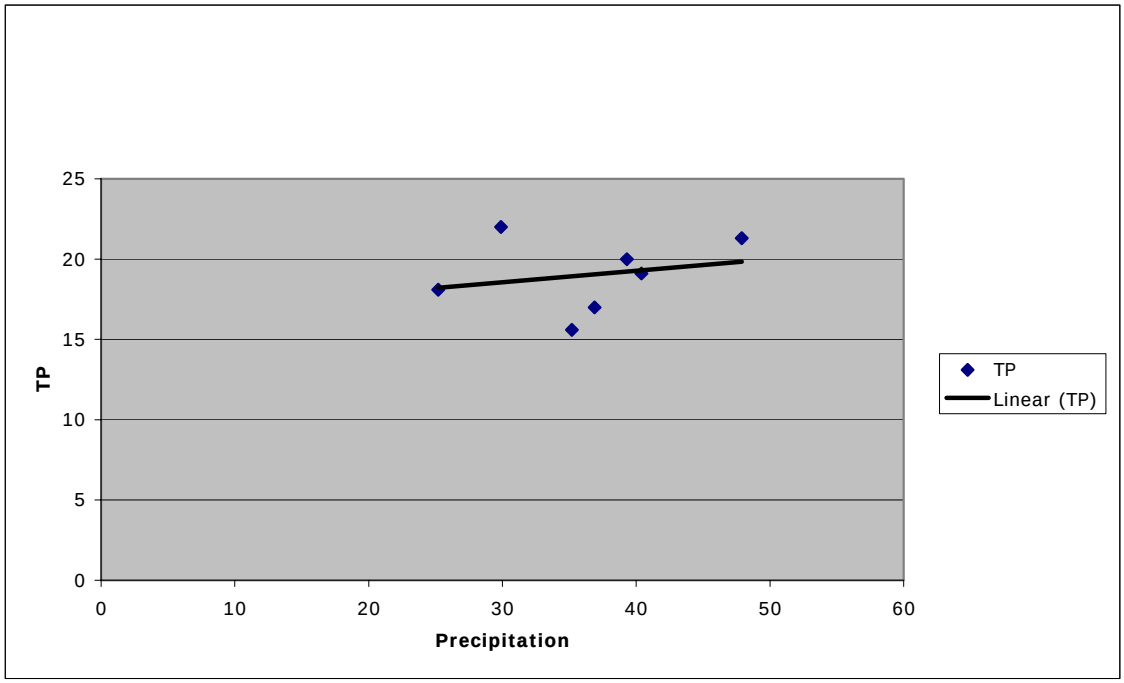
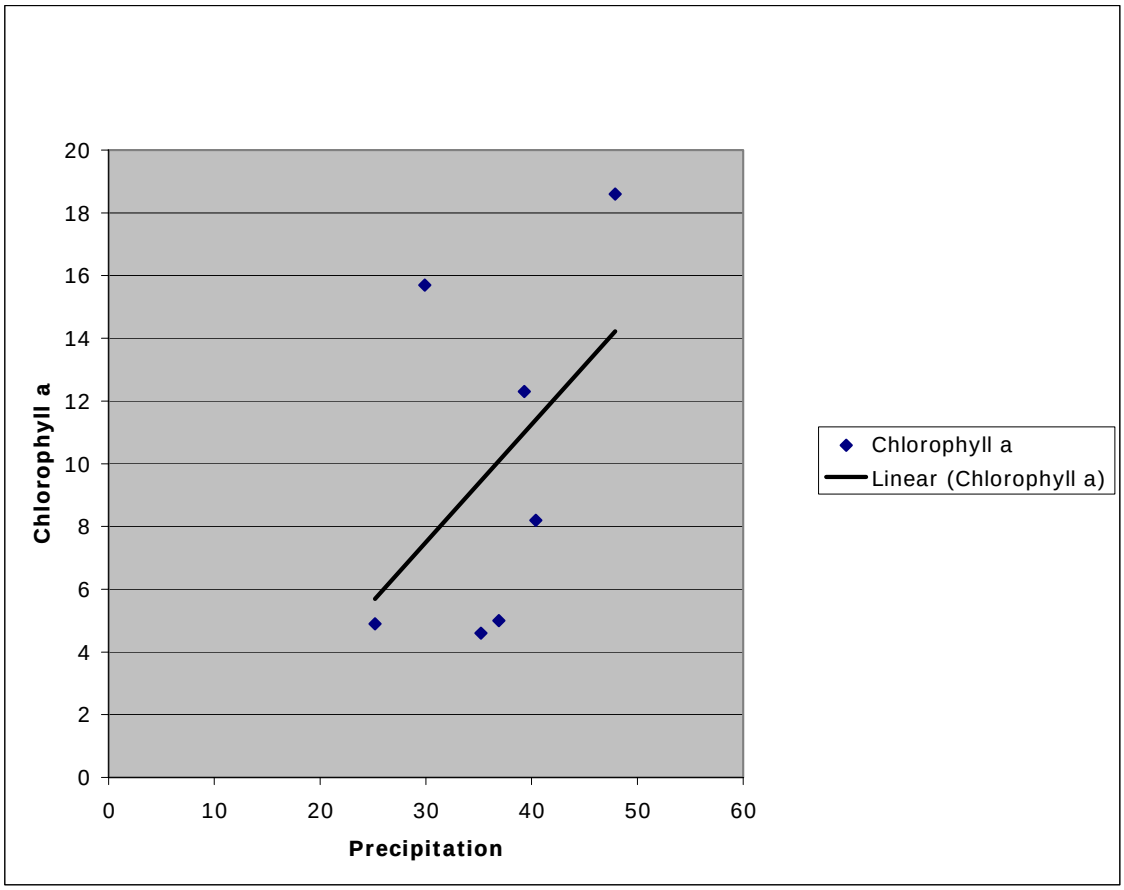


Figure 3. Chlorophyll a vs. Precipitation, WY 1998-2004.



Precipitation will increase phosphorus loading to the lake by increasing shallow groundwater flow to the lake as well as the occasional surface flush of the ground surface. This would explain the higher chlorophyll levels during higher precipitation years. There was no apparent relationship in those water years between annual precipitation and water transparency.

Phosphorus and nitrogen are the two plant nutrients that are most often limiting plant growth in fresh water in the northwestern U.S. The summer Total Nitrogen to Total Phosphorus ratio (TN:TP ratio) over the monitored time period averaged 28.9 (Table 2). Values over 16 indicate a phosphorus-limited lake (Cooke et al 2005). In Leota, mean TN:TP ratios were well above that threshold of 16 showing that the lake is clearly phosphorus-limited, thus responsive to either enhanced phosphorus loading (moving into eutrophy) or reduced phosphorus loading (moving below mesotrophy towards oligotrophy).

Average TP in that time period was 19.0 µg/l, TN was 541 µg/l, and chlorophyll *a* was 9.9 µg/l. The nutrients placed the lake in the middle of mesotrophy whereas resulting (chlorophyll *a* (phytoplankton production) gave a higher productivity, in the meso-eutrophic range. The anoxic days boundary values are included to show how many deep-water anoxic days might be expected in a mesotrophic to meso-eutrophic lake (20 to 40

days) even though anoxic days of deep waters were not quantified in Lake Leota. Its measured chlorophyll *a* suggests that Lake Leota averages 20-40 days of anoxic bottom waters in the summer-fall.

These data are an excellent long-term record of water column measures relevant to the lake's productivity potential. The above metrics, along with the Trophic Status indices presented in Table 4, efficiently track phytoplankton potential and actual growth over the summer period. These values can be compared with "standard" values prepared from a large number of lakes with varying trophic status (Table 3 below).

Table 3. Trophic state boundary values (Cooke et al. 2005).
CMF note: "Boundary" values are the break points between the trophic categories of oligotrophy, mesotrophy, and eutrophy.

Metric	Unit	Oligo-Mesotrophic	Meso-Eutrophic	Eutrophic-Hypereutrophic
Secchi Transparency	m	4	2	1
TP	µg/l	10	25	100
TN	µg/l	350	650	1,200
Chlorophyll *a*	µg/l	3.5	9	25
Anoxic Days	#	20	40	60

Trophic state is further defined by the Trophic Status Index (TSI), an integrative measure of lake potential and actual productivity (North American Lake Management Society et al. 2001; Cooke et al. 2005). TSI values from the KCVLMP are presented in Table 4.

Table 4. Trophic Status Index (TSI) values calculated from the KCVLMP water column-monitoring program for Lake Leota, Water Years 1998-2004.

Water Year	Trophic Status Index Secchi	Trophic Status Index TP	Trophic Status Index Chlorophyll *a*	Trophic Status Index Overall	Apparent Trophic State
1998	48	44	46	46	Mesotrophic
1999	44	48	53	49	Mesotrophic
2000	46	48	55	50	Mesotrophic
2001	49	49	54	51	Mesotrophic
2002	46	46	48	47	Mesotrophic
2003	41.4	44.8	44.9	43.7	Mesotrophic
2004	41.5	46.4	45.7	44.5	Mesotrophic
Mean	**45.1**	**46.6**	**49.5**	**47.3**	**Mesotrophic**

Since TSI values of 40 to 50 are considered mesotrophic, these calculated TSI values for water transparency and TP place Leota in the upper mesotrophic range (Cooke et al 2005, KCVLMP 1997-2005). TSI values for chlorophyll *a* place the lake right at and sometimes into the lower range of eutrophy (TSI > 50). Actual realized chlorophyll development is then slightly greater than water transparency and nutrient concentrations would predict. This is not uncommon in a shallow lake where nutrients are more efficiently utilized than in a deeper lake. The shallow water column permits phytoplankton to spend more time in warmer, better-lit surface waters thereby using available nutrients more efficiently.

2.2.4 Lake Leota Plant and Animal Communities

Phytoplankton. The phytoplankton community of Lake Leota is dominated by Chrysophytes, the flagellated golden brown algae. The Chrysophytes *Dinobryon*, *Synura*, *Ceratium*, and *Gloeobotrys* consistently dominate the plankton through much of the low flow seasons, accounting for the lake's brown water during times of little of no surface inflows. Minor, but common, members of the plankton community are the diatoms *Fragilaria*, *Asterionella*, and *Cyclotella*. Bluegreen algae numbers are low and seldom mentioned in the KCVLMP reports. Although blue-green blooms have not been a concern to date in Lake Leota Chrysophyte blooms are not rare. In September-October, 1999, a fall bloom persisted into mid-October with up to 35 µg/l chlorophyll *a* and water transparency of 2.0 m. Late summer blooms of Chrysophytes in 2001 produced chlorophyll *a* levels of 45 µg/l, exceeding 20 µg/l for 7 weeks. Secchi transparency dropped to 0.8 m at the bloom peak. A 7-week algae bloom is a very long bloom, again indicating the lake is moving into eutrophy. In 2002 there was a spring bloom of 17 µg/l chlorophyll *a* and 2004 had a fall bloom with 40 µg/l chlorophyll *a* and 2.2 m transparency. In recent years, Lake Leota has been clearly experiencing eutrophic algae levels of Chrysophyta blooms in recent late summer-fall periods even with mesotrophic nutrient concentrations.

The absence of blue-green algae blooms is notable as most north temperate zone lakes that are phosphorus-limited show increasing incidence of blue-green blooms in mesotrophic lakes. Seepage lakes with more highly colored water from a peat-rich, conifer-dominated watershed, however, commonly have an algae community dominated by diatoms and chrysophytes, the golden brown, flagellated algae.

Wetlands and the Shoreline Littoral Community. (The following is based on observations of Mike Falter, as well as Sarah Cooke in Appendix C.) Lake Leota has been identified on the King County Wetland Inventory as Big Bear Creek 9, a Class 2 wetland. The wetland described by the County encompasses the shoreline area with a few larger non-wetland areas (identified below and on App. C. All waterfront lots appear to have a narrow band of wetland vegetation at the interface of the lawn and water's edge. The City has documented a series of discrete wetlands along the lakeshore on various maps

that show critical areas. Appendix C shows the approximate extent of wetlands along the edge of the lake.

The dominant emergent plants observed in this littoral band around the lake are: Douglas spirea (*Spirea douglasii*), willows (*Salix sitchensis, Salix lucida, and Salix scouleriana),* Nootka rose (*Rosa nutkana*), Soft rush (*Juncus effusus*), Yellow flag iris (*Iris pseudacorus*), reed canarygrass (*Phalaris arundinaceae*), marsh cinquefoil (*Potentilla palustris*) Slough sedge (*Carex obnupta*), sawbeak sedge (*Carex stipata*), common cattail (*Typha latifolia*), creeping buttercup (*Ranunculus repens),* common horsetail (*Equisetum arvense),* giant horsetail *(Equisetum telmateia),* redtop *(Agrostis gigantea*), and Japanese knotweed (*Polygonum cuspidatum*). Further out in deeper water (0.5-2.5 m) the aquatic plant community shifts to one dominated by the long-stemmed emergents the yellow water lily (*Nuphar polysepala*) and exotic white water lily (*Nymphaea odorata*) as well as submergent plants dominated by coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*), common bladderwort (*Utricularia vulgaris*), whorled watermilfoil (*Myriophyllum verticulattum*), and common naid (*Najas flexilis*). We collected low-growing muskwort (*Chara* sp.), stonewort (*Nitella* sp.), and moss (*Fontinalis* sp.) on the lake bottom beneath these afore-mentioned emergents and submergents out to 2.5 m depth, at the deepest observed limit of rooted aquatic plants in the lake.

Reed canarygrass, Japanese knotweed, and the white water lily are three of the more aggressive exotic emergent plants in Lake Leota. Apart from the adverse effects of these aggressive exotics on native plant diversity, they do have a positive role in nutrient absorption in the littoral zone. This band of emergent plants very effectively protects the shoreline from wave erosion and further buffers open lake waters from overland and shallow seepage flow of nutrients through nutrient uptake. The exotic submergent, Eurasian watermilfoil (*Myriophyllum spicatum*) or a possible hybrid with the whorled watermilfoil had been suspected with increased plant growth in the lake in 2004 (Patti An, personal communication with John Lombard 2/3/07). The King County Lake Monitoring Program (Drew Kerr working with Sally Abella) did genetic testing on the plants and concluded that it is not Eurasian Milfoil, but a native *Myriophyllum* species behaving aggressively. Plant morphology and filament counts by the author suggested that the milfoil common in Lake Leota around its margin is a hybrid of *M. spicatum* and *M. verticullatum* but since the Eurasian, whorled, and hybrid variants all have similar morphology, genetic testing is the definitive assessment.

Milfoil populations continue well into the early winter as indicated by a recent plant survey around the lake on November 8, 2004. At that time, the plant dominated the lakeshore emergent community. In July 2006, we noted no rooted aquatic plants beyond 2.5 m depth, thereby defining the littoral zone as the bottom sediments in the 0-2.5 m contour (0-8.2 ft). Since depth is a principal determinant of rooted aquatic plant occurrence, approximately 34% of the lake is potential rooted aquatic plant habitat. On our site visit, we did notice, however, that much of south shore sediments shallower than 8 ft had no obvious submergent rooted plants.

Wetland areas are identified by the city as being present around the lake's edge have been mapped on various maps (App. C). These have been compiled onto acetate overlaid on the aerial photographs (App. C). We visited the two largest wetland systems. The third large wetland system was on property to which we had no access (at the outlet of the lake in the northeast corner of the lake).

Zooplankton and Benthic Macroinvertebrates. Daphnia (water fleas) are a commonly mentioned zooplankton (very small, weakly swimming, open water crustaceans) in the lake by lake monitors. They have not been quantified over the monitoring program years. Routine monitoring reports, however, do indicate that Leota zooplankton may be very abundant at times.

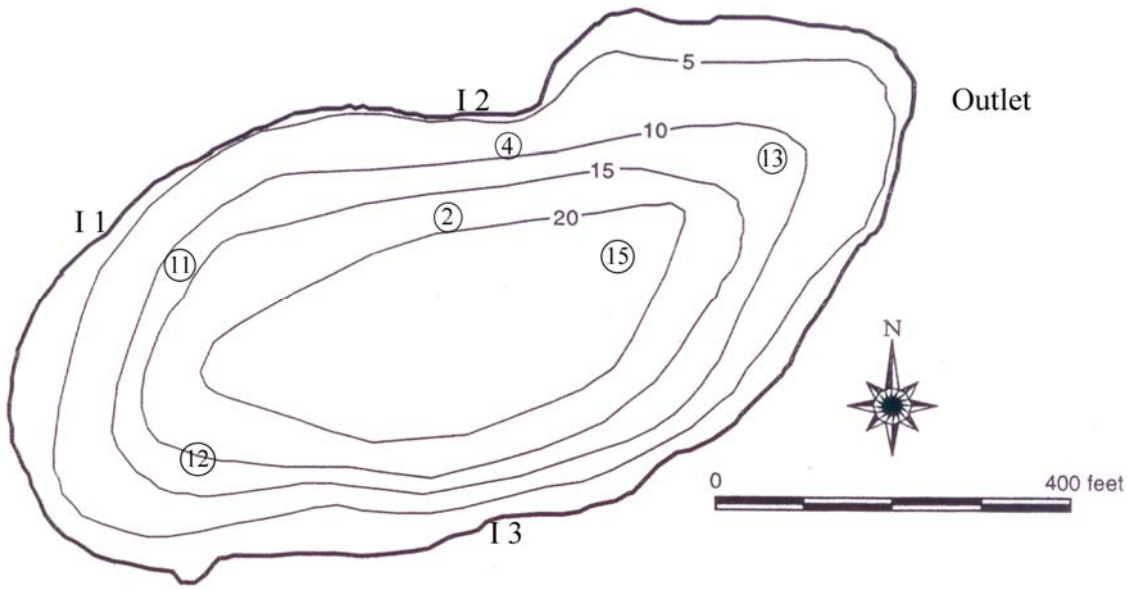
Sediment bottom invertebrate communities are a sparse assortment of midge larvae, mayflies, and caddisflies in littoral sediments where organic content is high beneath rooted vegetation beds. Benthic invertebrates are even more sparse in deeper sediments beyond rooted plants (>2.5 m depth). The sporadic periods of apparent deoxygenation in the deeper sediments would tend to suppress both numbers and diversity of benthic fauna.

2.2.5 Lake Leota Sediments

Sediment Carbon, Nitrogen, Phosphorus, and Sulfur: Sediments in Lake Leota appear to have a surprisingly high (considering it's such a small lake) clay content and very little vegetation and litter from terrestrial sources. That degree of sediment fineness in natural lakes is usually typical of exceptionally deep pelagic (open water) sediments or where sediments have formed very slowly in deep, very large central lake basins far removed from terrestrial influences. Neither is the case with Lake Leota, leaving stormwater inputs as the obvious source of the very fine sediments found there.

Metals in storm runoff to the lake were voiced as a concern at the July 2006 CAP meeting. Because Leota is a seepage lake with no significant loss of inflowing sediments downstream thus retaining its sediments, these sediments are a valid record of past loading of silts, clays, nutrients, and metals. Six sediment Ponar dredge samples collected by Hinson and Falter were therefore sent to the University of Idaho College of Agricultural and Life Sciences Analytical Sciences Laboratory, a lab certified by USEPA and the Idaho Division of Environment. Three samples were from comparatively shallow sediments (2.5-3.7 m) and three were from deeper sediments (4.5-7.0 m)(Figure 4).

Figure 4. Lake Leota with sediment sample sites indicated. Circled numbers refer to sediment samples described in Table 5. The 3 inlets are designated by I1, I2, or I3.



The Ponar dredge samples the top 5 inches of sediments. All samples were very fine-grained with little vegetative litter. Most of the samples had layers (varves) of beige-gray colored clay throughout the darker brown sediments. Dark brown was the predominant color with occasional black patches of reducing sediments left over from past brief anoxic intervals. Sediment descriptions and analytical results follow in Table 5.

Sediment carbon and nitrogen were higher in shallow samples than in deep samples, most likely because of high littoral (shallow water) photosynthesis and production of organic matter and also because of organic matter loss from deeper sediments by decomposition. Carbon content of shallow sediments averaged 19.3% compared to 13.6% in deeper sediments. For similar reasons, total nitrogen was higher in shallow sediments compared to deep sediments (1.40% compared to 0.96%). Loss of organic nitrogen from deeper, more oxygen-starved sediments is common because of denitrification loss to nitrogen gas in addition to high decomposition rates in those environments removed from light and reaeration from surface waters. Both carbon and nitrogen were high, in the eutrophic range, compared to sediments in a very eutrophic reach of the Snake River in southern Idaho where sediment carbon and nitrogen averaged 2.5% and 0.23%, respectively.

Sediment total phosphorus, however, was lower in shallow samples than in deep samples (1,077 µg/g compared to 1,867 µg/g). The heavy emergent and submergent aquatic plant communities at shallow sites will strip much of the available phosphorus from shallow sediments through the growing season, concentrating the phosphorus in above-sediment plant biomass. Deeper sediments, however, actively bind phosphorus with iron oxides during the majority of the months when surface sediments are aerobic. The lakewide mean sediment phosphorus of 1,472 µg/g compares to literature values of ~1,000 for oligotrophic lakes and ~ 2,500 and higher for eutrophic lakes (Cooke et al 2005). In a

eutrophic reach of the sediment-laden Snake River in southern Idaho, Falter et al. (1995) found sediment total phosphorus to average 1,031 µg/l over the summer.

Note: The probable aerobic nature of the lake's sediments for at least most of the year is further supported by the even distribution of sulfur in the sediments…. *if* deep sediments were anaerobic they would be concentrating disproportionately large amounts of sulfur as heavy metal sulfides, especially considering the moderately high availability of heavy metals in Lake Leota. Instead, mean sulfur concentrations were equal between shallow and deep sediments.

Sediment Metals: Metals concentrations from the 2006 sediment sampling are detailed in Table 5. The following observations may be made on the metals data from Lake Leota sediments:

- Shallow sediments were lower in total arsenic than deep sediments (<38 µg/g compared to 49 µg/g).
- Shallow sediments were lower in total chromium than deep sediments (35.3 µg/g compared to 75.6 µg/g).
- Shallow sediments were lower in total cobalt than deep sediments (11.1 µg/g compared to 20.3 µg/g).
- Shallow sediments were lower in total copper than deep sediments (45.3 µg/g compared to 65.6 µg/g).
- Shallow sediments were lower in total lead than deep sediments (111.3 µg/g compared to 173.3 µg/g).
- Shallow sediments were lower in total iron than deep sediments (~14,200 µg/g compared to ~33,000 µg/g).

Sample 4, taken just off the north inlet (I2), was an outlier in metals content, with concentrations of all metals (except those lower than MDL) far less than all other sites (Table 5). That channel drains a small drainage with some storm water retention capability. Even if we discount the one shallow station with very low concentrations of phosphorus and metals we can conclude that deeper sediments seem to collecting phosphorus and most heavy metals.

Table 5. Total carbon, nitrogen, phosphorus, sulfur, and metals concentrations in Lake Leota surface sediments. July 19, 2006. Dry weight concentrations. Phosphorus, sulfur,

			Sample 4	Sample 11	Sample 13	Sample 12	Sample 7	Sample 15	Lake Minimum Value	Lake Maximum Value	Lake Mean Value
		Depth >>	2.5 m	2.75 m	3.7 m	4.5 m	6.0 m	7.0 m			
Sediment Description			Fine brown organic over gray clay lenses, aerobic but few reducing chunks	Very fine brown organic, aerobic	Fine dark brown, highly organic, aerobic	Fine dark brown, scattered clay lenses, aerobic, very fresh	Fine dark brown, gelatinous, gray clay lenses, anaerobic	Fine dark brown, over thick gray clay layer	-	-	-
Element	Unit	MDL									
Carbon	%	0.02	20.0	19.0	19.0	18.0	14.0	8.8	8.8	20.2	**16.5**
Nitrogen	%	0.01	1.5	1.3	1.4	1.2	1.0	0.7	0.7	1.5	**1.2**
Phosphorus	µg/g	38	630	1,200	1,400	1,700	1,900	2,000	630	2,000	**1,472**
Sulfur	µg/g	75	3,500	7,200	6,200	6,600	6,100	4,200	3,500	7,200	**5,633**
Arsenic	µg/g	< 38	<38	<38	<38	43	48	38	<38	48	**<38**
Barium	µg/g	0.75	70	260	210	260	320	370	70	370	**248**
Beryllium	µg/g	0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	**<0.38**
Cadmium	µg/g	1.5	<1.5	3.4	2.9	3.5	3.0	1.7	<1.5	3.5	**2.9**
Calcium	µg/g	7.5	3,300	9,200	8,600	9,300	8,700	7,900	3,300	9,300	**7,833**
Chromium	µg/g	1.5	9.9	54	42	56	75	96	9.9	96	**55**
Cobalt	µg/g	1.5	3.3	18	12	16	19	26	3.3	26	**16**
Copper	µg/g	7.5	17	59	60	61	69	67	17	69	**56**
Iron	µg/g	3.8	3,500	21,000	18,000	23,000	33,000	43,000	3,500	43,000	**23,583**
Lead	µg/g	7.5	34	140	160	210	190	120	34	210	**142**
Magnesium	µg/g	0.75	880	5,900	4,700	6,100	8,200	10,000	880	10,000	**5,963**
Manganese	µg/g	0.38	190	510	340	410	460	560	190	560	**412**
Molybdenum	µg/g	3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	**<3.8**
Nickel	µg/g	3.8	12	67	53	70	100	130	12	130	**72**
Potassium	µg/g	38	120	1,400	1,400	1,700	2,200	2,600	120	2,600	**1,570**
Vanadium	µg/g	0.75	16	67	51	75	85	110	16	110	**67**
Zinc	µg/g	1.5	78	310	260	280	250	190	78	310	**228**

and metals by ICP trace element screening scan.

Metals levels are high compared to lakes receiving less urban runoff such (Smith et al 1996, MacDonald et al 2000). Mean lead levels in Lake Leota deep sediments, for example, were 173.3 µg/g compared to the 128 µg/g level determined as a consensus effects level above which ecological impacts are expected to occur more often than not (Consensus-based Probable Effects Concentration) and in more than 50% of benthic organisms (Effects Range Median) (Table 6). Lake-wide mean sediment lead was 142 µg/l compared to the 128 µg/g consensus effects level. Regional northwest background levels of lead in freshwater sediments are accepted as in the 0-33 µg/g range. Mean nickel levels in Lake Leota deep sediments were 100 µg/g compared to the 49 µg/g consensus effects level and to the 50 µg/l median effects level. Lead and nickel were the metals found in highest concentration relative to their likely biological impact.

Table 6. Mean concentrations of selected metals in Lake Leota sediments, July 19, 2006. (Dry weight concentrations) compared to environmental effects thresholds.

Metal	Unit	mdl	Leota Minimum Value	Leota Maximum Value	Leota Mean	Lowest Effect Level	Probable Effects Level	Consensus-Based Probable Effects Concentration	Effects Range Median	Severe Effects Level
						Note 1	Note 2	Note 3	Note 4	Note 1
Arsenic	µg/g	< 38	<38	48	**<38**	6	17	**33**	85	33
Cadmium	µg/g	1.5	<1.5	3.5	**2.9**	0.6	3.5	**5**	9	10
Chromium	µg/g	1.5	9.9	96	**55**	26	90	**111**	145	110
Copper	µg/g	7.5	17	69	**56**	16	197	**149**	390	110
Iron	µg/g	3.8	3,500	43,000	**23,583**	21,200	-	-	-	43,766
Lead	µg/g	7.5	34	210	**142**	31	91	**128**	110	250
Manganese	µg/g	0.38	190	560	**412**	460	-	-	-	1,100
Nickel	µg/g	3.8	12	130	**72**	16	36	**49**	50	75
Zinc	µg/g	1.5	78	310	**228**	120	315	**459**	270	820

Note 1: Ontario Ministry of Environment and Energy 1993.
Lowest Effect Level = Level of sediment contamination at which the majority of benthic organisms are unaffected.
Severe Effects Level = Level of sediment contamination at which pronounced disturbance of the benthic community can be expected,
i.e. adverse effects in >95% of benthic organisms.
= Sediment concentration of a compound that would be detrimental to the majority of benthic species.

Note 2: Smith et al 1996.
Probable Effects Level = Concentration above which adverse effects are expected to occur frequently.

Note 3: McDonald et al 2000; Ingersoll et al 2000.
Consensus-Based Probable Effects Concentration = Consensus-derived concentration above which adverse effects are expected to occur more often than not.

Note 4: Long and Morgan 1991.
Effects Range Median = Chemical concentration above which adverse effects are seen in more than 50% of benthic organisms.

Most of the heavy metals analyzed were elevated over levels for freshwater sediments agreed to cause deleterious effects in benthic organisms living in lake sediments (Ingersoll et al 2000, MacDonald et al 2000, Persaud et al 1993). Stormwater runoff is the obvious source for most of these heavy metals, which mainly come into the lake attached to sediment particles; stormwater runoff flows are the most significant source of particulate matter to Lake Leota.

The conclusion that these elevated metals are coming into the lake from stormwater inputs down the intermittent surface channels rather than from internal lake-wide processes is further supported by the observation that one sediment sample (2.5 m depth, just east of the north inlet, no rooted plants) had low phosphorus and was very low in all the metals tested, relative to the other five sites. Metals at that site approached regional background levels in the range of lowest effects levels (Tables 5 and 6). Such variability could easily be from a localized eroding channel blowout bringing relatively clean, i.e. low metal concentrations, sediments into the lake.

2.3 Factors Controlling Lake Leota's Condition

2.3.1 Groundwater seepage

Lake Leota is primarily groundwater-fed with a seepage base flow:

- There are no perennial surface channels feeding the lake; surface inflows are intermittent.
- Some, but not large, surface fluctuation occurs after intermittent surface inflows.
- Nearly all outflow leaves the lake as seepage; it is reasonable that near-lake soils and alluvium would be similarly porous with high groundwater conductivity. This is corroborated by Anderson's sub-report.
- Water temperatures below the thermocline (the sharp density gradient in the water column separating warmer surface waters from colder deep waters) remain cold through the summer, colder than would be possible in such a shallow lake in this mild climate without significant cold groundwater seepage into the lake.
- Observation of emergent vegetation in the lake littoral zone indicates little surface elevation change through the summer (Cooke's sub-report) indicating a base inflow through the summer large enough to match outflow.

The underground seepage flows (clear, with low sediments, phosphorus, and bacteria but probably with significant nitrogen levels) dominate lake inflow. Soils around the lake are sandy loam merging into more peaty soils in wetland areas. These have high hydraulic conductivity and tend toward acidity thereby effectively mobilizing septic drainfield effluents.

2.3.2 Overland Flow

Residents report that in many, even moderate, precipitation events, surface flows do enter the lake down its three main, normally dry tributaries (northwest corner, north center, and south center of the lake). Storm events are now causing significant channel-shaping flows close to the lake in these tributaries. Residents and the water quality monitors have reported over the past 20 years that the lake can rapidly become quite colored (brown) following a precipitation event. There are three potential sources for this observed turbidity: 1) in-lake disturbance of shoreline or shallow sediments; 2) phytoplankton blooms; and/or 3) surface flows, either overland or down surface channels.

The lake shorelines are very stable, largely because of: 1) low gradient nearshore riparian lands, and 2) dense riparian vegetation providing soil stability and absorption of any non-channelized overland flows to the lake. Cooke's sub-report has described the 100% vegetative cover of these near-shore lands around the lake. Stable shorelines and apparently stable shallow sediments in the absence of bottom churning by carp eliminate shoreline and lake sediments as turbidity sources. Algae blooms would not muddy the lake so rapidly nor account for the clay deposits in sediments (Section 2.2.5 and

Photograph 8). The only remaining turbidity source is the intermittent surface flows from overland sources down tributary channels. Color (dissolved organic substances from the peaty wetland soils and coniferous tree cover prevalent in the drainage) can come in to the lake in both surface and seepage flows if hydraulic conductivity is high enough.

2.3.3 Nearshore Development and Lake Use

The lakeshore is fully developed and comprised of platted lots with residences, mostly year-round. Apparently all residences are on individual septic systems with drainfields. The soils described above readily mobilize and transport the limiting nutrients, phosphorus and nitrogen, downhill short distances to the lake. The extensive lawns encompassing the lake also undoubtedly supply large amounts of available plant nutrients to the lake. Although landscaping, shoreside riparian plants, and in-lake littoral vegetation comprise a nutrient-absorbing buffer zone, many nutrients still are transported to the lake.

2.3.4 Eutrophication

Lake lifetime is a critical issue since the lake is not static in time; as the basin shallows, it becomes more productive with water increasingly enriched from lake sediments. Since the lake is now mesotrophic to meso-eutrophic, higher rates of nutrient loading would be expected to speed shallowing and lake aging. With advancing eutrophy in the already shallow lake, the lake as a permanent basin is probably in jeopardy given the present stormwater loading further decreasing water depth. Throughout King and Snohomish Counties, untreated urban/suburban stormflows have been shown to contribute high sediment loads, as well as nutrients, toxics, and bacteria to receiving basins. The end result of the aging process is a wetland followed by a wet meadow.

The controlling roles of 1) storm runoff and 2) littoral (inshore) organic-rich sediment deposits from emergent (primary) and submergent macrophytes (secondary) appear to be the major factors setting the lake's life span.

2.3.5 Metals in Lake Sediments

Metal concentrations in the sediments of Lake Leota are elevated; most samples exceeded thresholds of probable injury to the benthic macroinvertebrate community. Lead and nickel were the two metals with highest concentrations relative to toxic thresholds. Evidence suggests sporadic overland flows (mostly from impervious, trafficked paved surfaces) as the major metals source.

So long as lake sediments remain aerobic and effectively bind most metals to the sediments, most metals impacts are to the sediment-dwelling benthic organisms. Anaerobic conditions, however, cause a reducing environment in the sediments whereby significant quantities of toxic metals can be mobilized from to the overlying water

column with potential toxicity to organisms lake-wide. A eutrophic lake with extensive time periods of summer/fall anaerobic sediments would produce those conditions suitable for metals release to the water column and downstream.

2.4 Relationship of Lake Leota to Downstream Stream Habitats

Lake Leota is trapping nutrients (relevant to downstream eutrophication) and heavy metals (relevant to downstream toxicity to migratory and listed salmonids) with potential future negative impacts on sensitive salmonid habitat downstream in the Cold Creek drainage. At present, the lake's deep sediment storage of phosphorus and metals effectively remove these drivers of eutrophication and toxicity from biotic uptake. At present levels of watershed development, stormwater runoff to Lake Leota is sufficient to increase sediment phosphorus to mesotrophic levels and metals to levels exceeding toxic thresholds. Sediment lead levels are higher than consensus concentrations found to produce adverse impacts on more than 50% of the benthic organisms in freshwater sediments. Little of this sediment apparently presently leaves Lake Leota because of its minimal surface outflow.

Most of Lake Leota's outflow is *via* seepage, hence is cooled by underground flow before emerging to lower stream channels. The 1979-2004 25-year monitoring trend by King County Water and Land Resources Division (WLR) in Cottage Creek showed an increase in temperature and decrease in dissolved oxygen over the monitoring period. Temperature and dissolved oxygen are both critical water quality parameters to downstream listed salmonids in the Cold Creek system. Warmer water directly limits salmonids and their food supply as well as reducing dissolved oxygen concentrations. In 2005, King County WLR showed Cottage Creek in the 75th percentile of streams in the WRIA 8 Region. This is a moderately high ranking which also points out is vulnerability to warmer, oxygen-deficient inflows. A lake shallowed by more sediment deposition would be expected to deliver more of its outflow to the surface outlet channel, thereby sending much warmer water downstream to the Cold Creek/Cottage Creek system.

The present lake basin is shallow, with limited sediment storage capacity and vulnerable to future sediment loading. Inflowing channels presently have areas of instability and eroding channels. Increased stormwater inflows resulting from higher density development in the drainage would speed basin filling and progress toward eutrophication, shortening the lake's life and thereby, its sediment and pollutant-trapping capability. Downstream impacts would increase under those conditions. Such downstream impacts of a shallower, warmer, more eutrophic outflowing Lake Leota on the sensitive downstream environment of migratory salmonids would certainly be complex and large in spatial scope, since they would extend well beyond the lake's watershed and the city limits. The linkages of Lake Leota to the downstream Cold Creek system and its salmonid populations gives it a very high environmental value.

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4.0 PHOTOGRAPHS

1. Lake Leota from the north looking south. July 19, 2006

2. Point of northwest tributary entering the lake. July 19, 2006

3. Point of north tributary entering the lake. July 19, 2006

4. Point of south tributary entering the lake, July 19, 2006

5. Culvert in South tributary. July 19, 2006

6. Lake outlet channel. July 19, 2006

7. Nymphaea and iris-dominated littoral, near northeast inlet. July 19, 2006

8. Lake sediments from point 2.5 m deep, 70 feet E of N inlet. Note lenses of fine clay deposits interspersed with orange lenses of oxidized iron. July 19, 2006

Appendix C.

Wetland Evaluation for City of Woodinville Sustainable Development Program

Appendix C-1.

Woodinville Additional Wetland Reconnaissance Survey, Jones & Stokes

Jones & Stokes

Technical Memorandum

Date: February 12, 2007

To: Cindy Baker, Interim Director, Development Services, City of Woodinville

From: Torrey Luiting, Wetland Restoration Biologist, Jones & Stokes

cc: Lisa Grueter, Senior Planner, Jones & Stokes

Subject: Woodinville Additional Wetland Reconnaissance Survey

Methods

On February 8, 2007, Jones & Stokes conducted an independent wetland reconnaissance with the portion of Woodinville, Washington currently zoned as R-1, as depicted on the attached Figure. The purpose of the reconnaissance was to identify possible and potential wetland areas based on a visual inspection from public roadways and from signed private roadways.

During the reconnaissance, Jones & Stokes placed particular emphasis on the Hillside Drainages basin, Golf Course Basin, the School basin, the Daniels Creek basin, and the Woodin Creek basin within the R-1 area (see attached Figure). We also drove the roadways throughout the Lake Leota basin, which had been previously surveyed for the City in October 2006 by Cooke Scientific.

Identification of 'possible' and 'potential' wetland areas was based on visual evidence of hydrophytic vegetation, as outlined in *Corps of Engineers Wetland Delineation Manual* (1987 Manual) (Environmental Laboratory 1987) and *Washington State Wetlands Identification and Delineation Manual* (Ecology 1997). Wetland functions and associated classification was based on the Washington State Wetlands Rating System for Western Washington (Hruby 2004) and the City of Woodinville's Critical Areas Development Standards (Chapter 21.24.320).

Under normal conditions, hydrophytic vegetation is considered prevalent if greater than 50% of the dominant species from each stratum (tree, shrub, vine, and herbaceous) are classified as obligate wetland (OBL), facultative wet wetland (FACW), and/or facultative wetland (FAC) according to the U.S. Fish and Wildlife Service (USFWS) publication National List of Plant Species that Occur in Wetlands (Reed 1988). These classifications are based on moisture

tolerance, as indicated in Table 1. Dominant species represent 20% aerial cover or more. Non-dominants (i.e., species with less than 20% aerial cover) are also noted when dominants are unclassified or primarily FAC.

Table 1. Plant Species Indicator Category Definitions

Category	Definition
Obligate (OBL)	Plants that almost always occur in wetlands (estimated probability > 99%) under natural conditions.
Facultative Wetland (FACW)	Plants that usually occur in wetlands (estimated probability 67 to 99%) but are occasionally found in non-wetland areas.
Facultative (FAC)	Plants that are equally likely to occur in wetlands or non wetlands (estimated probability 33 to 67%).
Facultative Upland (FACU)	Plants that usually occur in non-wetlands (estimated probability 67 to 99%).
Upland (UPL)	Plants that almost always occur in non-wetlands (estimated probability > 99%) under natural conditions.

Source: Reed 1988

We labeled areas identified during our reconnaissance as 'potential wetland' areas or 'possible wetland' areas; we also indicated areas were our visual reconnaissance was limited and our views restricted, but in which there may be wetlands.

'Potential wetland' areas observed by Jones & Stokes were areas in which the dominant vegetation was composed of species rated FAC or wetter, and in which non-dominates were also generally rated FAC or wetter and/or there was visual evidence of saturated soils or surface ponding at the time of our field investigation. These areas are most likely wetland, but again, site-specific soils and hydrology investigations would have to be performed during the growing season to definitively document all three required parameters (hydrophytic vegetation, hydric soils, and wetland hydrology during the growing season) necessary to be considered a jurisdictional wetland.

'Possible wetland based on vegetation' areas were areas in which the dominant vegetation was composed of species rated FAC or wetter, but in which non-dominates were generally rated FAC or drier. These areas may be wetland, but site-specific soils and hydrology investigations would have to be performed during the growing season to definitively determine whether or not the area meets all three wetland criteria (hydrophytic vegetation, hydric soils, and wetland hydrology during the growing season) and would thus be considered a jurisdictional wetland.

'Visual reconnaissance limited' areas were areas in which some hydrophytic vegetation was visually discernible from a distance (e.g. the dominant trees), but where distance from the

roadways and/or other visual barriers prevented a close enough inspection to visually determine non-dominant vegetation species and/or hydrologic conditions. While these areas may contain wetlands, determining their plant communities and/or soils and hydrology conditions would have required access through and onto private property.

Results

Jones & Stokes identified seven 'potential wetland' areas, mostly located within the Hillside and School Drainage basins (see attached Figure). The majority of the 'potential wetland' areas are located in topographic depressions and are clearly dominated by the typical Pacific Northwest forested wetland combination of hydrophytic trees and shrubs, most commonly red alder (*Alnus rubra*, FAC), black cottonwood (*Populus balsamifera*, FAC), and western red cedar trees (*Thuja plicata*, FAC) interspersed with Douglas fir (*Pseudotsuga menziesii*, FACU) and big-leaf maple (*Acer macrophyllum*, FACU) trees along the higher outer edges. The understory of these areas is typically dominated by salmonberry (*Rubus spectabilis*, FAC+) and sword fern (*Polystichum munitum*, FACU). Himalayan blackberry (*Rubus armeniacus*, FACU) was also occasionally present along the outer edges. Surface saturation and/or ponded surface water was present in several of these areas at the time of our field reconnaissance. However, none of these areas appeared to support a dominance of western red cedar and/or Sitka spruce (*Picea sitchensis*, FAC) that is indicative of prolonged surface saturation and a 'forest swamp' community. A site-specific field investigation of soil profiles and hydrology is necessary to determine whether or not these areas meet all three wetland criteria and thus would be regulated as wetlands. Given their estimated relative sizes, landscape positions, and apparent vegetation classes (forested and scrub-shrub, based on Cowardin et al. 1979), these 'potential wetland' areas would likely be rated as Category 2 or 3 wetlands according to the City of Woodinville's Critical Areas Development Standards (Chapter 21.24.320).

Jones & Stokes also identified eight 'possible wetland based on vegetation' areas (see attached Figure). Red alder trees similarly dominated the 'possible wetland' areas with understories dominated by salmonberry. These areas generally had a greater proportion of subdominant vegetation that can be characteristic of drier habitats, including big-leaf maple trees, sword fern, and salal (*Gaultheria shallon*, FACU). However, these drier species sometimes do occur on topographically elevated hummocks interspersed within forested and scrub-shrub wetlands. A site specific investigation during the growing season would be required in these areas to determine whether there is sufficient dominance by hydrophytic vegetation to meet the wetland vegetation criteria, as there may be additional hydrophytic herbaceous vegetation present that is not visible during February. In addition, field investigation of soil profiles and hydrology is necessary to determine whether or not these areas meet all three wetland criteria and thus would be regulated as wetlands. If these 'possible wetland' areas are found to indeed be jurisdictional wetlands, they would likely be rated as Category 2 or 3 wetlands according to the City of Woodinville's Critical Areas Development Standards (Chapter 21.24.320) due to their estimated relative sizes, landscape positions, and apparent vegetation classes (forested and scrub-shrub

predominately).

Finally, Jones & Stokes identified ten areas where our visual reconnaissance was limited due to the distance of accessible roadways from undeveloped areas. In many cases, there were also visual barriers (e.g. dense tree canopy, topography, buildings/fences) preventing clear sight-lines into these areas. In these areas, hydrophytic tree species were present (generally red alder and black cottonwood), but we could not determine whether or not they were the dominant species. Similarly, we could also not determine whether the understory species were typical hydrophytes such as salmonberry, or typical upland understory species. A site-specific investigation during the growing season would be required to determine whether these areas contain wetlands.

Conclusions

The combination of this reconnaissance, the City's wetland inventory, and the survey conducted by Cooke Scientific, provides a thorough reconnaissance level survey of the R-1area, suitable for the planning level efforts associated with the City's Sustainable Development Project. For the purposes of inventorying the extent and general nature of wetlands, the level of effort expended and the level of detail provided are typical and appropriate.

The data collected by both Jones & Stokes and Cooke Scientific indicate that the wetlands present within the R-1 area are typical forested and scrub-shrub wetlands, either depressional, riverine flow-through (associated with Cold Creek), or lacustrine fringe (surrounding Lake Leota). The wetlands are dominated by the typical wetland trees and shrubs, which are commonly found throughout western Washington, particularly within urban municipalities in which much of the original forests and wetlands were cleared for residential and commercial development. These types of wetlands are generally seasonally saturated to ponded and provide a variety of wildlife habitat functions, particularly for birds and small mammals, as well as water quality improvement and hydrologic (stormwater retention) functions typical of depressional wetlands within urbanized areas. Given the prevalence of mapped, 'possible', and 'potential' wetlands between 162nd Avenue NE and 166th Avenue NE, these features may be hydrologically linked to each other via surface and/or subsurface connections within the School Basin. However, none of the mapped, potential, or possible wetlands identified appear to be of exceptional local significance, or of irreplaceable ecological functions.

While site-specific investigations and field delineations would provide an exact accounting of wetlands, such an effort is logistically difficult since investigations would require every property owner to grant site access and agree to have a legally regulated feature (wetlands) and its buffer delineated and recorded on his or her property. However, such site-specific analysis can occur at the time of proposed development applications.

The planning-level wetlands reconnaissance conducted to date will help provide a guide to local wetland locations as property owners request development over time. Any proposed development on parcels containing or adjacent to wetlands, regardless of residential density

zoning, would require a site-specific delineation to determine the exact wetland extent and boundaries. Development applications would then be required to provide that the delineated wetlands be protected by standard minimum buffers of 100 and 50 feet for Class 2 or 3 wetlands, respectively (per City of Woodinville's Critical Areas Development Standards Chapter 21.24.330). Unavoidable impacts to a wetland or its buffer would require federal, state, and local permits, as well as compensatory mitigation for 2 acres of wetland mitigation per acre of impact for Class 2 wetlands and 1.5 acres of mitigation per acre of impact for Class 3 wetlands, per Chapter 21.24.250 (City of Woodinville Critical Areas Development Standards).

Qualifications

These conclusions are based on my best professional judgment as a wetland professional and field biologist. I have over 10 years of professional experience in wetlands, including reconnaissance, field delineation, wetland functions and values assessment, fish and wildlife habitat assessments, and project permitting. My field experience spans both Western and Eastern Washington wetlands, as well as in Northern Oregon. Prior to joining Jones & Stokes, I was an Environmental Coordinator for Seattle District, Corps of Engineers projects, worked with the Corps Regulatory Branch on Section 10 and Section 404 permits, and was a project manager for 5 years at a local wetland-consulting firm. I have been an invited panelist for the University of Washington's Wetland Science and Management Certification Program, speaking about the 'real-world' relationship between landscape ecology and wetland science. I have authored numerous project-specific biological and environmental assessments for a wide variety of projects, analyzing immediate and cumulative impacts associated with projects across a range of scales. At Jones & Stokes, I specialize in project management and permitting of wetland restoration projects, in addition to wetland assessment and delineation projects.

I am also a Distance Learning instructor for Seattle Central Community College in Environmental Science. I hold a Masters of Science degree from the University of Washington School of Fisheries (1996), with an emphasis in wetland biology, and am a Summa Cum Laude graduate of the University of Wisconsin, Green Bay, in Environmental Science (1992).

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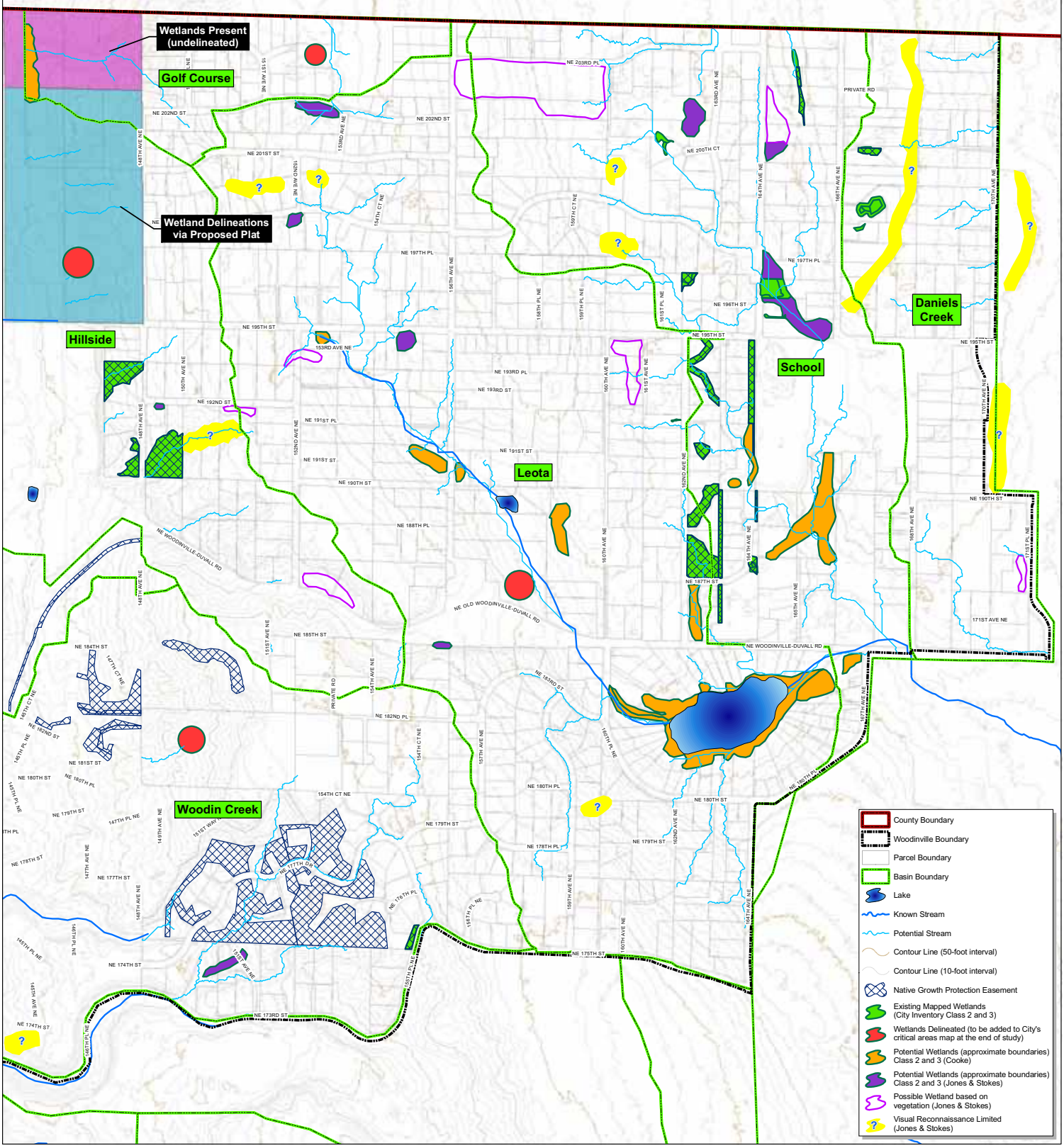
City of Woodinville

Sustainable Development Project



Compilation of Wetlands Reconnaissance and Inventories

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City of Woodinville
17301 - 133rd Ave NE
Woodinville, WA 98072
www.woodinville.wa.us
425-489-2700

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Appendix C-2.
Woodinville Wetland Survey, Cooke Scientific

COOKE SCIENTIFIC
4231 NE 110TH ST, SEATTLE, WA 98125
PHONE: (206) 695-226 FAX: 206-368-5430
COOKESS@AOL.COM WWW.COOKESCIENTIFIC.COM

Memorandum

TO: John Lombard, Steward and Associates

FROM: Sarah Spear Cooke

DATE: October 26, 2006

SUBJECT: Woodinville Wetland Survey

Enclosed please find, a map of wetlands that Dustin Hinson and I evaluated for the City of Woodinville's R-1 environmental report and a table with accompanying information for each wetland we mapped. The table includes a hydrogeomorphic classification, the Cowardin classification (where known), an estimated rating using the Washington State Department of Ecology's Wetland rating for Western Washington (Hruby 2004), approximate acreage in two cases, whether or not this information was verified in the field, and miscellaneous information on the location and other characteristics of the wetland.

Our survey was not comprehensive. Given budget and time constraints and the approved scope for the R-1 report, we focused on wetlands that were part of the area draining to Lake Leota, particularly those that have a direct hydrologic connection to the lake, at least seasonally. We also examined some of the larger wetlands in the vicinity of Leota Junior High School, where the City's maps generally show the greatest concentration of wetlands in the R-1 area. Access was limited to public property or where private property owners happened to be present and gave us access during our time in the field.

While our survey was limited by these constraints, I am confident that we evaluated the wetlands in the R-1 zone of most significance for the environmental report, and that our general conclusions would still hold after a more detailed survey. All of the wetlands we observed have been substantially degraded by past alterations and impacts from surrounding development. We found no Category I wetlands and none that were likely of great significance to fisheries resources downstream. No wetland in the R-1 zone has high habitat values, based on the Washington Department of Ecology's rating system; most have low habitat scores, although some around Lake Leota would likely be rated as having moderate habitat values (scores between 20 and 28 in Ecology's system). Wetlands in the Lake Leota basin are still important for protecting the lake's water quality, both through filtration of pollutants and detention of stormwater to reduce erosion downstream.

Our judgments are based on extensive professional experience, which in my case includes more than 19 years in wetlands ecological research and environmental consulting. I am a certified "Wetland Scientist" by the Society of Wetland Scientists and am one of three fellows

recognized by the Society of Wetland Scientists to date. I have taught “Wetland Ecology” for the Wetland Certification Program at the University of Washington, “Wetland Vegetation Identification” at the University of Washington and at Portland State, “Wetland Delineation” using the 1987 and Washington State Department of Ecology’s Wetland Delineation Method for the U.S. Army Corps of Engineers agency training classes, and “Wetland Rating in Western Washington” for the Washington State Department of Ecology using the Wetland Rating Method for Western Washington (Hruby 2004). I am the author/editor of A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon (Seattle Audobon Society/Washington Native Plant Society 1997) and a contributing author to Wetlands and Urbanization: Implications for the Future (CRC Press 2004). I also conducted scientific research on wetland ecosystems for the Department of Ecology’s Western Washington Stormwater Manual.

City of Woodinville R-1 Zone Wetland Inventory

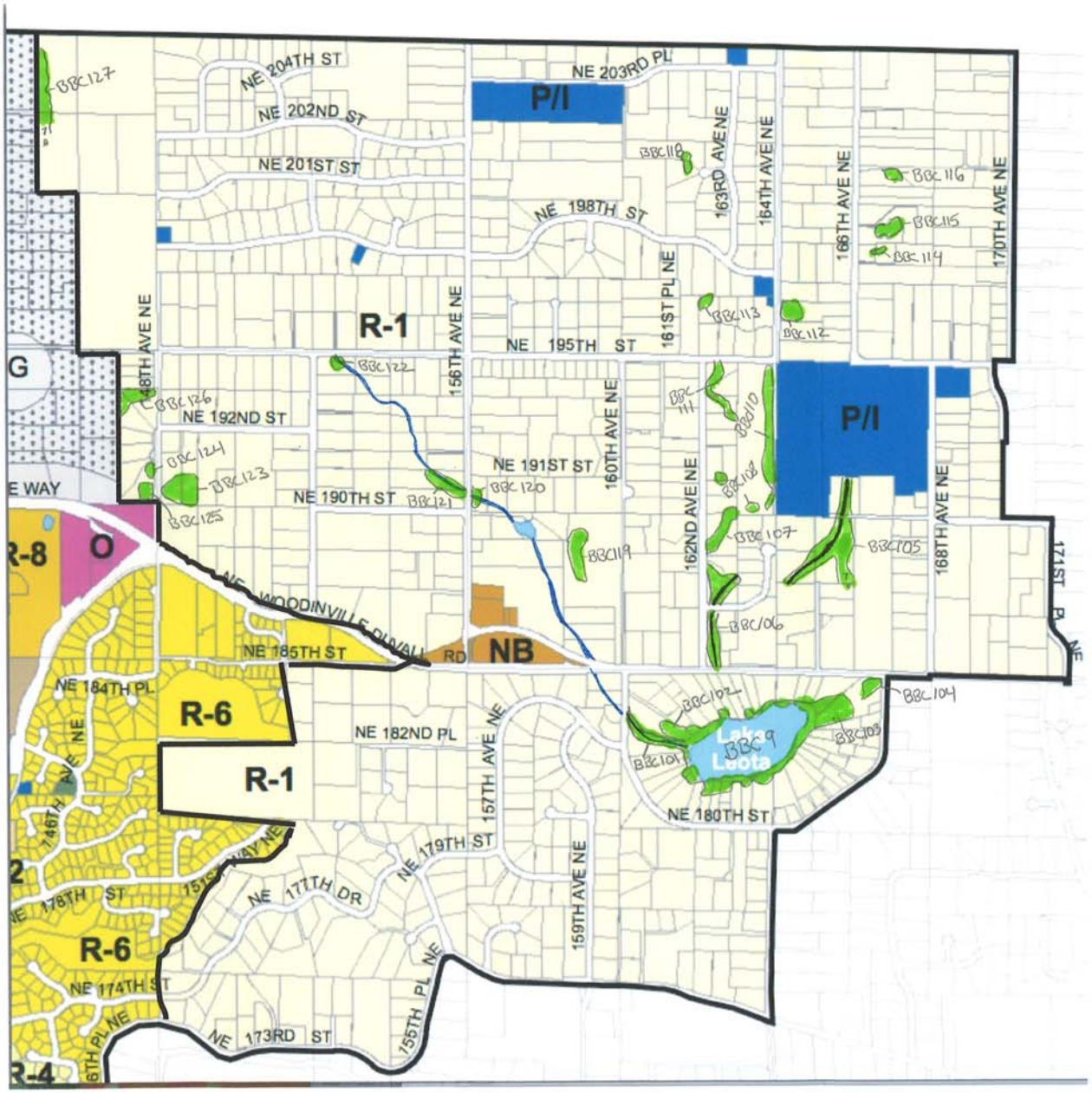
Wetland code	Approx acreage	Rating*[1]	HGM class	Cowardin Class	Field Verified*[2]	Location and Misc Notes
BBC 9	± 13	2	Lacustrine fringe	PUB PAB, PEM, PSS	Yes	The exact extent of this wetland is not known. It is clear it runs the periphery of the open water of Lake Leota and that is within NE 180th St and NE Woodinville Duvall Road, but extends to a larger area on some lots. BBC101, 102, and 103 have been described (in city files) and are extensive and so identified separately although they are continuous with this wetland
BBC 101	0.5	2	Riverine flow-through	PFO PSS PEM	Yes	See BBC 9. This wetland is continuous with Coldwater creek as it enters Lake Leota. The creek only flows periodically now. It used to flow all year long.
BBC 102	-	2	Lacustrine fringe	-	No	See BBC 9. This wetland is continuous with BBC 9 but extends northwest from the NW corner of Lake Leota onto two lots.
BBC 103	-	2*[3]	Lacustrine fringe	-	No, but is present	See BBC 9. This wetland is located on the northeast corner of Lake Leota and is the largest scrub shrub/forested wetland in the system.
BBC 104	-	2*[3]	Riverine flow-through	PSS PFO	Yes	Located at the NE corner of the intersection of NE 180th St and NE Woodinville Duvall Road. Enters a culvert that heads NE under the Woodinville-Duvall Road. Is the outlet to Cold Creek.
BBC 105	-	2*[3]	Riverine flow-through	PSS PFO	Yes	Located south of the high school, north and south of NE 190th St. There is a seasonal channel that flows from a culvert that originates at the high school and heads south and disappears into a culvert just east of 163rd Ave NE.

*[1]Using the WSDOE Wetland Rating for Western Washington (Hruby 2004)
*[2] Wetland may be present but they have not been verified as part of this study. Their size and location comes from City database and should be field verified.
*[3] Estimated rating. The full rating form should be completed in order to verify this estimated rating

Wetland code	Approx acreage	Rating*[1]	HGM class	Cowardin Class	Field Verified*[2]	Location and Misc Notes
BBC 106	-	2*[3]	Riverine flow-through	PFO PSS PEM	Yes	This wetland is east of 162nd Ave NE. A seasonal stream flows into the wetland from a culvert, travels down the riparian corridor, passes under NE 187th Street, and passes back into a culvert under Woodinville-Duvall Road.
BBC 107	-	3*[3]	Depressional outflow	-	No No access	This wetland is located east of 162nd Ave NE. There was no access and so its characteristics are not known. It is believed it is fed via a culvert and exits into a culvert that then feeds into BBC106, but this is not confirmed.
BBC 108	-	-	Depressional closed	PEM	YES	This is a Stormwater pond with an emergent fringe of vegetation.
BBC 109	-	-	Depressional closed	-	NO No access	This wetland is located east of 162nd Ave NE. There was no access and so its characteristics are not known.
BBC 110	-	3*[3]	Riverine flow-through	PEM PSS	YES	Located adjacent to the western edge of the play fields of Leota Junior High. This channel is mostly exposed gravel with a few patches of scattered wetland in areas where water pools. The channel meets up with culverted flows from the high school and heads south.
BBC 111	-	3*[3]	Riverine flow-through	PSS	YES not full access	This wetland is located at the SE corner of the intersection of NE 195th St and 162nd Ave NE. It begins at a culvert under NE 195th St and heads south and west to the edge of 162nd Ave NE, then heads south and east. Access was not possible but it is believed it passes into a culvert at that point.
BBC 112	-	-	Depressional closed	-	No	This wetland is located east of 164th Ave NE.
BBC 113	-	-	Depressional closed	-	No no access	This wetland is located in the middle of a block west of 164th Ave NE and between NE 195th St and NE 198th St.
BBC 114	-	-	Depressional closed	-	No no access	This wetland is located east of 166th Ave NE.
BBC 115	-	-	Depressional closed	-	No no access	This wetland is located east of 166th Ave NE.

Wetland code	Approx acreage	Rating*[1]	HGM class	Cowardin Class	Field Verified*[2]	Location and Misc Notes
BBC 116	-	-	Depressional closed	-	No no access	This wetland is located east of 166th Ave NE.
BBC 117	-	-	Depressional outflow	-	No no access	This wetland is located east of 164th Ave NE and west of 166th Ave NE in the middle of a block.
BBC 118	-	-	Depressional closed	-	No no access	This wetland is located west of 163rd Ave NE off of a cul-de-sac that is NE 200th Ct.
BBC 119	-	-	Depressional outflow	-	No no access	This wetland is located west of 160th Ave NE.
BBC 120	-	-	Depressional outflow	PEM PSS	Yes	This wetland is located east of 156th Ave NE. Most of the area is a gravel-filled detention facility that appears to infiltrate stormwater. Only a small amount of wetland is present within this facility. More investigation is needed.
BBC 121	-	-	Riverine flow-through	PFO PSS	Yes partial access	This wetland is located west of 156th Ave NE. Cold Creek enters the wetland to the NW and exits to the SE under 156th Ave NE. It is a heavily forested cedar wetland.
BBC 122	-	-	Depressional outflow	PEM	Yes from the road	This headwater wetland starts in the mowed lawn of the property just south of NE 195th St.
BBC 123	-	-	Depressional closed	-	No	This wetland is located across two lots east of 148th Ave NE and south of NE 192nd St.
BBC 124	-	-	Depressional closed	-	No	This wetland is located west of 148th Ave NE.
BBC 125	-	-	Depressional closed	-	No	This wetland is found on two lots west of 148th Ave NE.
BBC 126	-	-	Depressional closed	-	No	Wetland located west of 148th Ave NE.
BBC 127	-	-	Slope and Depessional outflow	PEM PSS	yes	This wetland is located at the toe of the slope east of 148th Ave NE just south of the Snohomish County border. It is located mostly within a ravine.

Woodinville R-1 Wetlands Map



Wetlands*

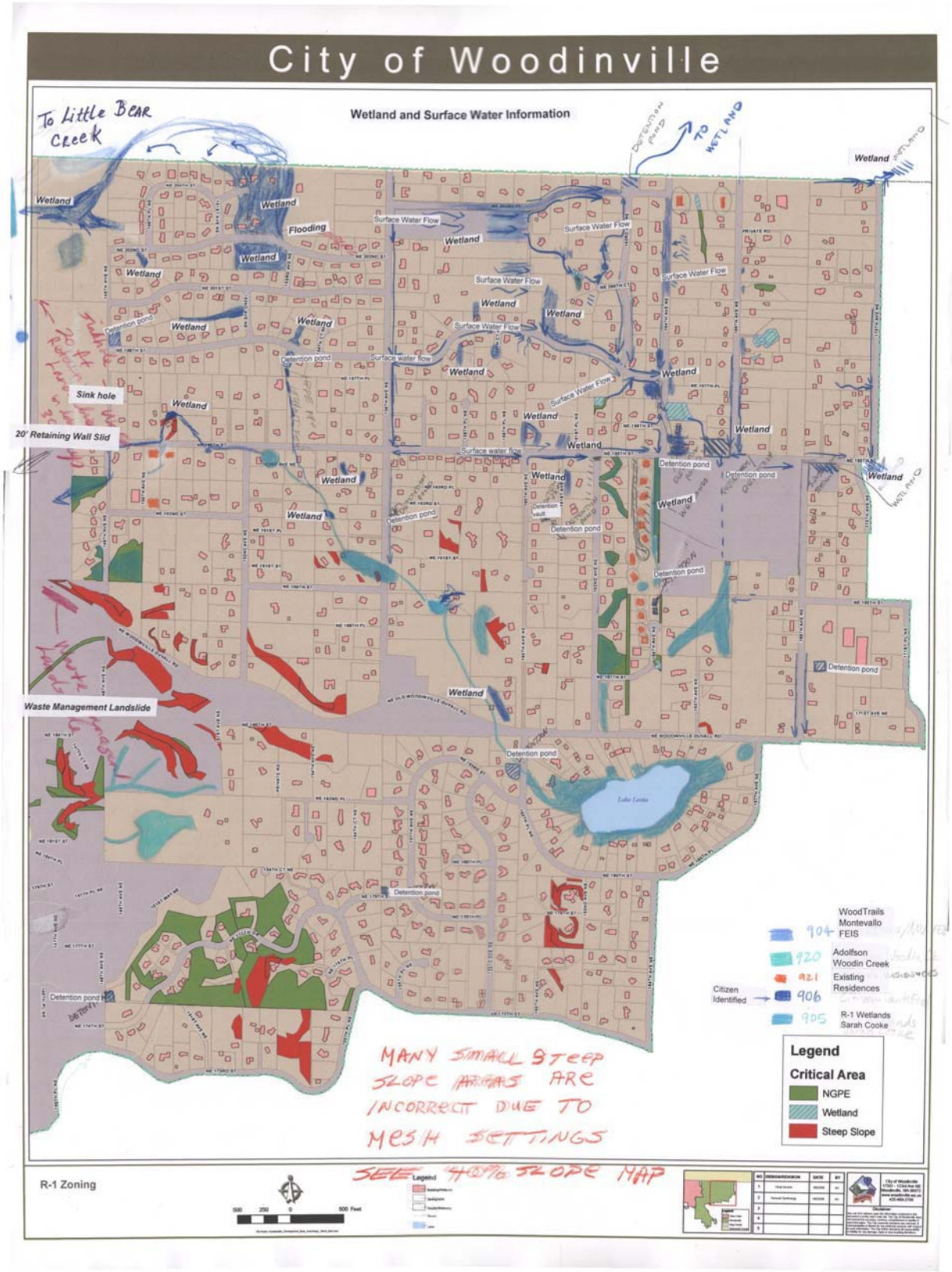
Cold Creek Tributary

Unnamed Tributaries

R-1 Boundary

*Note: All wetlands location and boundaries are approximate. These should be surveyed.

Appendix C-3.
Citizen Advisory Panel Supplied Map



Appendix C-3. Citizen Advisory Panel Supplied Map

This map was supplied by members of the Citizens Advisory Panel (CAP). The Compilation Map in Appendix C-1 identifies many of the same potential wetlands. Some of the CAP identified areas may be located in areas less visible from public roadways due to location of homes, fences, and intervening vegetation, and would require verification following access authorization by private property owners.

Appendix D.

Low-Impact Development Analysis for City of Woodinville Sustainable Development Program, Perteet Inc.

Woodinville Sustainable Development Study

October 18, 2006

Prepared by:

Perteet

Perteet Inc.
2707 Colby Avenue, Suite 900
Everett, Washington 98201
1-800-615-9900
425-252-7700

With edits by the City of Woodinville

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1.0 PROJECT DESCRIPTION

1.1 Study Area & Background Information

The overall purpose of this study is to assist the City of Woodinville with its Sustainable Development Program, including an analysis of the R-1 Area, with an evaluation of current and potential land uses and related densities in the R-1 Area and their impacts on the environment. For this particular portion of the study, the focus is to identify the benefits of using low impact development techniques as part of the sustainable development program for the City. This report is to be considered part of a larger group of studies that has been prepared and organized by Steward & Associates, on behalf of the City of Woodinville.

The R-1 Area is located at the easterly portion of the City of Woodinville, as shown in Fig. 1.1.

Figure 1.1: R-1 Study Area

1.2 Purpose and Goals

The study area within the City of Woodinville is at the headwaters of two significant fish-bearing streams, the Bear Creek Basin and the Little Bear Creek Basin. These two basins are located within the Lake Washington/Cedar/Sammamish Watershed (WRIA 8). These upper-reaches of the watershed have increased pressures of development, which threaten the water quality in the streams. It is feared that as development continues in the study area, further degradation of the water quality will occur which will threaten the sustainability of aquatic habitat in the stream, including salmon. The land-uses and future developments within the study area need to be managed in a manner that minimize negative impacts on the water quality in the basins, and if possible improve the water quality and flow conditions where degradation has already occurred.

The Lake Washington/Cedar/Sammamish Watershed (WRIA 8), located in western Washington, is home to three populations of Chinook salmon: Cedar River, North Lake Washington, and Issaquah. Each year Chinook salmon spawn and rear in the WRIA 8 rivers and streams, and use the lakes, rivers, estuary, and nearshore to rear and migrate to the ocean. Development in the watershed for human use has dramatically altered the habitat that salmon need to survive. Chinook salmon (known more commonly as king salmon) are declining; they are far less abundant now than they were even in recent decades, and all three populations are at high risk of extinction. In 1999, the federal government listed Puget Sound Chinook salmon and bull trout as threatened under the Endangered Species Act (ESA). The factors that limit salmon habitat are similar for the lakes, rivers, and creeks in the watershed, although the magnitude of impact varies by type of water body and specific watershed area. It is important to understand the limiting factors that interact with one another to worsen the habitat problems seen in the aquatic systems. The factors that limit habitat are listed below.

- Altered hydrology (e.g., low base flows, higher peak flows following storms, and increased 'flashiness', which means more frequent and rapid responses when it rains)
- Loss of floodplain connectivity (e.g., reduced access to side-channels or off-channel areas due to bank armoring and development close to shorelines)
- Lack of riparian vegetation (e.g., from clearing and development)
- Disrupted sediment processes (e.g., too much fine sediment deposited in urban streams, or sources of spawning gravel disconnected from the river channel)
- Loss of channel and shoreline complexity (e.g., lack of woody debris and pools)
- Barriers to fish passage (e.g., from road crossings, weirs, and dams)
- Degraded water and sediment quality (e.g., pollutants and high temperatures)

With these environmental concerns and general objectives being in the forefront of the community, there are goals which have been identified pertaining to land-use and development within the study area. These goals are listed below.

- Identify land-use measures that will minimize negative impacts on lakes and streams to the maximum extent practicable, which will in turn contribute to the sustainability of a healthy environment.

- Achieve a higher level of stormwater quality than what can be attained through conventional stormwater management measures. This will contribute to the sustainability of a healthy aquatic habitat in the lakes and streams.
- Prepare an estimate or qualitative assessment of the benefits of using low impact development techniques based upon several studies that have been recently published on the subject. Also conduct a continuous simulation analysis on the performance of select low impact development techniques, to estimate their hydrologic benefits under sustained wet-weather conditions, and which has been specifically prepared for this study by Perteet Engineering, Inc.

Sustainable development, through the use of low impact development techniques, is a means to better protect the environment and preserve stream habitats. This report discusses the alternatives and provides a general description or estimate of the benefits and constraints on using various low impact development techniques.

2.0 LOW IMPACT DEVELOPMENT METHODS

2.1 Introduction & General Discussion

Low impact development (LID) techniques cover a wide array of alternatives. In essence, LID techniques are integrated land-management stormwater practices that are widely dispersed throughout a development (e.g., residential plat, commercial property, or a relatively large land area). Their application and practical use to be considered for an area depend upon site constraints, land availability, and public acceptance. Site constraint issues include: terrain, subsurface soil conditions and depth to groundwater. Land availability is simply keeping reserved a portion of the land within a development to construct and use an LID system. A big part of public acceptance includes informing the public and land-owners of the function of the LID system on their property, and the need to maintain it in perpetuity.

Subsurface soil conditions play a major part in determining the size and type of LID techniques that can be used. Soils can be divided into two major types: a) well-draining soils; and b) low-to-moderate draining soils. Well-draining soils are generally found in the outwash soil zones. Low-to-moderate draining soils are found in the till soil zones. The LID techniques that can be used over well-draining soils include all techniques described herein, and they should also include infiltration systems that provide for virtually all of the runoff to infiltrate into the deeper soil layers with the use of multiple stormwater facilities that are widely dispersed through a site. This does a far better job of emulating natural conditions than conventional drainage facilities (e.g., catch basins, storm pipes, and end-of-pipe storm ponds that then discharge into a stream).

Even though the till soils infiltrate stormwater at such a slow rate, so much so that they are often discounted in a hydrologic analysis when considering major storm events (e.g. 10-yr or 50-yr storms, for example), infiltration should not be completely discounted in till soils, when considering the path rain water takes in a forested condition. Over the course of a year the amount of infiltration allowed through a till soil is oftentimes in the range of 18 inches/year, equivalent to 0.05 inch during a 24 hour period, which is insignificant in a major storm event (which can generate 2 to 3 inches of rain in the same 24 hour period). Over the course of the same annual period where the total precipitation is around 42 inches, the total infiltration of 18

inches is not insignificant (≈ 40% of total precipitation is infiltrated), if it can be captured and held in the soil matrix and then slowly infiltrated into the deeper soil layers between storms. This slow infiltration process is what naturally occurs in a forested condition. Downstream channels are not negatively impacted. Several LID techniques more closely emulate this same natural process in developed land-use conditions. If a significant portion of rain water can be infiltrated, even in till soils which more closely match natural conditions, then this will provide lower water temperatures for water entering streams. This in turn contributes to a healthy aquatic habitat by keeping stream temperatures low and within safe levels for salmon.

There is no automatic break-point in the number of LID techniques that are implemented on a site which contribute to their effectiveness. A major point is the more LID techniques that are used; the better the system will function in providing a high-level of stormwater quality through treatment and more closely emulating natural conditions. Conversely, if a minimal number of LID techniques are used on a land area that will have a very dense development with a high amount of impervious surfaces—their benefits will, in most cases, be negligible.

In this study, the goal is to identify specific LID techniques which are practical to construct, that can be implemented with the adoption of revised land-use codes that reduce the impacts from development on the natural environment, and which have been utilized in other areas of the country. We have also identified a grouping of LID techniques that can be implemented together, applicable for each of the respective land-use zone densities for residential development.

2.2 Low Impact Development Compared to Conventional Stormwater Management

Conventional drainage facilities include capturing runoff from impervious surfaces (roads, driveways, roofs) and grassed areas, where pollutants are captured and rapidly conveyed to a drainage pond. Conventional systems include catch basins in streets, and storm pipes that are directly connected to drainage ponds (for detention and water quality treatment). A well designed drainage pond will capture/remove and treat about 80% of the pollutants, using total suspended solids (TSS) as the indicator, since many pollutants attach themselves to the TSS. This percent removal of pollutants is an approximation, because pollutant concentrations in stormwater vary by a considerable amount. To account for the variability, sampling and measuring is quantified by determining event mean concentration (EMC) taken with several water samples over the course of a runoff event. In essence the EMC of pollutant concentrations and removal rates are determined by averaging the measured concentrations of the constituent of several water samples.

Low Impact Development (LID) techniques perform, in most instances, better than conventional drainage techniques because they more closely emulate natural/undeveloped conditions. Generally, LID techniques should be used in conjunction with conventional detention and water quality facilities in order to contribute to a higher level of water quality and aquatic habitat within a watershed.

Temperature in streams is important for salmon habitat. By lessening the amount of surface runoff and instead increasing groundwater flows, temperature benefits can be realized. A study was done for the Stillaguamish River where these effects were evaluated.[13] It was demonstrated here that the groundwater inflows into the streams could increase if recharge is increased with

stormwater management. At the request of members of the Stillaguamish Implementation Review Committee (SIRC), the sensitivity of predicted stream temperatures to increases in groundwater inflows was tested by predicting stream temperatures that would be associated with additional inflows of groundwater equal to 10% of the surface flows in reaches that are surrounded by glacial outwash materials. This is a lower number than what could be realized if multiple LID techniques would be implemented. The evaluation conducted was a sensitivity analysis to examine hypothetical conditions. The temperature of these groundwater inflows was estimated to be 11°C based on the mean annual air temperature and median value reported by the U.S. Geological Survey (USGS) (1997). Hypothetical increases in groundwater inflows were evaluated in Pilchuck Creek below the state Highway 9 bridge, and other areas along the Stillaguamish River. The result of the study at the Highway 9 bridge is summarized in Figure 2.1.

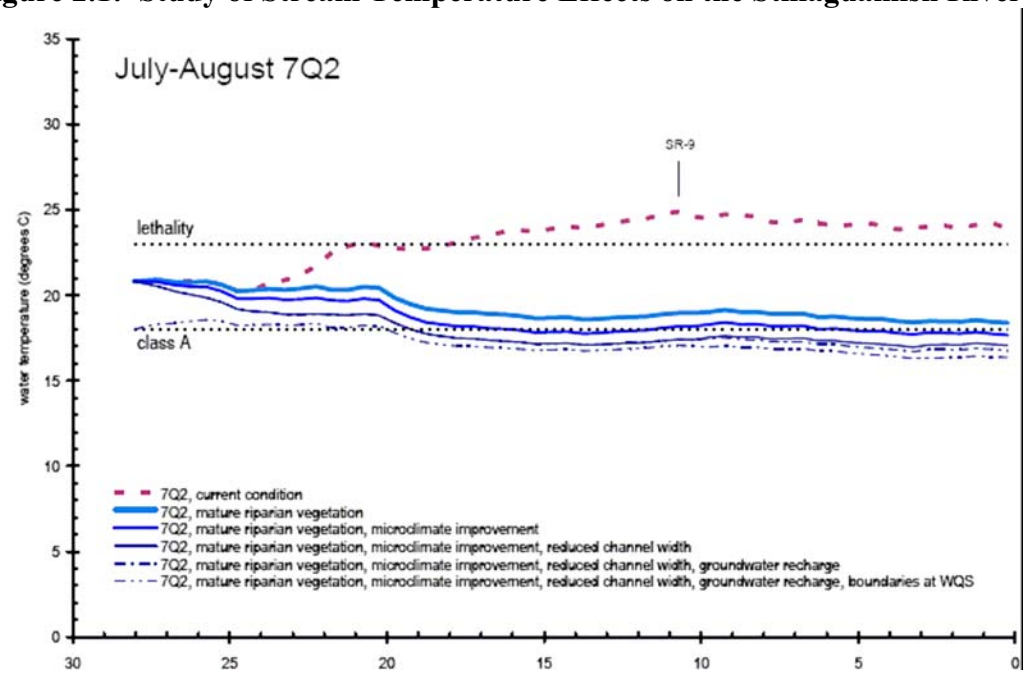
Above about 23° C, the water temperature in a stream becomes lethal. These are the conditions for the summer months within the Stillaguamish River. The study demonstrates that the water temperature can be dropped to safe levels if there is a preservation/restoration of a partially shaded riparian corridor along the river with vegetation, increased groundwater recharge, and revision of the channel width to narrower widths, as it was when the watershed was less developed.

The study demonstrates the importance of:

- keeping contributing stormwater that flows into the river to lower temperatures;
- maintaining groundwater inflow, instead of converting rain water to surface runoff, (as is commonly the case when the watershed gets developed using conventional stormwater techniques only); and
- maintaining a vegetated buffer along the riparian corridor.

Conventional stormwater management techniques do not address temperature effects or the benefits and needs of closely emulating natural conditions. Using stormwater LID techniques with several integrated infiltration systems that provide a certain level of groundwater recharge provides this benefit to stream temperatures.

Figure 2.1: Study of Stream Temperature Effects on the Stillaguamish River[13]



Variations in pollutant concentrations and actual constituents vary substantially by:

- location or land use;
- time in the course of a storm single event;
- duration of dry period between storms; and
- storm intensities.

For fish-bearing streams located within a watershed and down-gradient of a developed area, the water temperature has a significant impact on the health of the fish. Salmon typically need cool water temperatures (around 10° to 15° C). Conventional surface water management methods do not address temperature problems that occur when land is developed. Stormwater temperatures rise substantially when they flow over hot pavement surfaces and hot roofs in the summer months, and it can rise even further when it flows to a pond that is exposed to the sunlight. The rise in water temperature and its effects are felt throughout the year. This is due to the loss of a large amount of the tree canopy, plant cover, and thick topsoil/duff, and is replaced with a substantial amount of impervious surfaces.

By comparison with conventional surface water management methods, the LID techniques reduce the amount of runoff generated by impervious surfaces and cleared/grassed areas because they direct the stormwater into the soil and plant zones, allowing for evapotranspiration, filtration, biodegradation of pollutants, infiltration (even if limited in amount), and they allow for some shallow interflow to occur. All of this reduces the amount of total runoff, lowers the temperature of the stormwater, and treats the stormwater near its source. The net result is an overall decrease in the amount of pollution entering lakes, streams, wetlands, and groundwater.

2.3 LID Techniques

There are a wide array of LID techniques that are available. Some of which are a variation on a common approach, but tailored to a specific site constraint. All LID techniques require that a certain amount of land be reserved and/or managed for their sustained use and function.

An identification of the techniques available, along with a brief description, are provided in Table 2.3a. The LID categories provided in the table are based upon function and general use. Photographs and/or drawings of LID techniques are provided in Section 7.

Table 2.3a: LID Techniques

LID Category	LID Technique	Description
Filtration with Amended Soils	Rain Gardens with High Infiltration Soils	A small landscaped depression with two types of engineered soil zones beneath the landscaping that consists of drain rock beneath an amended soil. Stormwater is collected in the small depression where it is filtered as it passes through the amended soil zone then through the drain rock, and then it infiltrates into the native soil.
	Rain Gardens with Low to Moderate Infiltration Soils	A small landscaped depression with two types of engineered soil zones beneath the landscaping, that consists of drain rock beneath an amended soil. Stormwater is collected in the small depression where it is filtered as it passes through the amended soil zone then stored in the drain rock. A portion of the runoff discharges into the native soils and the remainder is collected in an underground perforated pipe.
	Biochannels (specialized rain garden)	An open ditch that is lined with an 18" thick amended soil and topsoil to capture and treat pollutants. The biochannel is typically landscaped and has dimensions in the range of 2 ft. to 4 ft. depth with gentle 3:1 side slopes. A gravel zone can be added beneath the amended soil to provide for localized detention/retention.
	Ecology Embankment	A 12 inch thick soil media with a mixture of dolomite, perlite, gypsum, and pea gravel. The dolomite and gypsum additives serve to buffer acidic pH conditions and exchange light metals for heavy metals. Perlite is incorporated to improve moisture retention, which is critical for the formation of biomass epilithic biofilm to assist in the removal of solids, metals, and nutrients. It is constructed along the shoulder of a roadway and designed to take runoff by sheet flow.
Land Cover Management	Native Growth Protection Areas	This includes: • Forest Preservation • Thick Organic Topsoil Preservation Maintain in perpetuity an area in its natural condition through an easement or similar document.
	Dense Vegetation Zones	Create an area that has a composted soil layer (e.g., 8" to 12" thick soil mixed with organics), dense plantings, and has good tree cover. Keep the area free from mowing and avoid the application of fertilizers.
	"65-10" Rule	Preserve at least 65% of a forest within a basin, and create no more than 10% impervious area within the same basin.
	Tree Canopy Zones	Provide for a designated area where a complete cover of a tree canopy is provided.

Table 2.3a: LID Techniques (cont.)

LID Category	LID Technique	Description
Dispersion of Runoff	Sheet Flow Dispersion	Runoff is not concentrated but rather it sheet flows into a naturally vegetated area. Pollutant removal typically occurs through a combined process of filtration through organic topsoil and plant uptake, and shallow surface infiltration.
	Impervious Area Disconnect; or "Hydraulic Disconnect"	Impervious areas do not connect directly to each other, (such as a house to a street). This allows for surface runoff from a roof to pass through a landscaped zone, or preferably a natural zone, before discharging onto a street or ditch system. This slows down and reduces the peak flows discharging from a site.
	Infiltration-Dispersion Trenches	Roof drains connect to: a dispersion trench, a splash blocks onto grass, or an infiltration trench.
Reduce Effective Impervious Areas	Narrow Streets and Shared Driveways	Reduced impervious surfaces equals a reduction in peak flows and total runoff.
	Cul-de-Sacs with Planters	The center of the cul-de-sac can be altered to include a planter area or rain garden without impeding the turn-around ability of emergency vehicles.
	Porous Pavement Options	Porous Asphalt Porous Concrete Street Pavers Perco-Crete®
	Porous Sidewalks Options	Porous Concrete Sidewalks Soft Surface Sidewalks Brick Pavers Perco-Crete®
	Vegetated Roofs on Commercial Buildings	Vegetated roofs have become a proven and practical method and in recent years have gained much interest, especially in highly urbanized areas.
Other	Minimal Excavation Foundations	The most common is the use of pin foundations. This is instead of excavating and removing the topsoil and upper soil strata. It preserves most of the hydrologic features of the native soils.
	Re-Use	Rainwater collected for reuse. This can include rain barrels that collect rain water from roofs, and rainwater collected in ponds and then during dry periods it is pumped for irrigation purposes.
	Shallow-Depth Storage	Direct stormwater into shallow-depth ground storage, with dead storage zones.

The "65-10" rule is based upon a study done by the University of Washington where the health of a stream was observed to degrade as the watershed associated with the stream was altered by clearing and development.[5] This study has been widely cited in the Pacific Northwest when considering land-use regulations. The results of the study are somewhat misunderstood because at first glance it implies a threshold of 65% forest needs to be preserved and a maximum of 10% impervious area is to be permitted within a watershed where the health of the stream is to be preserved. The report clearly states that there is no distinct threshold. Rather it states that "the

10% imperviousness is not a threshold; it simply corresponds to levels of degradation that are sufficiently severe to be readily apparent [in the stream]". The study did not take into account the mitigation of developments through the use of drainage ponds and stormwater quality treatment, or using LID techniques. Taken in context of the results of the study, the "65-10" rule can be a means to preserve a stream corridor, but the question is unsettled as to whether or not it is the only method of doing so. The report does stress the importance of either preserving the forest or "developing new approaches to mitigate the consequences of watershed urbanization on streams" [5].

2.4 Environmental Benefits Using LID

The environmental benefits of implementing the various LID techniques are summarized in Tables 2.4a and 2.4b. Virtually all of these options provide a temperature benefit to the stormwater because of: a) the contact time in the soil; b) reduced amount of runoff exposed to impervious surfaces; or c) both. Unfortunately, there is not much data available as to the specific performance on temperature on the micro level, such as for a specific LID technique. Nevertheless, on the macro land-use scale over broad areas, it is known that stream temperatures rise due to the removal of trees and other changes in land use. So the LID techniques that reintroduce features which are very similar to natural conditions do well in providing a level of mitigation on the rise temperature on surface waters that discharge to streams.

Table 2.4a: Amended Soil LID Techniques Summary of Environmental Benefits

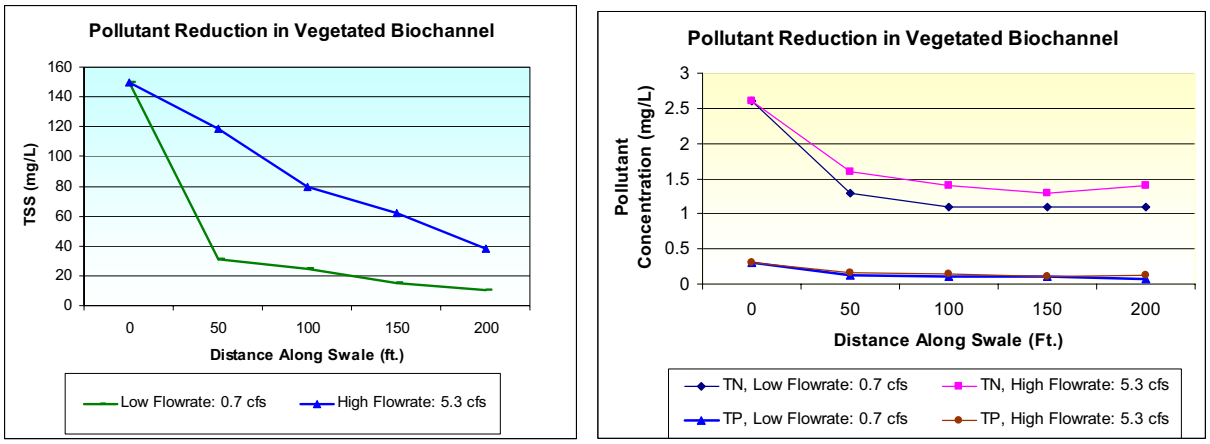
LID Techniques	Benefits
Filtration with Amended Soils BMP's Include: • Rain Gardens • Biochannels • Ecology Embankment [6] Biochannel Along Street	The amended soil zone with organics capture, filter and biodegrade pollutants. It also reduces the temperature of the stormwater by capturing it in the soil, and it allows for a greater amount of stormwater removal via evapotranspiration by putting stormwater in contact with plants through retention in the soil matrix. Typical removals of pollutants are summarized below. [1,4] Constituent — Percent Removal TSS — > 95% copper — > 90% lead — > 95% zinc — > 85% Total Phosphorus — >70% Nitrate — ≈ 10% Ammonia — >20% Reduction in runoff volumes vary depending upon the types and infiltration capacity of the underlying soils. Reduction in runoff has been found to be up to 50%[8] due to plant uptake alone.

Table 2.4b: Other LID Techniques Summary of Environmental Benefits

LID Techniques	Benefits
Land Cover Management Create Native Growth Protection Areas	This option substantially reduces total runoff and corresponding pollutant loadings by simply maintaining a significant portion of the land in its native state with forest cover, underbrush and thick topsoil. The combination of all 3 levels provide for a very high level of environmental protection that exceeds each stand-alone LID technique described below: a) tree canopy; and b) sheet flow dispersion.
Land Cover Management Tree Canopy ('urban forest') 	A tree canopy provides a high level of removal of rain water that would otherwise be converted to runoff. Typical values of rainwater removal are listed below. [2] Winter = 0.9 mm/day Spring = 1.9 mm/day Summer = 1.9 mm/day Tree canopies remove pollution from the air including carbon monoxide, Sulfur dioxide, nitrous dioxide, and others. It is estimated that a tree canopy removes over 100 lb of air pollution per acre per year. [11]
Sheet Flow Dispersion	Sheet flow dispersion can provide a high level of water quality treatment similar to filtration by amended soils provided that it sheet flows over a native-plant area that does not have fertilizers or chemicals applied onto the area.
"Hydraulic Disconnect"	The peak flow rate of runoff can be significantly reduced as compared to directly connected impervious areas (such as roof downspouts connected directly to storm pipes). The percent reduction is variable and not well known, but some studies report the reduction in peak flows can be up to 50%. [7] A reduction in pollutants would be realized simply due to the reduced runoff, but actual pollutant reductions are not known.
Shallow-Depth Storage	The removal of pollutants is similar to filtration with amended soils but with a higher removal rate of nitrate and ammonia.[3] Nitrogen/Nitrate/Nitrite Removal - 60% to 70%
Porous Pavement Surfaces 	Reduces runoff in proportion to how well the underlying soil infiltrates. It also provides water quality treatment through capture of pollutants in the soil matrix. For pollutants from porous pavers in a parking lot, the percent removals are summarized below.[9] Constituent — Percent Removal Copper — >85% Zinc — >50% Motor Oil — >95%
Vegetated Roofs	Nearly all runoff is intercepted in the summer months, and the runoff is substantially reduced in the wet-winter months.[10]

Biochannels perform well in capturing and breaking down pollutants even in low infiltration soils, with widely varying flow rates. If the biochannels are constructed without an amended soil zone at its base, then the treatment occurs as stormwater flows along the length of the channel. This is very similar to a biofiltration swale, with the exception being that there is a higher amount of vegetation in the channel. For this condition, much of the pollutant reduction occurs in the first 50 feet of the channel as shown in the charts in Figure 2.2.

Figure 2.2: Vegetated Biochannel Performance[12]



Flowrate (cfs) = cubic ft./sec. TN = Total Nitrogen; TP = Total Phosphorus

3.0 POTENTIAL LID TECHNIQUES FOR VARIOUS LAND-USE DENSITIES

3.1 General Description

The benefits of using LID can divided into three main categories: 1) stormwater quality treatment; 2) a reduction in runoff, either a reduction in peak flow or a reduction in total volume; and 3) a reduction in the water temperature that enters into receiving waters. Conversely, as a land area has increased urban density, generally this creates more impervious areas, an increase in water-born pollutants and runoff, less tree and plant cover, higher water temperatures, and generally a reduction in the benefits and performance of the LID techniques.

A relative comparison in the performance of the LID techniques is provided in the following tables. Table 3.1a provides a comparison for sites located over till soils (e.g., relatively low infiltration capacity). Table 3.1b provides a comparison for sites located over outwash soils (e.g., relatively high infiltration capacity). The tables identify performance characteristics for both water quality and flow runoff reduction. It is a qualitative assessment, in that specific performance comparisons can only be made on a site-by-site basis given all the variables associated with LID facilities, such as LID facility size, land-use, pollutants generated due to the land-use type, variability of the underlying soils, and other parameters. However, the qualitative assessment is in most cases based upon actual performance studies conducted. These studies do provide a generalized sense of how well the LID facility will perform across various land-uses and differing ground conditions.

As urban densities increase some LID techniques become less effective because less land can be devoted to their use, and this is coupled with a corresponding increase in pollutant loadings, an increase in runoff, and increase in water temperature from receiving waters. As urban densities

increase it becomes impractical to utilize certain LID techniques. For example, for ¼ acre size residential lots (R-4 zoning), developed on a few acres of land in a typical pattern, the density of single-family homes would be too great to be able to preserve a forest area in most cases (e.g., Native Growth Protection Area). More specifically, the LID benefits in the R-3 and R-4 land-use zoning scenarios are significantly restricted over till soils because the amount of impervious area is greatly increased, and conversely the amount of land available to provide LID facilities has now significantly diminished. This results in a substantial decrease in the benefits of using what LID techniques that can be used on the denser land area. As a result, in the tables a constructability rating (CR) is shown which reveals the level-of-use where a LID facility can be utilized. Since a major goal of using LID techniques is to have a widely distributed and integrated stormwater management system — in order to more closely emulate natural conditions — the constructability rating should be used as a means to compare the effectiveness of the LID techniques over the various urban densities. In the table, the lower the constructability rating (CR), the less widespread the LID facility can be utilized, hence the less effective it can be.

Sites that have outwash soils in natural-undeveloped conditions infiltrate nearly all of the rain water that falls on the site, resulting in virtually no runoff generated. When a site is developed, this should be emulated by providing several infiltration facilities that are widely distributed throughout the property. This can be done by using rain gardens with infiltration, infiltration trenches, porous pavement, and biochannels with infiltration which will have gravel beneath the amended soil.

Most sites with outwash soils have groundwater tables that are at least 5 feet deep below the surface so that LID techniques which use infiltration function well with this type of subsurface condition. With shallower groundwater depths, infiltration still occurs, but to a lesser degree.

The performance and limitations of LID techniques are described in more detail in the following sections of this report.

Table 3.1a: Relative Performance Comparison of LID Techniques Over Till Soils

LID Techniques	Residential Zoning Districts			
	R-1 (1 acre lots)	R-2 (1/2 acre lots)	R-3 (1/3 acre lots)	R-4 (1/4 acre lots)
	LID Overall Effectiveness: High	LID Overall Effectiveness: Moderately High	LID Overall Effectiveness: Medium	LID Overall Effectiveness: Low
Rain Gardens	CR = 3	CR = 3	CR = 3	CR = 2
Biochannels	CR = 3	CR = 3	CR = 3	CR = 2
Ecology Embankment	CR = 3	CR = 3	CR = 3	CR = 3
Forest Preservation Areas (NGPA)	CR = 3	CR = 2	CR = 1	CR = 0
Dense Vegetation & Thick Topsoil Areas	CR = 3	CR = 2	CR = 1	CR = 0
Tree Canopy Areas	CR = 3	CR = 3	CR = 3	CR = 2
Sheet Flow Dispersion	CR = 3	CR = 2	CR = 1	CR = 0
Hydraulic Disconnect	CR = 3	CR = 3	CR = 2	CR = 1
Porous Pavements	CR = 3	CR = 3	CR = 3	CR = 3

Low Med High Low Med High Low Med High Low Med High

Relative Benefit for Stormwater Quality Treatment: longer bar denotes relatively greater benefit. See further explanation in report.
Relative Benefit for Flow Runoff Reduction: longer bar denotes relatively greater benefit. See further explanation in report.
Constructability Rating (CR): 3 = very feasible in most locations; 2 = feasible in some locations;
1 = feasible in only a few limited locations; 0 = not feasible within the probable site constraints

Table 3.1b: Relative Performance Comparison of LID Techniques Over Outwash Soils

LID Techniques	Residential Zoning Districts			
	R-1 (1 acre lots)	R-2 (1/2 acre lots)	R-3 (1/3 acre lots)	R-4 (1/4 acre lots)
	LID Overall Effectiveness: High	LID Overall Effectiveness: Moderately High	LID Overall Effectiveness: Medium	LID Overall Effectiveness: Low
Rain Gardens	CR = 3	CR = 3	CR = 3	CR = 2
Biochannels	CR = 3	CR = 3	CR = 3	CR = 2
Ecology Embankment	CR = 3	CR = 3	CR = 3	CR = 3
Forest Preservation Areas (NGPA)	CR = 3	CR = 2	CR = 1	CR = 0
Dense Vegetation & Thick Topsoil Areas	CR = 3	CR = 2	CR = 1	CR = 0
Tree Canopy Areas	CR = 3	CR = 3	CR = 3	CR = 2
Sheet Flow Dispersion	CR = 3	CR = 2	CR = 1	CR = 0
Hydraulic Disconnect	CR = 3	CR = 3	CR = 2	CR = 1
Porous Pavements	CR = 3	CR = 3	CR = 3	CR = 3

Low Med High Low Med High Low Med High Low Med High

Relative Benefit for Stormwater Quality Treatment: longer bar denotes relatively greater benefit. See further explanation in report.
Relative Benefit for Flow Runoff Reduction: longer bar denotes relatively greater benefit. See further explanation in report.
Constructability Rating (CR): 3 = very feasible in most locations; 2 = feasible in some locations;
1 = feasible in only a few limited locations; 0 = not feasible within the probable site constraints

3.2 Filtration with Amended Soils

This category of LID techniques includes: rain gardens, biochannels, and ecology embankment. The essential components of all of these techniques includes a soil filtration zone (normally 18" thick) and a water storage zone (either above ground, within a gravel media, or both). The rain garden includes an additional component of organically rich topsoil and plant zone at the surface, which provides another level of pollutant uptake, its capture and decomposition by the plants and organics.

The soil filtration zone is to have a relatively high amount of organics which is typically quantified by measuring its cation exchange capacity (CEC). Any element with a positive charge is called a cation. The amount of these positively charged cations a soil can hold is described as the CEC and is expressed in milliequivalents per 100 grams (meq/100g) of soil. The cation exchange capacity (CEC) is a value given on a soil analysis report to indicate its capacity to hold cation nutrients. The CEC of a soil is important because it indicates the nutrient and water holding capacity. The disadvantages of a low CEC include the limited availability of mineral nutrients to the plant and the soil's inefficient ability to hold applied nutrients. Plants can exhaust a fair amount of energy (that might otherwise have been used for growth, flowering, seed production or root development) scrounging the soil for mineral nutrients. Soluble mineral salts (e.g., Potassium sulfate) applied in large doses to soil with a low CEC cannot be held efficiently because the CEC is too small. The larger this number, the more cations the soil can hold. The standard for the soil should have a minimum CEC of 5 meq/100 grams. This is the standard set forth in the Washington Dept. of Ecology "Stormwater Management Manual for Western Washington", 2005. The soil can be readily sampled in the field and then economically tested in the lab to verify compliance. Organically rich topsoil oftentimes meets this standard, which is why it is frequently advantageous to stockpile topsoil on site (which has been removed for roads and buildings) during construction, and then to reuse it in the topsoil in areas where it is advantageous. In this case of course, the native soil would not need to be amended.

Rain gardens and biochannels work well when they are widely distributed throughout a development site where they individually capture, treat and dispose of stormwater from relatively small contributing areas. Stormwater is disposed of through infiltration, soil evaporation, and plant uptake via the evapotranspiration process. It is estimated that rain gardens and biochannels capture and dispose of up to 50% of the runoff they receive via plant uptake alone.[8] This amount varies depending upon the size of the LID facility, season, types of plants, and amount of runoff which flows into it. The major components of a rain garden

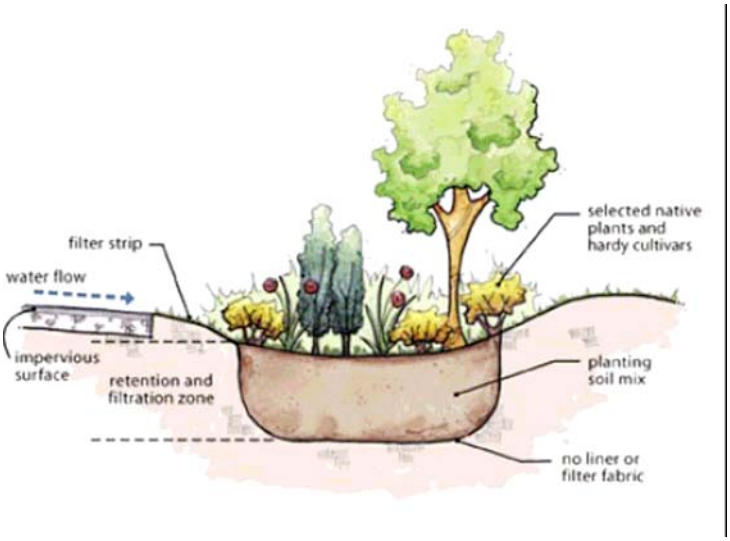


Figure 3.1: Rain Garden

include storage, plant treatment/filtration zone, and gravel zone. A typical rain garden detail is shown in Figure 3.1, excluding the gravel zone that is typically beneath the filtration zone.

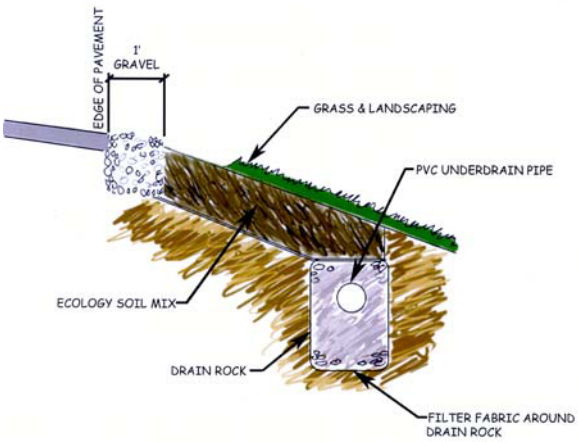


Figure 3.2: Ecology Embankment

Ecology embankment is intended to capture stormwater from sheet generated from roadways, and hence this technique is not used when curb and gutters are needed along a roadway.

Over highly infiltratable soils (e.g., outwash areas), all three types of these LID techniques work well in disposing of virtually all of the runoff into the ground, with conveyance sometimes added only to function as an overflow in the event of extreme storm events (e.g., normally greater than peak flow generated by a 50-yr storm event). In this case, the natural flow patterns of a site can most closely be achieved.

Rain gardens and biochannels necessitate that a certain amount of land be reserved for their construction and use. Rain gardens are typically located in common areas, front yards of single-family homes (widely done in Spokane County), and commercial landscape areas. Rain gardens can be readily be incorporated into the landscaping of a site. While the rain gardens function best with a variety of native-type plants, they also function with short-cut lawn grasses. If lawn grasses are used, then the surface water depth is set quite shallow, generally no more than a one foot depth. Rain gardens without underdrains and within lawn areas are widely used in Spokane County where the soil is well draining, and they are referred to locally as Grassed Percolation Areas. Rain gardens within the front yards of single-family residential homes or commercial landscape zones are normally preserved through the creation of a drainage easement encumbered on the property.

For low-to-moderate infiltratable soils, these facilities still re-introduce a significant amount of stormwater back into the ground and create an opportunity for plant uptake, instead of it all becoming surface water runoff. A decrease in the total volume of runoff can be upwards of 50% due to plant uptake, and slow infiltration occurs which provides a decrease in the runoff volume in the range of a 15% - 30% reduction in runoff realized, depending upon the infiltration rate of the underlying soil, the storage volume designed into the facility, and the loading into the facility. The additional realized benefit is on water temperatures because more water is collected and conveyed via groundwater. There is the need to design the rain gardens of a size that is not too large, and taking into account these factors in the hydrologic analysis. This needs to be done on a site-by-site basis, with a good knowledge of the subsurface soil conditions and their infiltration capacities.

3.3 Land Cover and Land Management

This category of LID techniques include the use of: forest or natural preservation areas, man-made dense vegetation & thick topsoil areas, and tree canopy areas (e.g., urban forest). In the Pacific Northwest, nearly all areas have a natural condition consisting of either forests or wetlands. Forest preservation consists of preserving not only the trees but also the healthy underbrush and thick, organically rich topsoil. All of these layers in a forest work together to provide a well-functioning means of capturing rain water and releasing only a small portion into streams at slower rates and extended periods to sustain stream channel flows and keep water temperatures low and at acceptable levels for fish habitat.

These land management areas need to be protected from disturbance during construction, and preserved through the use of Native Growth Protection Areas, also referred to as a Native Growth Protection Easement (NGPE), via an easement or by creating a separate tract within a development. The area should be further protected with signs and/or short fences around its perimeter to let adjacent property owners know of its use and importance. The use of NGPE's can be utilized in areas where there are large lots, typically 1 acre or larger. But they can also be used to a limited extent and benefit for lots down to ½ acre in size.

The use of man-made dense vegetation and thick topsoil areas can be used in areas where restoration of land to its natural state can be achieved. Trees and plants can restore a site to its natural condition within 10 to 15 years after planting, allowing time for the trees to mature. The creation of a thick topsoil (8" to 12" minimum), is a relatively newer means of land management, and is considered costly to do. Depending upon existing site conditions, it normally consists of mixing an organically rich topsoil into the native soil by roto-tilling methods.

The greater the amount of land that is preserved in its natural state; the better it will perform. There is no clear break-point for how much land preservation is needed. But, taking this approach to its near-best performance, implementing the "65-10" rule within a watershed will preserve the health of a stream in the absence of doing any other stormwater measures. On a more practical level, following the "65-10" rule for even a single property will provide significant benefits for the water quality and quantity generated from that particular parcel.

The practical uses and limitations of these land-use LID options depend largely upon the goals and desires of a community. In many instances, forest preservation areas and man-made vegetation zones can be readily provided on 1 acre or larger lots and between houses while keeping the yards relatively small. These create native-plant buffer zones that also allow for sheet flow dispersion of runoff from houses and driveways, which in turn increase the effectiveness of their use for stormwater management.

Creating or preserving tree canopies, street tree corridors, or "urban forests" is a simple means of reducing runoff. It creates a cooler environment, it reduces air and noise pollution, and it can be readily integrated into a development. Tree canopies can easily be incorporated along streets, within landscaped areas, and even within sidewalk corridors.

3.4 Dispersion

Dispersion methods typically include: sheet flow dispersion, splash blocks from roof downspouts, and hydraulic disconnect.

Sheet flow dispersion functions in a manner where stormwater is intentionally not allowed to become concentrated flow (such as not collecting it in a gutter or ditch along the roadway), rather stormwater sheet flows off an impervious surface and into a NGPA. The Washington State Department of Transportation (WSDOT) has created design procedures that specify the amount of land-area that needs to be preserved for sheet flow dispersion, based upon the width of the roadway and soil type. This is shown in Figure 3.3 and is identified in the WSDOT Highway Runoff Manual as BMP FC.01. Soil Types shown in the figure refer to the NRSC Hydrologic Soil Groups. Soil types A & B are generally outwash soils. Soil types C & D are generally till soils. Dispersion is another means of reintroducing stormwater into the ground, which in turn lowers water temperatures in the downstream systems.

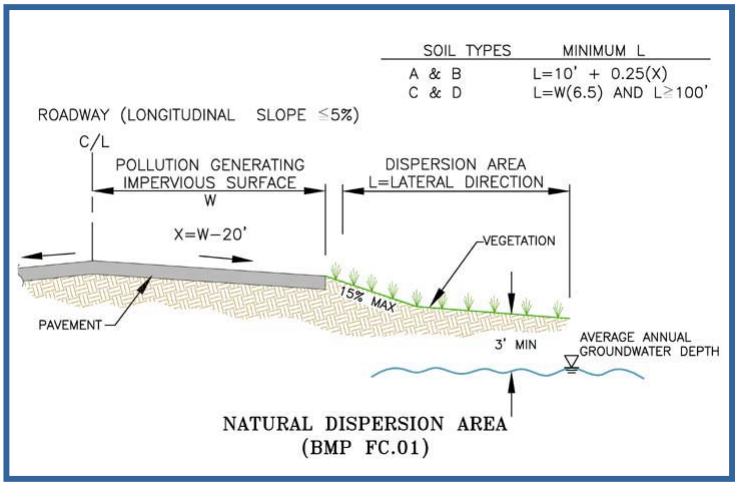


Figure 3.3: Sheet Flow Dispersion

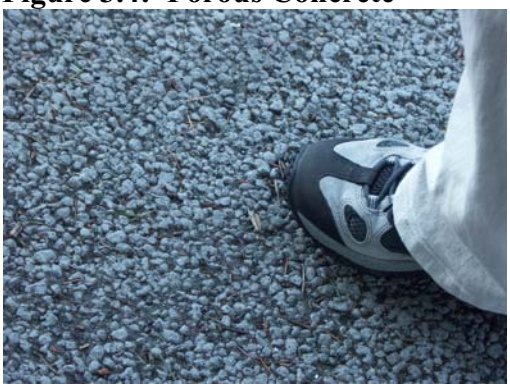
For runoff from roofs, splash blocks are placed at the base of the downspouts and rain water is allowed to dissipate into a lawn or other type of landscape feature.

Hydraulic disconnect is a generalized version of the use of splash blocks. Hydraulic disconnect has been shown to significantly reduce the peak flow rates generated from an urbanized area, and it can somewhat reduce the volume of runoff generated from a storm event. Hydraulic disconnect is simply preventing runoff from going from one impervious surface directly onto another impervious surface or directly into a storm conveyance system. By designing a building, impervious parking area or driveway with a specified layout, hydraulic disconnect is provided by causing runoff from impervious surfaces to flow onto a landscaped area.

3.5 Effective Impervious Area Reduction

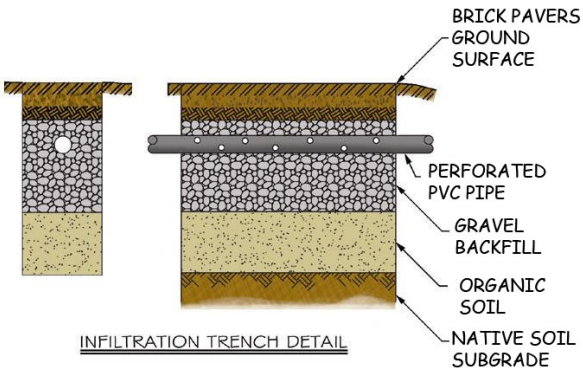
This category of LID techniques includes such measures as providing narrow streets, shared driveways, modified cul-de-sacs, porous road surfaces (e.g., pervious concrete, pervious asphalt, and brick pavers), and porous sidewalk surfaces. Narrow streets are discussed in the StreetScapes section of this report.

Figure 3.4: Porous Concrete



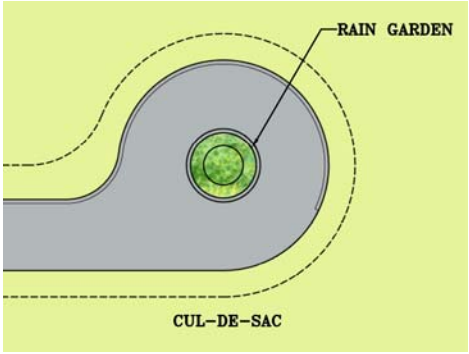
Porous road surfaces are typically more expensive to construct, but this can be offset by construction cost savings in having a reduction size in the drainage detention facilities. Since more runoff is infiltrated into the ground and there is less effective impervious area, the size of the detention facility to serve the project can be smaller.

Figure 3.5: Treatment Soil Zone Beneath Porous Road Surfaces



Stormwater quality treatment for porous road surfaces can be achieved by providing an amended soil zone beneath the structural pavement section (e.g., paver surface and gravel base). It is usually effective to provide for porous road surfaces over well-draining soil (such as outwash). The amended soil zone needs to be a minimum of 18 inches thick, meet the criteria for amended soil as described in Section 3.2 of this report, and be above the high groundwater table. Generally, the amount of organics in the amended soil zone is 6% to 8% of the soil by volume. A typical detail of this treatment zone beneath the porous road surface is shown in Figure 3.5. The necessary thickness of the gravel base beneath the porous road surfacing is dependent upon traffic loads of the roadway, driveway or parking lot.

Figure 3.6: Modified Cul-de-Sac



Modified cul-de-sacs include a center area that has a landscaping in the center of the circle instead of asphalt. This allows for the turning movements of emergency vehicles, yet it can significantly reduce the amount of impervious area created by a cul-de-sac.

One of the more recent methods for generating porous surfaces for pathways is the use of porous concrete and EssentialSoils, which is an engineered, organic-based topsoil that does not erode, allows for storage of stormwater and allows for plant growth.

Another means of reducing the effective impervious area is by providing for vegetated roofs (e.g. "EcoRoofs"). This has become more widely accepted on commercial buildings in North America. For residential houses, vegetated roofs are generally not used to date in North

America, but they are used in Europe and widely so in Norway on both old and new construction. Their benefits include:

- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.
- A green roof with a 12 cm (4.7 inches) substrate layer can reduce sound by 40 decibels; a 20 cm (7.9 inches) substrate layer can reduce sound by 46-50 decibels.
- Urban temperature reduction on hot summer days. Studies in Chicago have shown that urban temperatures have decreased substantially in areas where vegetated roofs are used as compared with conventional tar roof surfaces.

Figure 3.7: Vegetated Roof with a Commercial Building Located in Toronto, Canada. Cover Area 903 m^2. Constructed 1998

3.6 LID Performance Evaluation

The performance of LID techniques vary depending upon site conditions and land use, along with the quantity and type of LID facilities incorporated into a site. However, general performance characteristics can be identified for commonly occurring urban densities, and LID techniques which are most likely to be used.

For this project, Perteet conducted a study to determine the effects and benefits of using LID techniques on a typical residential subdivision that covered 4.5 acres of wooded land over till soils. While the parcel was an actual parcel located within Woodinville, the development scenarios were hypothetical. A performance comparison was made using MGS Flood®, a continuous simulation model to account for back-to-back storm events that commonly occur in the Pacific Northwest, and specifically the Woodinville area. The study evaluated four single-family residential scenarios, specifically it included zoning districts R-1, R-2, and R-4. Approximately ½ acre was preserved for a stormwater pond and the rest of the site was developed into single-family residential lots. For the analysis, there was 3,200 square feet of

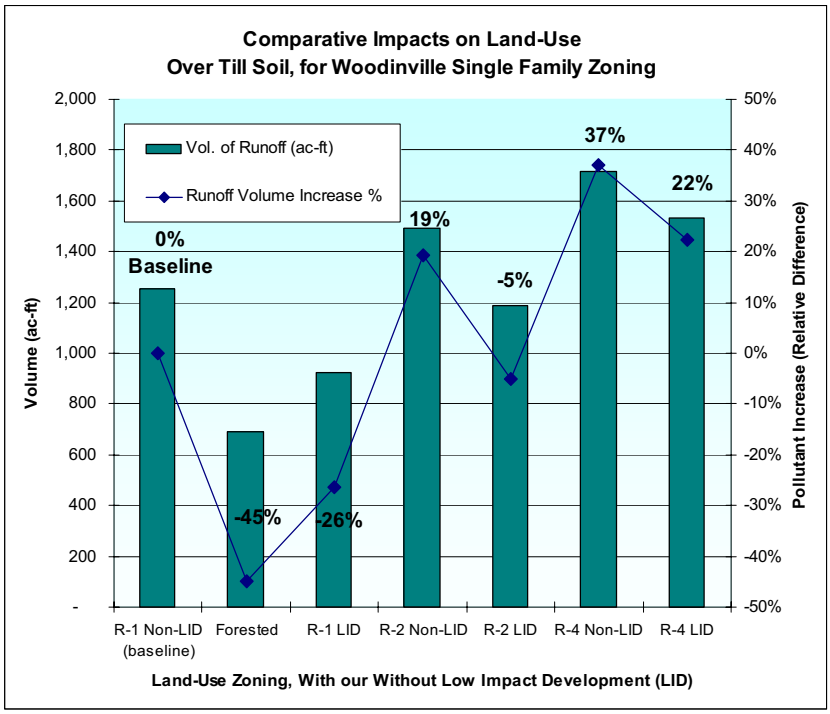
impervious area used, not including the driveways because those would be constructed of pervious concrete. For the comparative study, the LID techniques that were selected are summarized in the Table 3.6a. The schematic exhibits of the lot scenarios used in the analysis are shown in Figures 3.7 through 3.12.

Table 3.6a: Parameters Used for LID Comparative Analysis

Residential Zoning District	Site Layout Parameters & LID Techniques Used
R-1	• 4 Single-Family Residential Lots • Forest Preservation (NGPA) on 65% of the Lot Areas • 15 ft. Wide Biochannels Along the Street Frontage • Driveways With Pervious Concrete • Roof Downspouts with Splash Blocks
R-2	• 8 Single-Family Residential Lots • Forest Preservation (NGPA) on 20% of the Lot Areas • 15 ft. Wide Biochannels Along the Street Frontage • Shared Driveways on 3 of the Lots • Driveways with Pervious Concrete • Roof Downspouts with Splash Blocks • Tree Cover for 10% of the Lot Areas
R-4	• 13 Single-Family Residential Lots • No Forest Preservation • 20 ft. Wide Internal Street & Cul-de-Sac • 15 ft. Wide Biochannels Along the Street Frontage and the Internal Street • Off-Street Parking Provided for the Internal Streets • Shared Driveways for 10 of the Lots • Driveways with Pervious Concrete • Roof Downspouts with Splash Blocks

The results of the analysis are provided in Figure 3.13. The analysis uses as a baseline for comparison the R-1 zoning without the use of LID. On the left side of the chart is total runoff volume generated over several years of performance. The specific volume amounts are not important, because they will change as the number of years change in the analysis. However, the comparative difference in volume between the various scenarios is what is significant. The runoff volume for the forested conditions is also shown in the chart. The comparison demonstrates that when LID techniques are implemented, the benefit in achieving a significant reduction in total runoff volume is significant. For the scenarios used and the LID techniques which are implemented for the R-1 zone, there will be approximately a 26% decrease in total. Similarly, there will be a 5% reduction in total runoff volume for R-2 zoning when LID techniques are implemented, as assumed in the scenario, as compared to the base-line condition.

Figure 3.13: LID Benefits & Comparison of Land Use
Perteet Study of a 4.5 acre residential site



The actual LID techniques chosen, their quantity and the amount of impervious area created, and the soil types, all will have an effect on the performance. The greater the quantity of LID techniques used, the closer the site will emulate natural hydrologic patterns. Therefore, this chart should not be taken as firm values in the performance between various development densities. Rather the overall trends and benefits that are to be realized is demonstrated by this analysis.

This chart shows how a select number of LID techniques can collectively benefit a site, as it pertains to stormwater quantity which discharges from a site. The performance of individual and separate LID techniques can be determined by modeling on a case-by-case basis, given specific site conditions.

For the R-3 zone, it can safely be estimated that the performance of LID versus Non-LID will be interpolated between the R-2 and R-4 zoning conditions shown in the chart.

4.0 MEASURES NEAR SENSITIVE AREAS

4.1 Near Stream Riparian Areas

While there are no specific or special methods that should be used in the vicinity of stream, there are certain LID techniques which integrate well with a riparian preservation zone.

Land cover management techniques integrate well in this situation. This includes forest preservation, creating man-made dense vegetation zones (e.g., restoration when needed), and sheet flow dispersion. The forested preservation (NGPE) areas that are established can oftentimes blend into a riparian zone. This has the added benefit of creating connected wildlife corridors if planned out adequately. Similarly, man-made dense vegetation zones, as described in Section B.3 of this report, function in a similar manner. Sheet flow dispersion generated from lawns, streets and houses can be done next to these land-management areas.

Perteet Inc.
425-252-7700 | 1-800-615-9900
2707 Colby Avenue, Suite 900
Everett, Washington 98201

WOODINVILLE REZONE STUDY
R-1 ZONING

FIG 3.7

Oct 17, 2006 - 4:20pm mickeyb J:\Surface_Water\26051 - Woodinville R-1 Zone Land Use Study\CAD\26051-Exhibits -R-1.dwg Layout Name: Layout1 (2)

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Everett, Washington 98201

WOODINVILLE REZONE STUDY
R-1 ZONING WITH LOW IMPACT DEVELOPMENT

FIG 3.8

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WOODINVILLE REZONE STUDY
R-2 ZONING

FIG 3.9

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WOODINVILLE REZONE STUDY
R-2 ZONING WITH LOW IMPACT DEVELOPMENT

FIG 3.10

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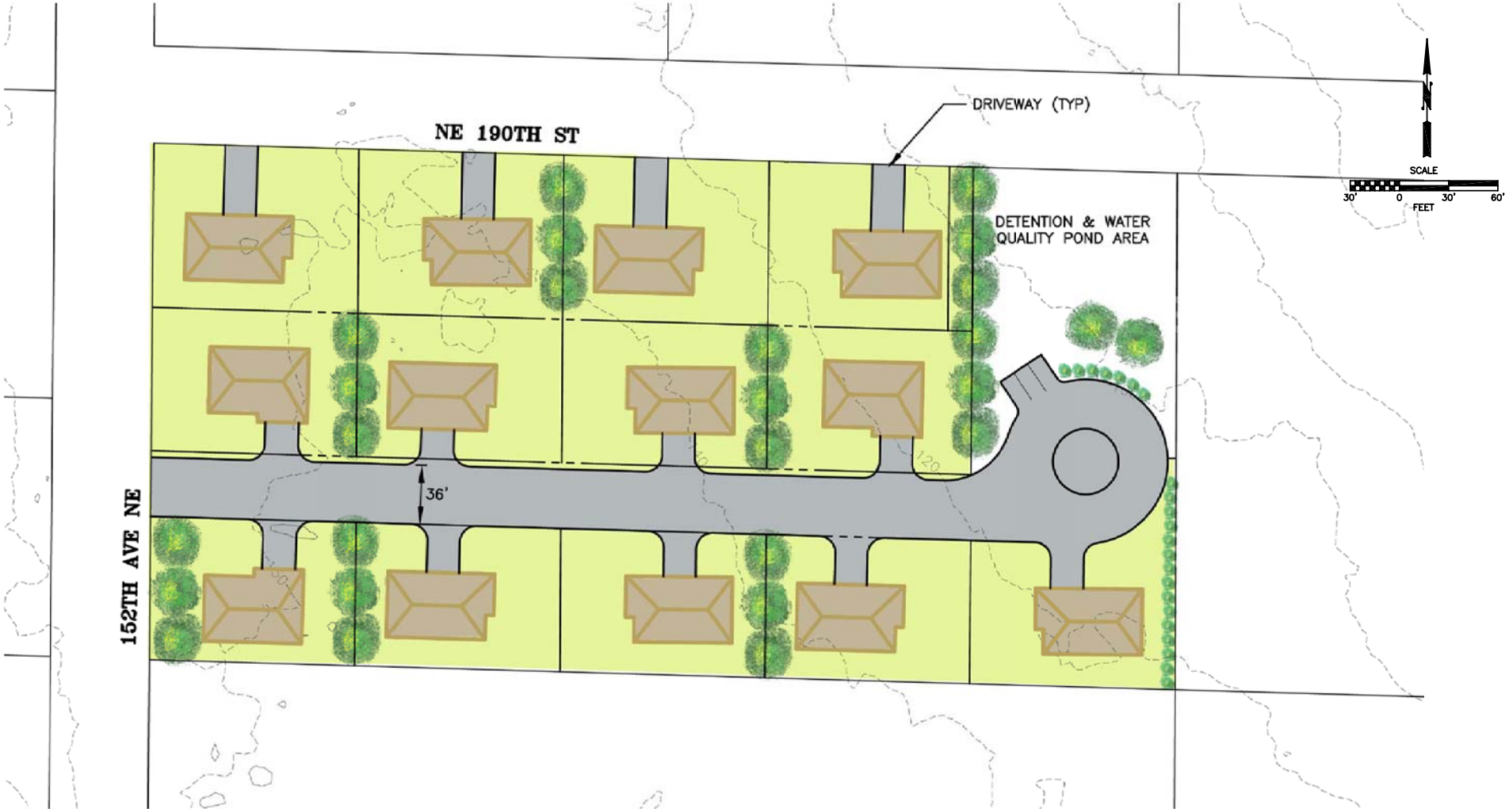

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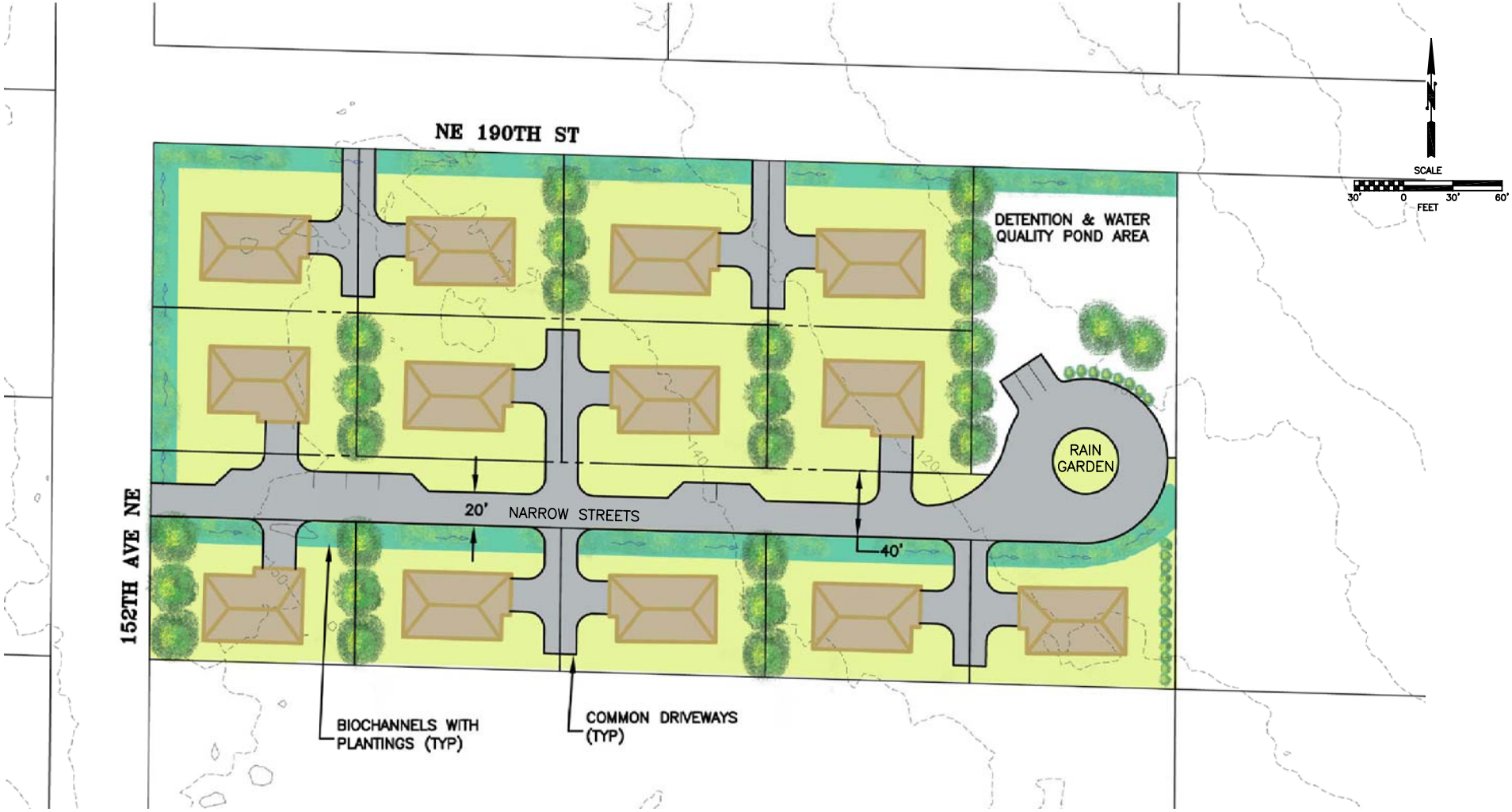
WOODINVILLE REZONE STUDY
R-4 ZONING

FIG 3.11

Oct 18, 2006 - 10:24am mickeyb J:\Surface_Water\26051 - Woodinville R-1 Zone Land Use Study\CAD\26051-Exhibits -R4.dwg Layout Name: Layout1 (2)



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WOODINVILLE REZONE STUDY
R-4 ZONING WITH LOW IMPACT DEVELOPMENT

FIG 3.12

Oct 17, 2006 - 4:17pm mickeyb J:\Surface_Water\26051 - Woodinville R-1 Zone Land Use Study\CAD\26051-Exhibits -R4-LID.dwg Layout Name: Layout1 (2)

4.2 Lake Leota Watershed

Lake Leota has shown a significant amount of sediment deposition, generated from sediment-laden runoff. This is likely caused by two major factors: a) inadequate flow controls from developments in the upper reaches of its watershed which causes higher flowrates than what the stream channels experienced under forested conditions; and b) construction activity within the watershed that have inadequate erosion control measures during wet-periods. It is suspected that several developments within the Lake Leota Watershed do not meet current flow control standards, which is the cause of these increase in flowrates. Therefore, it is recommended that regional detention ponds and regional sedimentation ponds (or combined facilities), be constructed in the upper reaches of the stream channels that contribute flow into the lake.

4.3 Landslide Hazard Areas

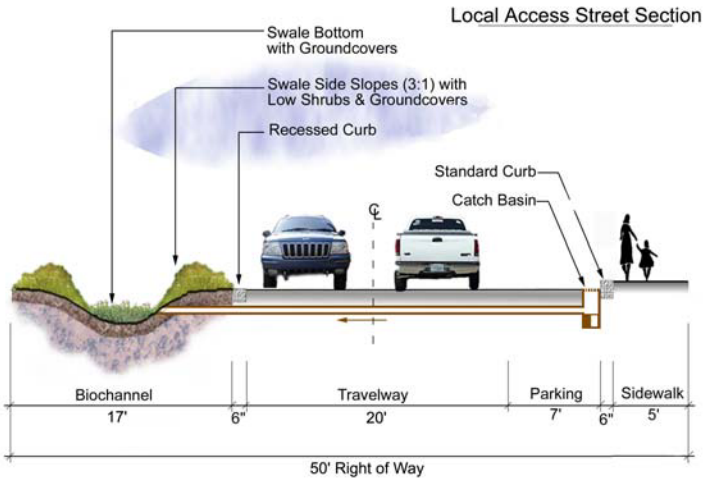
These types of hazard areas are mapped out in the planning process, and are generally based upon aerial topographic mapping of the city. As a result, site specific conditions are normally not known. Consequently, many areas that are mapped as landslide hazard areas are sites that have a potential for being a landslide hazard, but in fact may or may not in actuality be a landslide hazard. A site specific investigation is what is needed to answer if a site actually does pose as a landslide threat. Only through a subsurface investigation that is conducted by a qualified geotechnical engineer or geohydrologist, can this determination be made.

If a site is verified by a qualified professional as actually being a landslide hazard, then special controls on the use of infiltration facilities may be needed. This could include such measures as preventing the use of large infiltration facilities, or limiting the location and/or rate of infiltration or other control measures. This needs to be dealt with on a site-specific, case-by-case basis with input from the geotechnical engineer.

5.0 STREETSCAPES AND LID

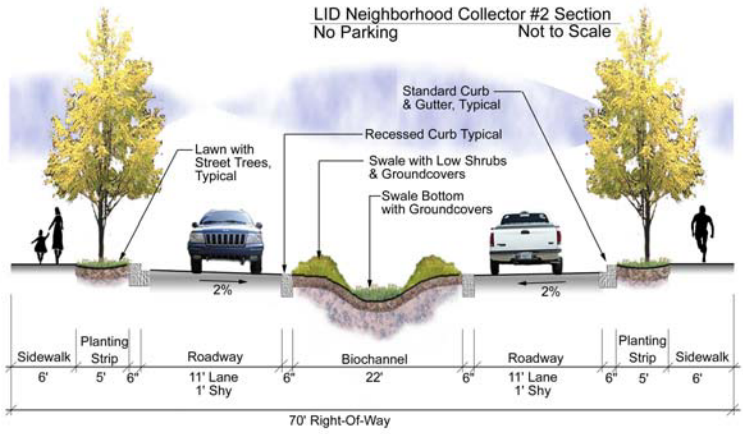
In the 1980's and 1990's it was common to construct wide streets, often in the range of 36 foot wide pavements plus 5 foot wide sidewalks on both sides, for local access streets in residential neighborhoods. Streets contribute a large portion of pollution-generated runoff, and a significant amount of the flows. So the narrowing of roadways will proportionally result in a decrease in pollutants and storm runoff.

Figure 5.1: StreetScapes with LID



Studies have shown that narrow streets in residential neighborhoods can be accommodated by providing off-street parking in porous/paver surfaces, or parking on only one side of the street. Normally emergency vehicle access is the driving concern for roadway width requirements, and access for fire trucks are oftentimes the limiting factor in determining minimum road widths. Based upon a cooperative study in Portland, OR between the fire department and public works, the minimum road width to allow the passage of emergency vehicles is 18 feet. Most communities have settled on a comfortable minimum of 20 feet paved width with off-street parking. When these narrower streets are incorporated into separated sidewalks, or porous concrete sidewalks, the net result can be an overall reduction in effective impervious surfaces from roadways of over 50%. A local access cross-section with this narrower impervious area and parking limited to one side is shown in Figure 5.1.

Figure 5.2: Boulevard StreetScape with LID



It is important to note that with a reduction in impervious area from the roadway there should not be a corresponding reduction in road right-of-way width, which would result in an increased density in the number of houses—which in turn would negate the benefits of using narrower streets. A municipality should keep the street right-of-way widths the same as is used for normal plat development standards, and use the excess space for landscaping and LID features such as rain gardens and biochannels. Figure 5.2 provides a boulevard streetscape that incorporates biochannels as an LID technique. The width of the biochannel will vary depending upon the width of the roadway and the level stormwater reduction desired. The biochannel will function best if stormwater runoff is allowed to sheet flow off of the roadway. This can be done by using recessed concrete curbs that are flush with the pavement surface. This creates a clean edge that is not prone to edge raveling of the asphalt.

Figure 5.3: Ash Avenue Park-n-Ride, Marysville, Wash.
Amended Soils Beneath Brick Pavers

Porous concrete or brick pavers can be utilized in parking areas, typically in instances where a site is located on outwash soils. In this case, stormwater quality treatment can be achieved by providing for a treatment zone beneath the porous pavement.

6.0 LID RECOMMENDATIONS, SUMMARY & CONCLUSIONS

6.1 Summary

With the goal of preserving fish habitat in the watersheds located within Woodinville, the implementation of Low Impact Development (LID) techniques for stormwater management will provide a higher level of protection of the fish-bearing streams, as compared to conventional stormwater management practices.

Mitigation of problems associated with land-development can be accomplished by:

- ✓ Maintaining low base flows in streams by reintroducing stormwater back into the ground through the use of rain gardens, biochannels, and other LID techniques.

- ✓ Keep stormwater temperatures low through land management techniques and LID stormwater management techniques. LID stormwater management will include: a) directing stormwater into filtration and amended soil zones instead of into storm pipe systems; b) designing facilities to infiltration stormwater into the ground as much as possible through the use of widely distributed and integrated rain gardens, biochannels and similar LID facilities—including over till soils; and c) minimizing the creation of effective impervious surfaces by constructing porous pavements, providing hydraulic disconnect, and creating narrow streets. Land management techniques include maximizing the use of native growth protection areas, creating tree canopy zones, and dense-vegetation zones.

- ✓ Prevent an increase in stream flows and flood duration, which can degrade the stream channel by eroding its banks. This is accomplished by: a) providing detention with continuous simulation modeling; b) limiting the discharge to below the erosive threshold of a stream channel; and c) minimizing the volume of storm runoff into a stream channel during storm events by dissipating storm water on-site through the use of LID techniques.

- ✓ Maintain riparian vegetation which provides cooler temperatures for the ecosystem in and around a stream corridor.

- ✓ Capture sediment-laden runoff generated from development that have already occurred. This can be done by constructing regional sediment ponds, and reducing flows in the streams by constructing regional detention ponds. These regional systems will serve areas that have already been subject to significant land development over the last few decades.

These land-use measures will minimize the negative impacts on our lakes and streams to the maximum extent practical and still allow for development to occur within the city limits and growth boundaries. A higher level of protection of the environment will be achieved as compared to conventional stormwater management practices.

6.2 Implementation: Update Drainage Standards & City Code

A specific performance standard for stormwater design needs to be defined and achieved in the implementation of using Low Impact Development techniques. It is recommended that the drainage standards be set to a higher level of stormwater management, as compared to conventional means, by requiring that a minimum number of LID techniques be implemented which achieve a definite performance level. Specifically, standards for using LID drainage methods should supplement the 2005 "Stormwater Management Manual for Western Washington" put forth by the Wash. Dept. of Ecology (WDOE Manual), which address requirements for flow control, temporary erosion control, and water quality treatment.

We recommend that some means of defining LID standards is needed. Otherwise with the pressure to maximize land-densities and increase urbanization, only a limited amount of LID techniques will be implemented, which will negate their benefits, and the goals to protect the environment will not be achieved. The LID standards could be fashioned in one of three ways:

1. **Simplified Method**: specify a minimum set of LID techniques to be implemented on individual lots, by providing a range of alternatives to be used, tailored for various development goals and site constraints. No detailed analysis is needed for this method.
2. **Site Storage-Slow Infiltration Method**: specify on-site retention storage requirements as a function of the amount of impervious area, to allow for plant uptake (e.g. evapotranspiration) and infiltration into the ground, to more closely mimic natural hydrologic conditions.
3. **Hydrologic-Volume Method**: specify the allowable total discharge volume that is generated from a site, using continuous simulation modeling, based upon a multiplier of forested (e.g. "natural") conditions.

These three methods are described in the paragraphs below. These LID standards will provide the added benefits of: a) more closely matching natural storm runoff conditions; b) reducing the total volume of runoff; c) reducing pollutants into lakes and streams; and d) keeping water temperatures cooler that will benefit downstream aquatic habitats. In all of these design

approaches, it is important to use these LID standards as a supplement to flow-control (e.g. detention of surface runoff), stormwater quality treatment, and conveyance standards. The key goals are to: a) create areas for plant uptake of runoff and pollutants; and b) create many small infiltration facilities wherever practical. Any development proposed needs to implement multiple LID techniques in order to achieve the volume criteria. If this criterion is met, then much of the stormwater will be reintroduced as groundwater, greater plant uptake of rain water will occur, temperatures will remain low, sustained flows during dry weather in the watershed streams will be achieved – the end result will be the accomplishment of a healthier environment for the watershed.

The **Simplified Method** would specify a minimum number of LID techniques to be used on individual lots, and for large commercial sites specify multiple LID techniques that are to be widely distributed over the project area. Options could be provided, allowing for developers to mix-and-match sets of LID techniques depending upon development goals and site constraints. For example, individual lots could discharge roof runoff and driveway runoff to rain gardens located in the front yard, or below ground infiltration trenches with amended soils, or sheet flow dispersion, or porous concrete driveways. For this method no detailed hydrologic analysis would be required, but a credit be given to allow for a reduction in the size of the detention pond that serves the residential subdivision or commercial site.

The **Site Storage-Slow Infiltration Method** would define the amount of above ground or below ground storage required, as a function of the impervious area. For instance, the first 1.5 inches of runoff would need to be directed to a rain garden, biochannel, or underground retention storage facility. For example, with a 2,400 square ft. house the runoff would be directed to a rain garden in the yard that would need to have a minimum size of 15 ft. x 15 ft. area. This method would encourage developers to minimize the amount of impervious area, such as providing for narrower driveways, porous concrete, etc. This method greatly reduces the volume of runoff by directing stormwater to landscape areas (for plant uptake) and introducing slow-infiltration into the soil, which more closely emulates natural conditions.

The **Hydrologic Volume Method** is the most rigorous engineering procedure that would be used. A maximum stormwater volume that could discharge from the site would be defined, calculated by using a continuous simulation hydrologic model (e.g. WWHM or MGSFlood). This maximum volume threshold could be a multiplier of the volume of runoff generated from forested conditions, and a developer's engineer would then need to provide enough LID techniques to demonstrate that the site would be below this threshold. This will allow a developer and design engineer to mix-and-match a variety of LID techniques to achieve this goal, yet this also provides flexibility that is appropriate and necessary by making allowances for site specific conditions.

For all of the LID design methods presented herein, the specific written design standards and calculation techniques would need to be developed. This task is beyond the scope of this study, but building upon the data presented in this report, this could readily be done.

For conducting the continuous simulation modeling, it will be important to define the LID credits appropriate for the various LID techniques being proposed. Also, the design methodologies are to be introduced in the drainage design standards to provide the design engineer the guidance on how to plan for and implement the use of the various LID facilities, such as rain gardens, biochannels, and hydraulic disconnect, to name a few. The continuous simulation modeling is done within the EPA computational software called HSPF that make use of multiple variables which represent the hydrologic performance of pervious surfaces. Presently the default values set for these (called PERLND variables) do not account for the use of LID techniques, in either the WSDOT model (MGS Flood), or the WDOE model (WWHM). We recommend that the variables be adjusted to account for the use of these LID techniques in these models, and that these adjustments need to be given in order to adequately account for their beneficial use. Both models allow for the user to make these changes. The recommended PERLND variable changes, to account for specific LID techniques, are provided in Table 6.2a.

Table 6.2a: Recommended HSPF Variables for LID Facilities

PERLND - Variable		Default Values			Till Soils: for LID Facilities	
Variable	Description	Forest	Pasture	Grass	Rain Gardens & Biochannels	Dense Landscaping
LZSN	Lower Zone Storage (inches)	4.5	4.5	4.5	4.5	4.5
INFILT	Infiltration Capacity (inches/hr)	0.08	0.06	0.03	0.08	0.07
LSUR	Overland flow length (ft.)	400	400	400	400	400
SLSUR	Slope of Ground Surface (ft./ft)	0.1	0.1	0.1	0.1	0.1
KVARY	Grounwater Exponent Variable	0.5	0.5	0.5	0.5	0.5
AGWRC	Active GW Recession Constant	0.996	0.996	0.996	0.996	0.996
INFEXP	Infiltration Exponent	2	2	2	2	2
INFILD	Ration of max/mean infiltration	2	2	2	2	2
BASETP	Base flow ET (fraction)	0	0	0	0	0
AGWETP	Active GW ET (fraction)	0	0	0	0	0
CEPSC	Inerception Storage (inches)	0.2	0.1	0.1	0.25	0.2
UZSN	Upper Zone Storage nominal (in)	0.5	0.28	0.25	1	0.5
NSUR	Roughness of Surface (Manning)	0.35	0.25	0.25	0.35	0.35
INTFW	Interflow Index	6	6	6	6	6
IRC	Interflow Recession Constant	0.5	0.5	0.5	0.5	0.5
LZETP	Lower Zone ET (fraction)	0.7	0.25	0.25	0.6	0.6

The criteria for peak flowrates established by the WDOE should also be implemented. This standard is generally considered the state-of-the-practice in the Pacific Northwest, in wet climates (generally west of the Cascades). In summary, these standards specify flow controls for ½ of the 2-year storm and up to the 50-yr storm event for both duration and frequency. These standards are defined and described in the WDOE "Stormwater Management Manual for

Western Washington", 2005. Similarly, the thresholds for when these standards need to apply to a project site should be in compliance with these WDOE regulations.

6.3 Special Drainage Criteria Over Outwash (well-draining) Soils

We recommend design criteria for well-draining soils similar to what is described in Section 6.2, but with the added criteria that runoff from the major storm events be conveyed to an infiltration system such as infiltration pond, infiltration trench, or gravel gallery, and all runoff up to and including the 50-yr storm event be disposed of by infiltration.

6.4 Special Drainage Criteria Over Landslide Hazard Areas

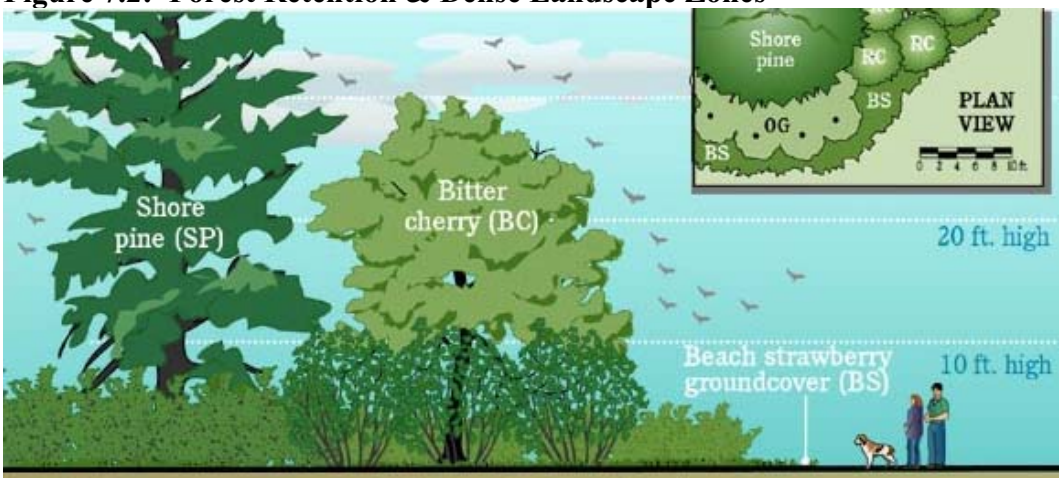
Landslide hazard areas pose a need for a higher level of geotechnical investigation prior developing the site. Since not all land areas identified in land-use maps are not in reality a landslide hazard, a site specific subsurface investigation is needed by a geotechnical engineer to verify whether or not there is a landslide hazard at or in the vicinity of the site. If a landslide hazard is deemed to be a real concern, then infiltration facilities will likely not be recommended, and all rain gardens and biochannels should have an impermeable liner in the bottom of the facility, to prevent infiltration. These facilities will still function well by lessening the effects of runoff through plant uptake and stormwater treatment.

7.0 LID EXAMPLES

Figure 7.1: Rain Gardens

Residential Front Yard	Rain Garden in Commercial Property

Figure 7.2: Forest Retention & Dense Landscape Zones



Dense Lanscape Zone Within a Residential Neighborhood

Figure 7.3: Porous Surfacing

Porous Concrete Sidewalk	Brick Pavers in Parking Lot

Figure 7.4: Infiltration-Gravel Gallery Within a Community Park

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Attachment B Neighborhood Character in the R-1 Zone Report

Neighborhood Character in the R-1 Zone

City of Woodinville

Prepared January 2007
Revised February 2007

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Appendices

Appendices follow the text at the end of the document.

Appendix A Woodinville Drainage Areas

Appendix B Independent Second Assessment of Neighborhood Character

Appendix C Additional Parcel Size Map

List of Acronyms

City	City of Woodinville
GMA	Growth Management Act
NB	Neighborhood Business

Chapter 1. Preface

The purpose of this report is to evaluate neighborhood character as one of the tools for determining residential density in the R-1 zoned area of the City. The end result could contribute to maintaining the R-1 zone or amending the zone by increasing density to a more compact urban development pattern. This report is also a part of a larger study referred to as the Sustainable Development Project, which includes three other reports – environmental, transportation and capital facilities (utilities). The results of the project are intended to provide the basis for recommended revisions, if any, to the Comprehensive Plan and Maps, housing and land use policies, and regulatory requirements.

The Growth Management Act (GMA) of the State of Washington (36.70A.070) discusses, in its housing element, the need for a plan, scheme, or design for housing that ensures the vitality and ***character*** of established residential neighborhoods. The housing element also discusses the need for an inventory and analysis of existing and projected housing needs, among other things and a statement about population densities.

This neighborhood character/housing study searched for commonality in four key elements to distinguish neighborhoods, including physiographic, man-made or physical improvements, socio-economic, and visual elements. In order to use these key elements, neighborhood identification, definition of neighborhood character, application of character principles to geographic areas, and measures to maintain and enhance neighborhood character were necessary.

The following steps were taken to determine "neighborhood character" and subsequently to correlate residential densities (see Figure 1 for the overall Method for determining Neighborhood Character).

Figure 1. Neighborhood Character Method

Step 1: Overlay natural & physical features to determine patterns of commonality

Geographic/Natural Features/Physical Improvements/Socio Economic

2006 Zoning Map: Figure 2
Relative Elevation: Figure 3
Physiography: Figure 4
Parcels of Low Vegetation/Canopy Cover: Figure 5
Transitional Land Form Features: Figure 6
Areas of Common Parcel Size: Figure 7
Building Texture/Rhythm: Figure 8

Step 2: Identify general neighborhood subareas using information gathered in Step 1

Conceptual Subareas: Figure 9

Step 3: Apply character indicators to determine level of consistency throughout conceptual neighborhood subareas

R-1 Area Neighborhood Characteristic Typologies: Figure 10

Physiographic Niche: revisit Figures 3, 4 & 6
Vegetation/Canopy Cover > 75%: Fig. 11
Manicured Landscape
Common Viewshed
Circulation Connectivity: Fig. 12
Parcel Accessibility
Cohesive Block Configuration
Areas of Common Parcel Size: Fig. 13
Sense of Scale and Fabric
Cohesive Street Presence
Building Texture/Rhythm: Fig. 14
Low Infill Potential: Fig. 15 & 16

Step 4: Review current densities in neighborhood subareas

Determine Neighborhood Subareas of Higher Neighborhood Character Order: Figure 17

Review Parcel Size Map as means of determining zoning densities that recognize existing neighborhood character: Figure 18

Zoning Consistency with Neighborhood Character: Figure 19

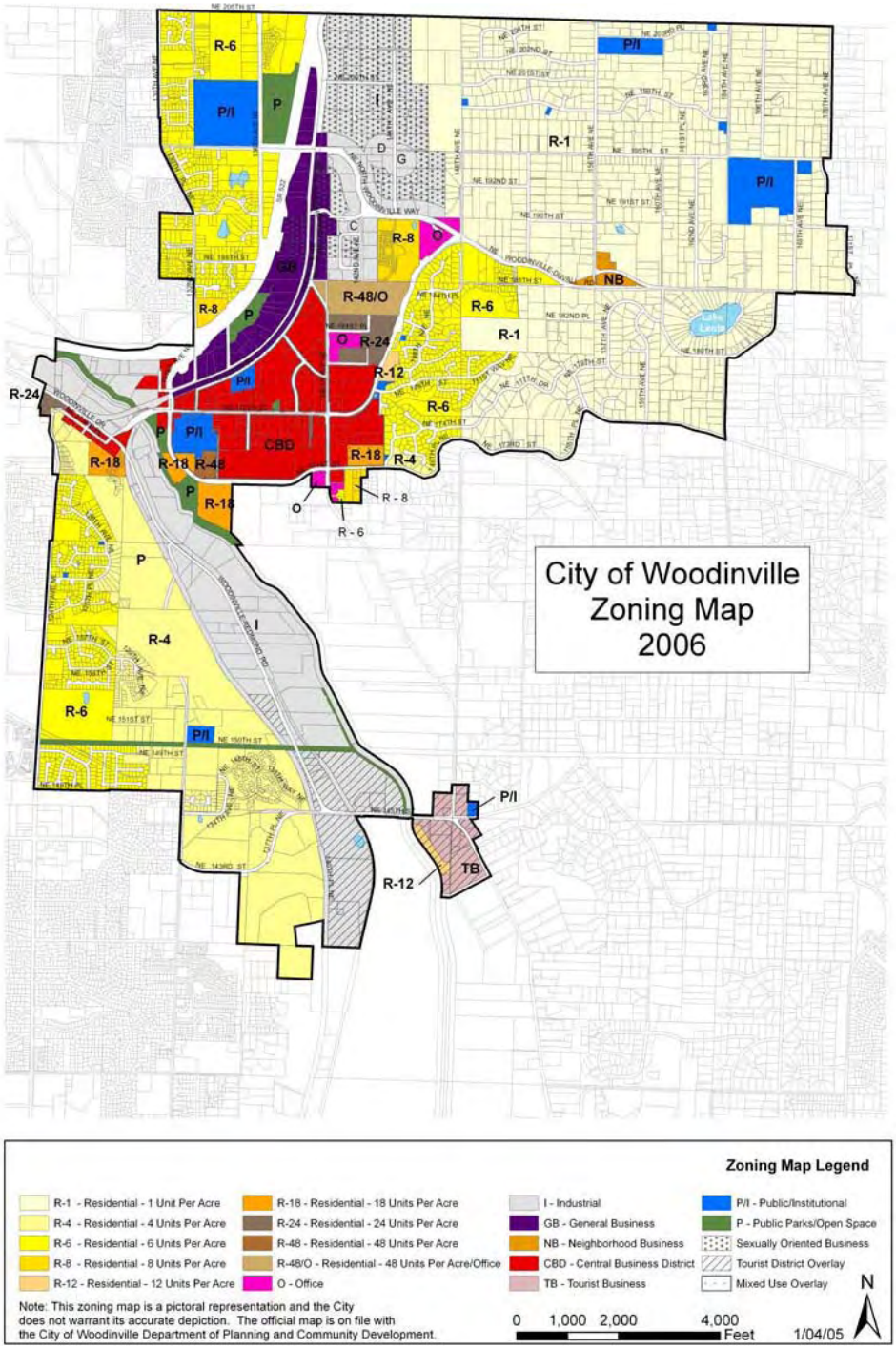
Those with high character – maintain predominant density
Those with least character – less likely to maintain particular density

- Step 1. Overlay geographic features, physical improvements, socio-economic data, and visual maps to determine patterns of commonality.
- Step 2. Using Step 1 data, identify on a broad-scale general neighborhood subareas.
- Step 3. Apply 12 character indicators to each neighborhood subarea identified in Step 2 to determine the level of consistency of those indicators throughout the neighborhood subareas. The greater the number of indicators having more consistency in the neighborhood subareas, the greater the neighborhood character in that subarea.
- Step 4. After determining the higher and lower ranking of character for each neighborhood subarea, the current and predominant densities in the higher order neighborhoods were recognized as having a high value. Those with lower ranking character could be designated for higher densities – in most cases R-4 densities. This process only evaluates neighborhood character as defined in this section and does not take into consideration the remainder of the other elements in the Sustainable Development Study: environmental, transportation, capital facilities. These have been evaluated in other sections of this document.

1.1. Introduction

The City of Woodinville is one of thirty-nine cities in King County and is adjacent to Snohomish County's boundary. In 2002, the City compared its demographics to King County as a whole and several Eastside and other nearby cities. Compared with Seattle, Mill Creek, Bothell, Kirkland, Redmond, Bellevue, and Issaquah, the city of Woodinville had the largest household size, the most population under age 19, the least growth between 1990 and 2000, and the smallest population. The City, since its inception, has promoted the desire to maintain a "Northwest Woodland Character," identifying that desire in numerous places, including its Comprehensive Plan goals, Land Use LU-1, Community Design Goal CD-2, and Environmental Goal ENV-6. Houses in the R-1 zone are mostly homes built in the 1960's through the 1980's on large lots, but in other R-zoned areas they are newer homes on smaller lots.

The City is approximately 3,500 acres of which ~60% is zoned residential and ~ 30% of that is zoned R-1 or approximately 1,100 acres. The R-1 residential neighborhood is located on the eastern uplands of the City of Woodinville (Figure 2, *2006 Zoning Map*), currently referred to as the R-1 Area, or the Leota and Wellington Neighborhoods. The R-1 area is the largest of the residential zones and one of seven Neighborhoods in the city. There are large areas of R-4, R-6, and R-8, with five residential designations making up the multifamily areas. See Figure 2 for the zoning map.



City of Woodinville Zoning Map 2006 **Figure 2**

Major access to the R-1 zone is via the Woodinville-Duvall Road, which generally bisects the area into a northern district and a southern district. The northern area is, in turn somewhat divided by a minor arterial (156th Avenue NE) into a western portion and an eastern portion. Woodinville-Duvall Road is classified as a major arterial that carries a high volume of pass-through traffic between downtown Woodinville and Duvall and the eastern outlying areas of King County. 156th Avenue NE also carries a moderate amount of pass-through traffic to and from Snohomish County.

In geological terms, the area is also characterized by a scoured marginal feature from a previous ice-contact slope located at the western edge of the area and acts as a major physical boundary between the valley below to the west and the City proper. The whole study area is a till-mantled, upland undulating plain consisting of north-south trending broad ridges and narrow plains eroded by recessional outwash channels. Lake Leota, a major water feature, is a rare and unique ancient kettle in the area.

Most of the land in the study area consists of mid-successional native conifer forests that have been converted from large tracts of land in the last half of the 20th century to large lot tracts (20 or more acres) and then to short-plat-sized lots (1 to 4 acres). This division has resulted in a haphazard ownership pattern, with reduced roadway connectivity, that is common in urban and suburban fringe areas of Puget Sound counties.

1.2. Background

1.2.1. Districts

City builders over many millennia divided their cities into districts. The preservation of the functional attributes of each district was an important factor in the success of the city, be it protection from invaders, economic vitality, spatial insulation, purposeful association, or quality of life reasons such as cultural preservation, aesthetics, social amenity, sovereignty, or health.

The concept of city districts in America has been studied for decades. Perhaps the most fundamental study was performed by Kevin Lynch and was published in his *Image of the City* in 1960 (Lynch, 1960). This book served as a primary text for urban design and city planning students for several decades. As Lynch's title suggests, he found ways to describe the city in terms of its form and function and the structural elements that define that form.

Most cities contain districts with varieties of functions. Some districts are predominantly residential in nature and function. Seattle has Madison Park, Laurelhurst, Mt. Baker, and Seward Park, all of which are characterized by exclusive residential development. San Francisco has Russian Hill, Pacific Heights, the Marina or Telegraph Hill, distinctive residential neighborhoods with notable character.

Other kinds of districts would be university districts, ports, central business districts, or a tourist district, to name a few. Many of these have special regulatory overlays placed on them to insulate and protect the vitality of their functions. Districts intended primarily for residential purposes commonly have minimum or maximum lot size or density requirements for a variety of purposes.

1.2.2. Woodinville Districts

The Comprehensive Plan for the City of Woodinville (City of Woodinville, 2006) defines the R-1 study area as the Leota Neighborhood (or district according to Lynch's definition). The Sustainable Development Project, of which this report is a part, extracts a great deal more detail from the concept of "neighborhood" definition. As Lynch describes in his book, cities have five basic elements.

- **Paths.** Paths are the channels along which an observer moves. They may be streets, walkways, transit lines, or railroads.

- **Edges.** Edges are the linear elements not used or considered as paths by the observer. They are the boundaries between two phases, linear breaks in continuity: cliffs, shores, edges of development zones, or walls. They are lateral references rather than coordinate axes. Such areas may be barriers, more or less penetrable, which close one area off from another; or they may be seams, lines along which two areas are related and joined together. These elements are important organizing features, particularly in the role of holding together generalized areas.

- **Districts.** Districts are the medium-to-large sections of the city, conceived of as having two-dimensional extent, which the observer mentally enters inside of, and which are recognizable as having some common identifiable character. Always identifiable from the inside, they are also used for exterior reference if visible from the outside. Most people structure their city to some extent in this way, with individual differences as to whether paths or districts are the dominant elements.

- **Nodes.** Nodes are points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he or she is traveling. They may be primarily junctions, places of a break in transportation, a crossing or convergence of paths. Or a node may be simply concentrations, which gain their importance from being the condensation of some use or physical character, as a street-corner hangout or an enclosed square. Some of these concentration nodes are the focus and epitome of a district, over which their influence radiates and of which they stand as a symbol. In any event, some nodal points are to be found in almost every image, and in certain cases they may be the dominant feature.

- **Landmarks.** Landmarks are another type of point reference, but in this case the observer does not enter within them, they are external. They are usually a rather simply defined physical object: building, sign, store, or mountain. Their use involves the singling out of one element from a host of possibilities.

The Leota District is defined by paths-edges (natural environment factors) and political boundaries. Thus, Snohomish County on the north, and King County on the eastern and southern edge provide political boundaries, and ice-scoured steep slopes on the western and southern edges of the study area become perceived strong edges to the district. Paths, even though they may be viewed as unifiers, may also be perceived as boundaries such as 156th Avenue NE, Woodinville-Duvall Road and the loop road around Lake Leota. The following section describes how neighborhood subareas were determined, according to the aforementioned step-wise process.

Chapter 2. Neighborhood Character

2.1. Steps 1 and 2: Determining Neighborhood Subareas

Neighborhoods are places where the composition of elements constitutes an identity that is generally based on commonality. The identity is usually a pattern or perceived pattern that manifests itself in a visual framework. Elements of this framework include the natural environment on which the neighborhood rests and the products of human development. In some ways, the pattern is seen in two dimensions, as though it were a map; in other ways, it has a sculptural or three-dimensional form. The following is a detailed description of the process for determining neighborhood subareas and is the first and second steps in the process of evaluating neighborhood character.

2.1.1. Step 1. Overlay Natural and Physical Features to Determine Patterns of Commonality.

The first step in the neighborhood character analysis (see Figure 1) is to overlay natural and physical features to determine patterns of commonality. For purposes of defining patterns that reveal neighborhood boundaries, a system of inventory and evaluation of data sets was introduced for extracting local information. Natural environment maps, maps of physical development, maps showing social and economic phenomena, and interpretive maps describing elements of the visual environment were developed and then evaluated.

The following information was relevant and useful in defining neighborhood subareas in the R-1 zone.

Geographic areas

- relative elevation (Figure 3)
- physiography (common land forms) (Figure 4)
- Parcels with low vegetation/canopy cover (lack of unified woodland character) (Figure 5)
- transitional landform features (ridge and plain separator slopes) (Figure 6)
- drainage basins (see Appendix A)

Human-made phenomena or physical improvements

- parcel size commonality
- age of housing
- building footprints

Socio-economic data (revealed no characteristics useful in contributing to neighborhood delineation)

- land improvement value
- total parcel value

Data and map interpretation field reconnaissance and visual recording, resulted in the production of the following interpretive maps:

- areas of common parcel size (Figure 7)
- building texture/rhythm (Figure 8)
- buildable lands (land available for development or redevelopment)

A series of map overlays and visual surveys were used in this report to describe neighborhoods. Mapped phenomena described patterns and define districts/neighborhoods as outlined by Lynch's five elements of a city. Neighborhood description methods utilized for this report also borrow in part from studies that precede it. Such studies include *Cities*, by Laurence Halprin, and *The Urban Design Plan for the City of Seattle*, published by the Seattle City Planning Department, among others.

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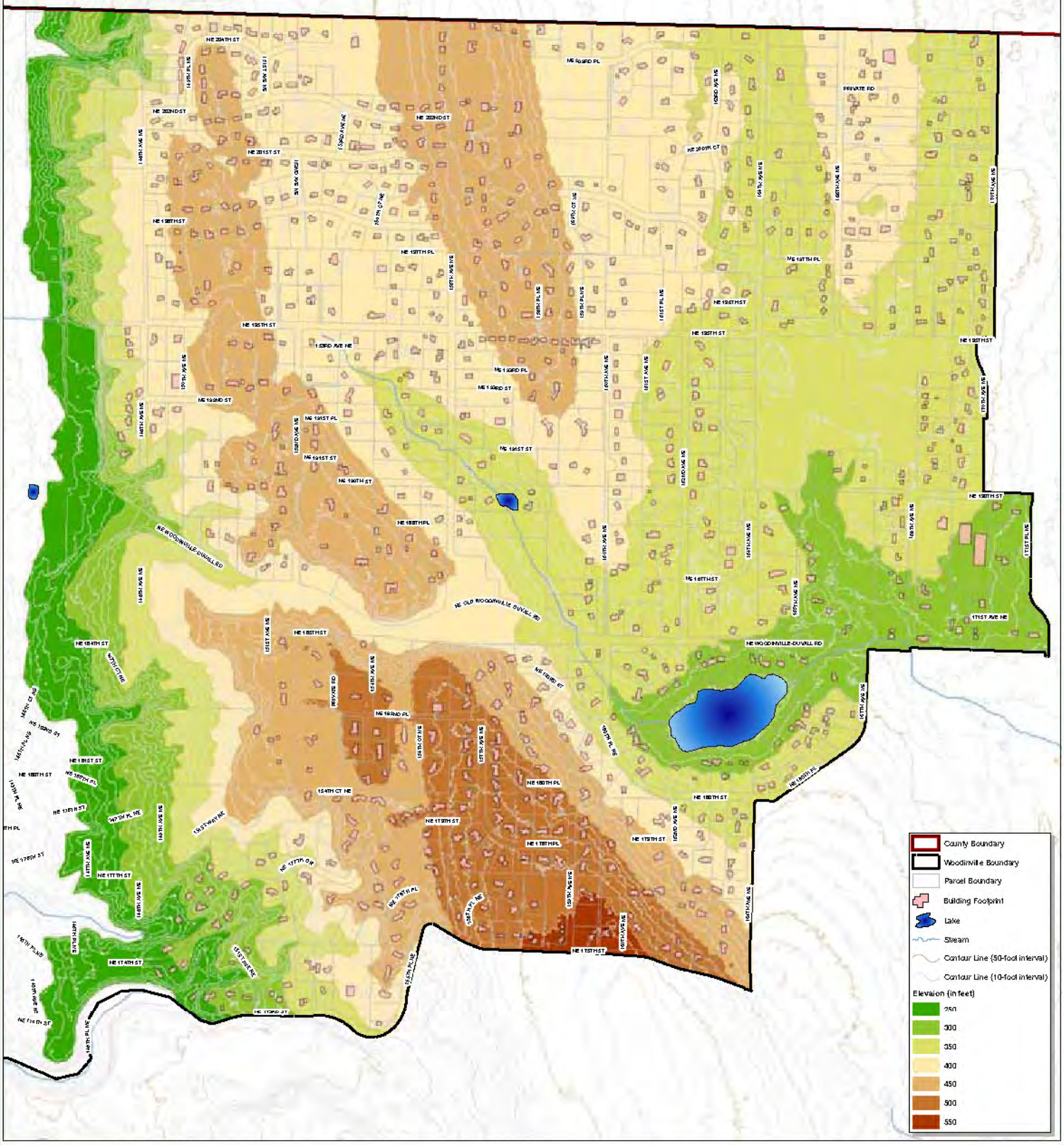

Relative Elevation

Figure 3

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Feet

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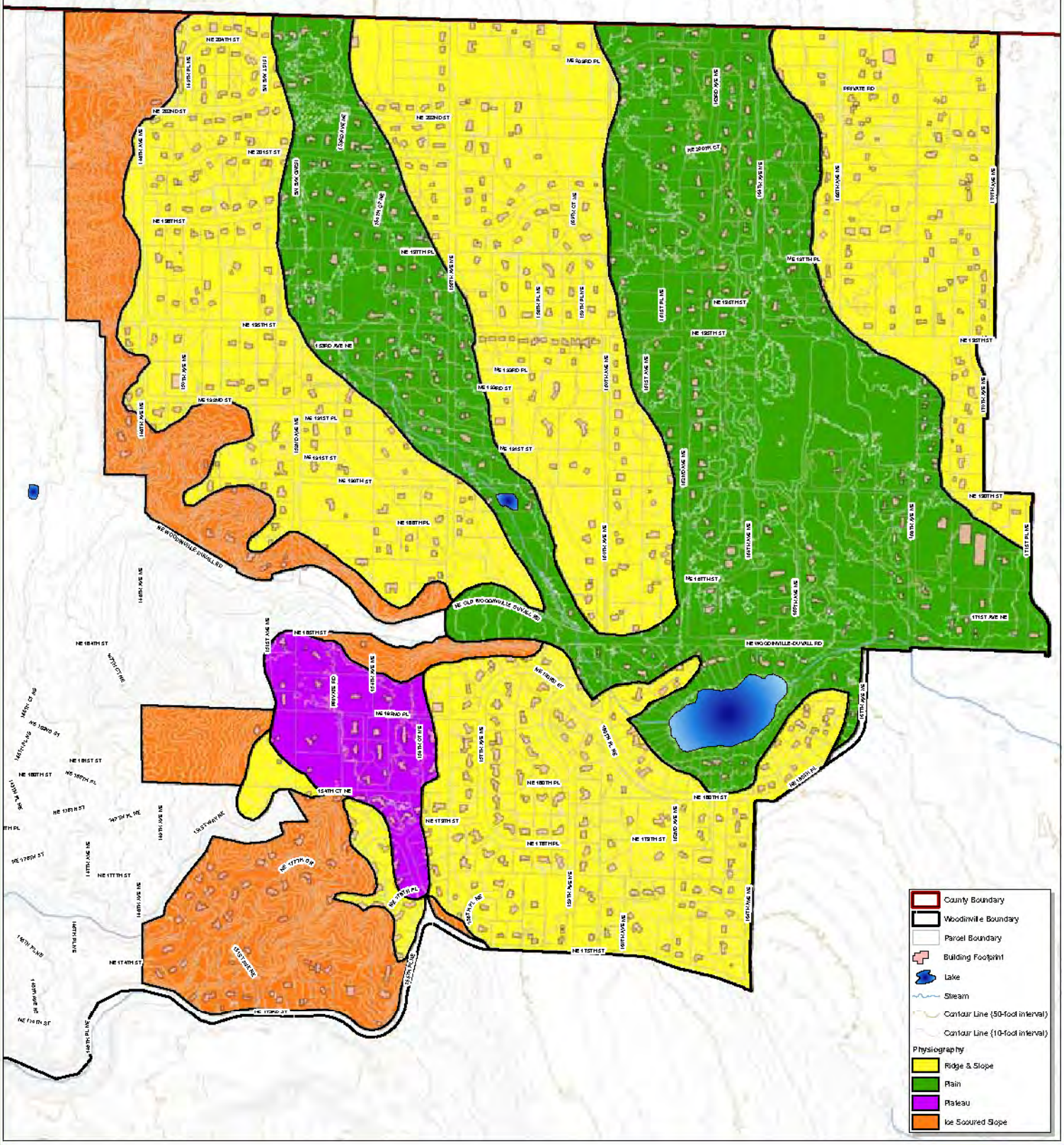

Physiography

Figure 4

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Feet

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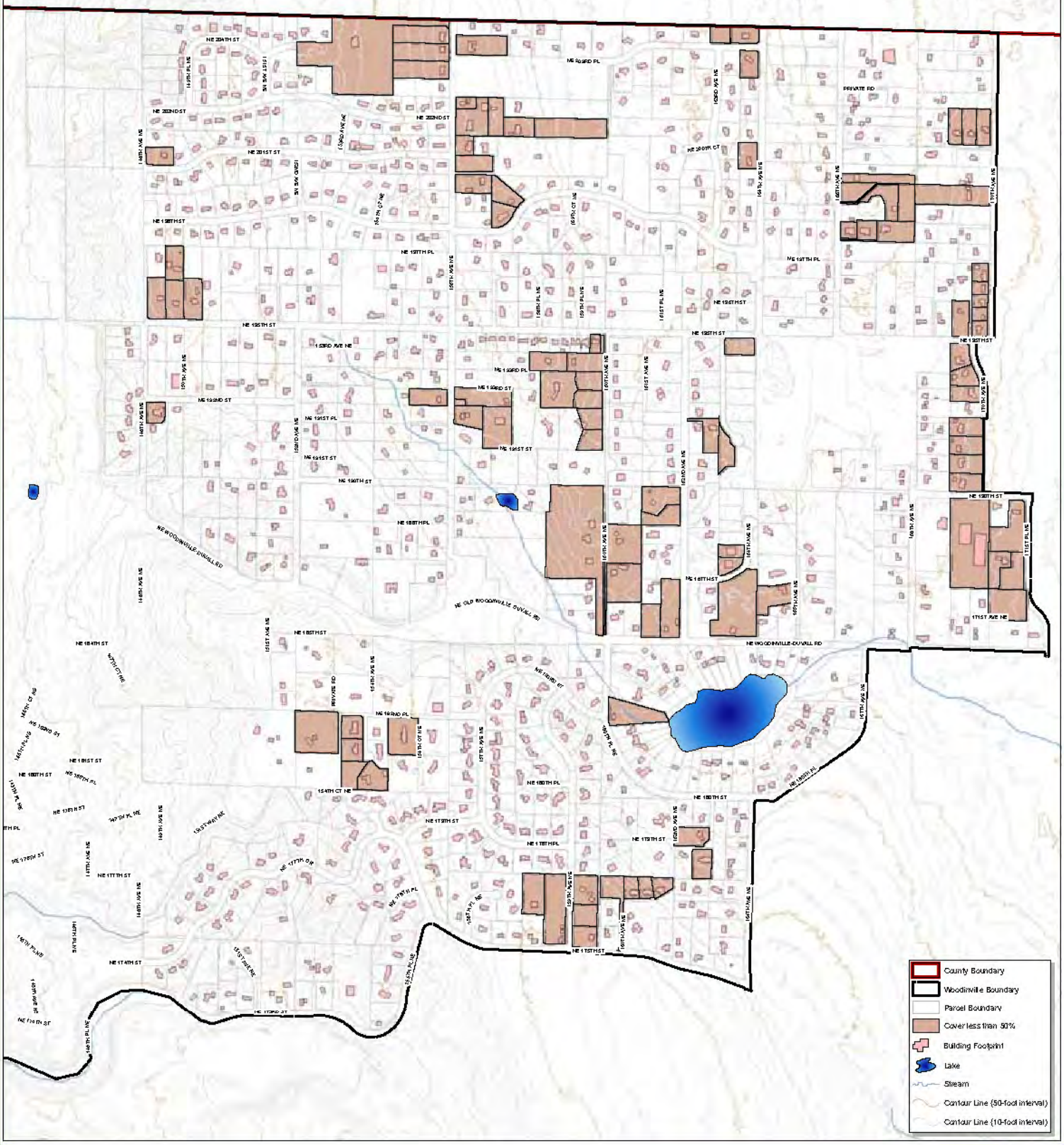

Parcels with Low Vegetation/Canopy Cover

Figure 5

0 500 1,000
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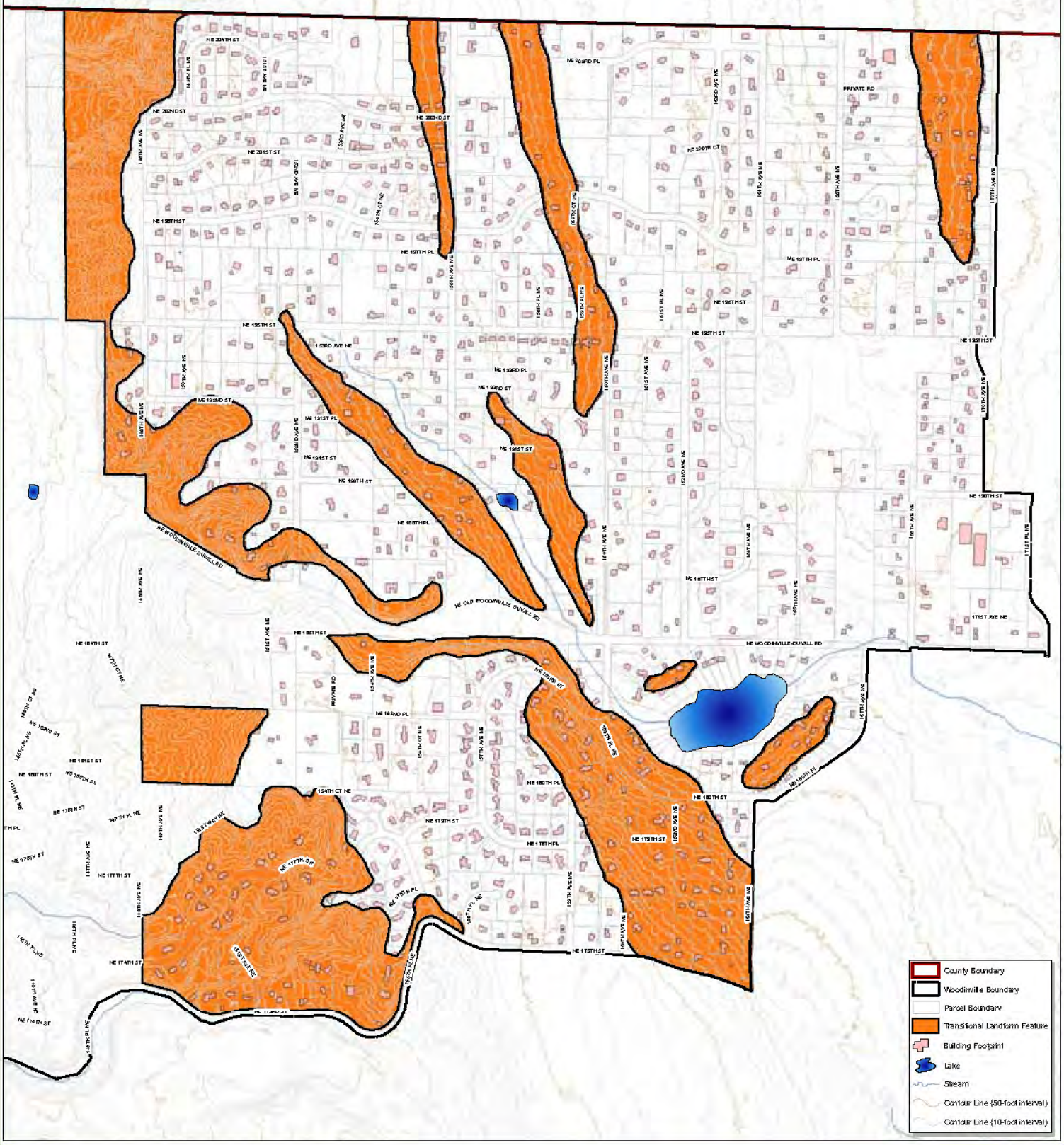

Transitional Landform Features

Figure 6

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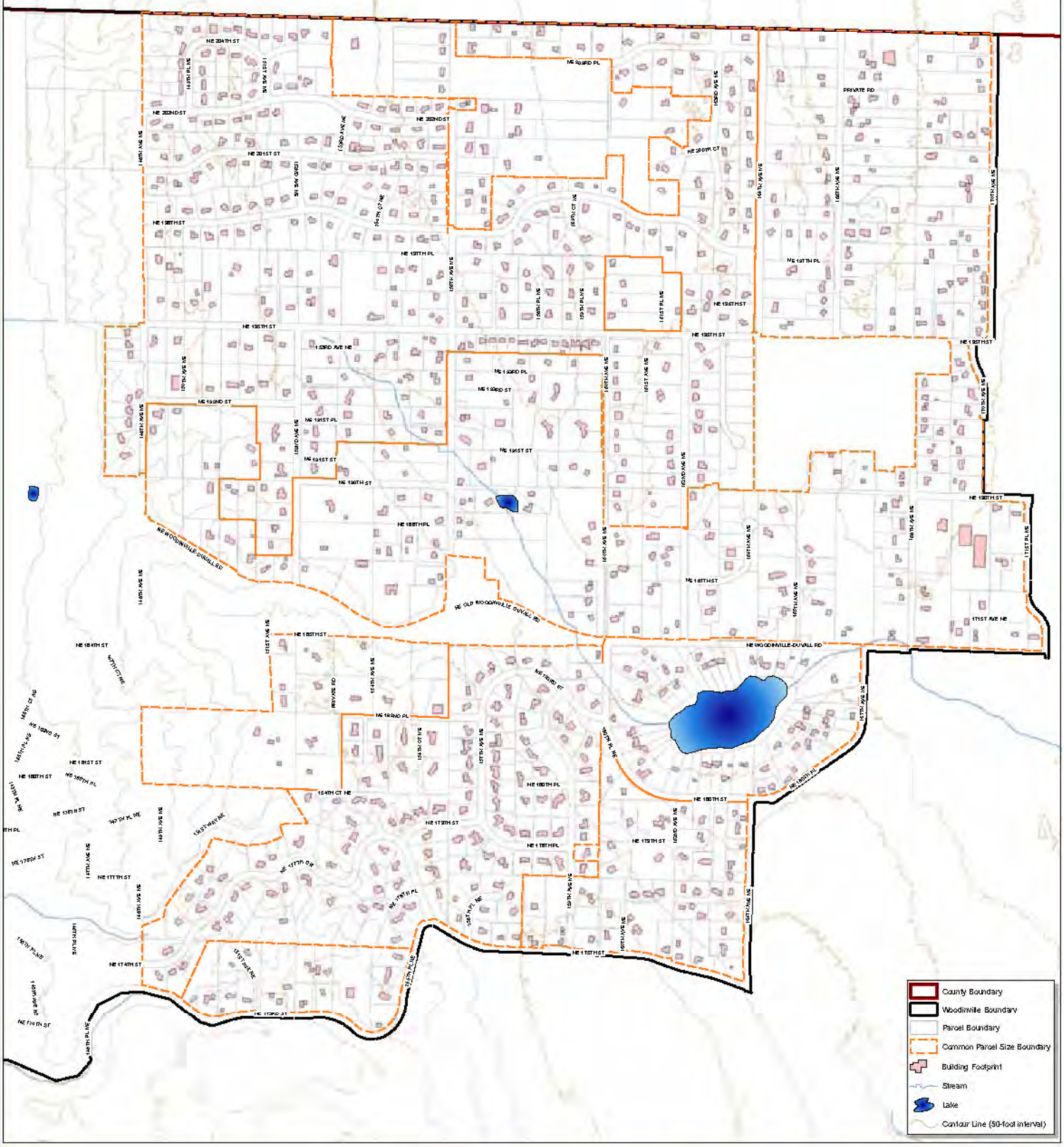

Areas of Common Parcel Size

Figure 7

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Feet

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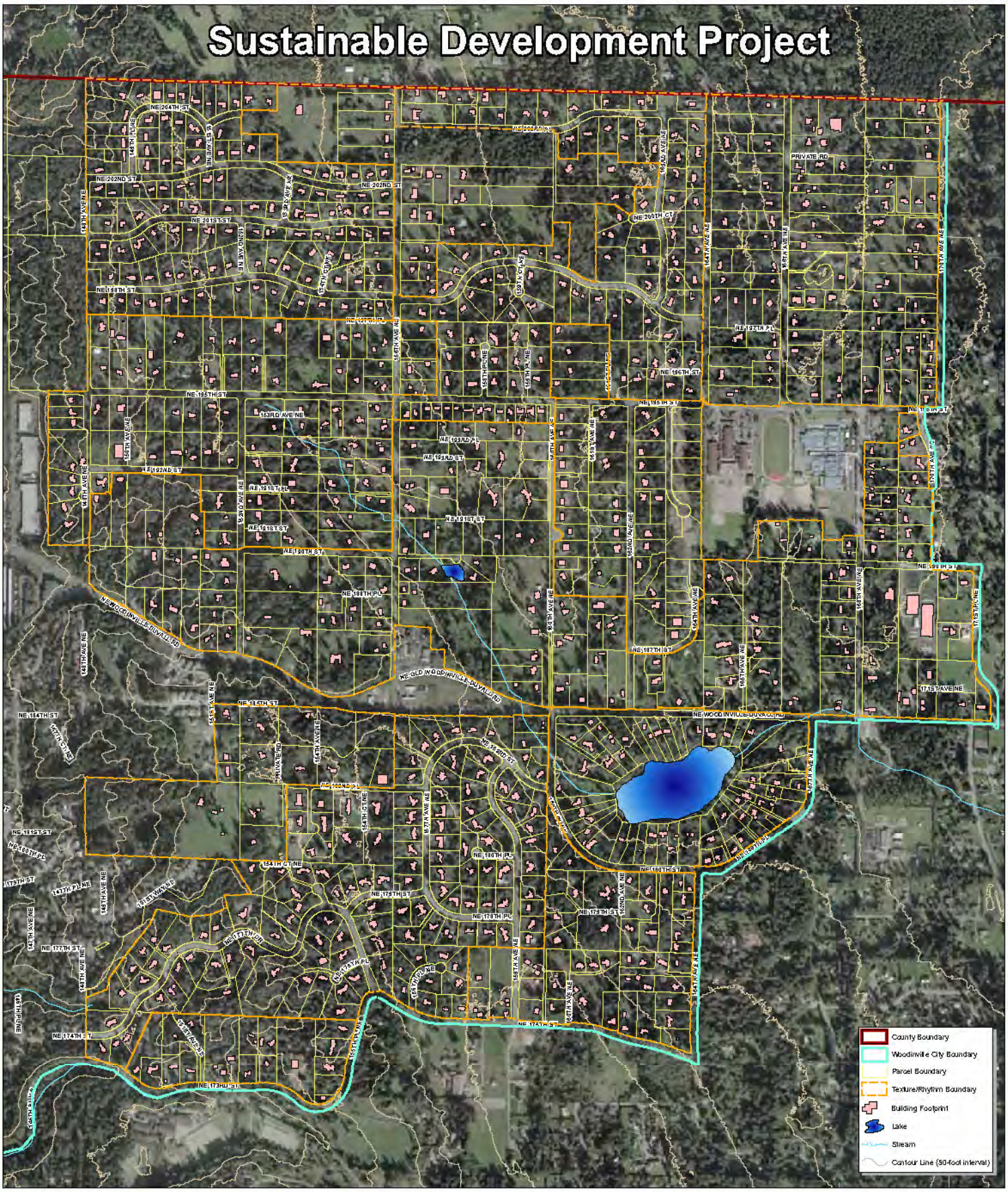

Building Texture/Rhythm

Figure 8

0 500 1,000
Feet

2.1.2. Step 2. Results of the commonality overlay analysis

At some level or on several levels (depending on geographic extent), much of the mapped units create patterns and places that lend definition to geographic boundaries and that ultimately define the neighborhoods in this study. Some, such as Leota, are defined very rigidly; others, such as South Wellington, have loose edges. The product of this analysis is shown on Figure 9 (R-1 Conceptual Subareas) that identifies twelve neighborhood subareas and is Step 2 on Figure 1. A description of these neighborhood subareas is as follows:

Northwest Wellington

The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns, and streets that together crisply define neighborhood boundaries.

Southwest Wellington

Accessibility and lot configuration largely define this neighborhood. External access is limited, which makes for an enclave-like place. The wooded setting adds immensely to a sense of place.

North Wellington

With few exceptions, this neighborhood is defined by its location in a physiographic plain and by the degree of road connectivity. External accessibility also defines boundaries and encloses the neighborhood.

Central Wellington

There is only one major access into this neighborhood, NE 195th Street. Other minor roads connect from different directions and are closed off or dead ends. Central Wellington is somewhat more defined by adjacent neighborhoods than it is unto itself.

South Wellington

This area is commonly accessed off of 156th Avenue NE. It contains many unimproved or private roads that are the result of short plat activity. Its boundaries, similar to those of Central Wellington, are easily defined by adjacent neighborhoods.

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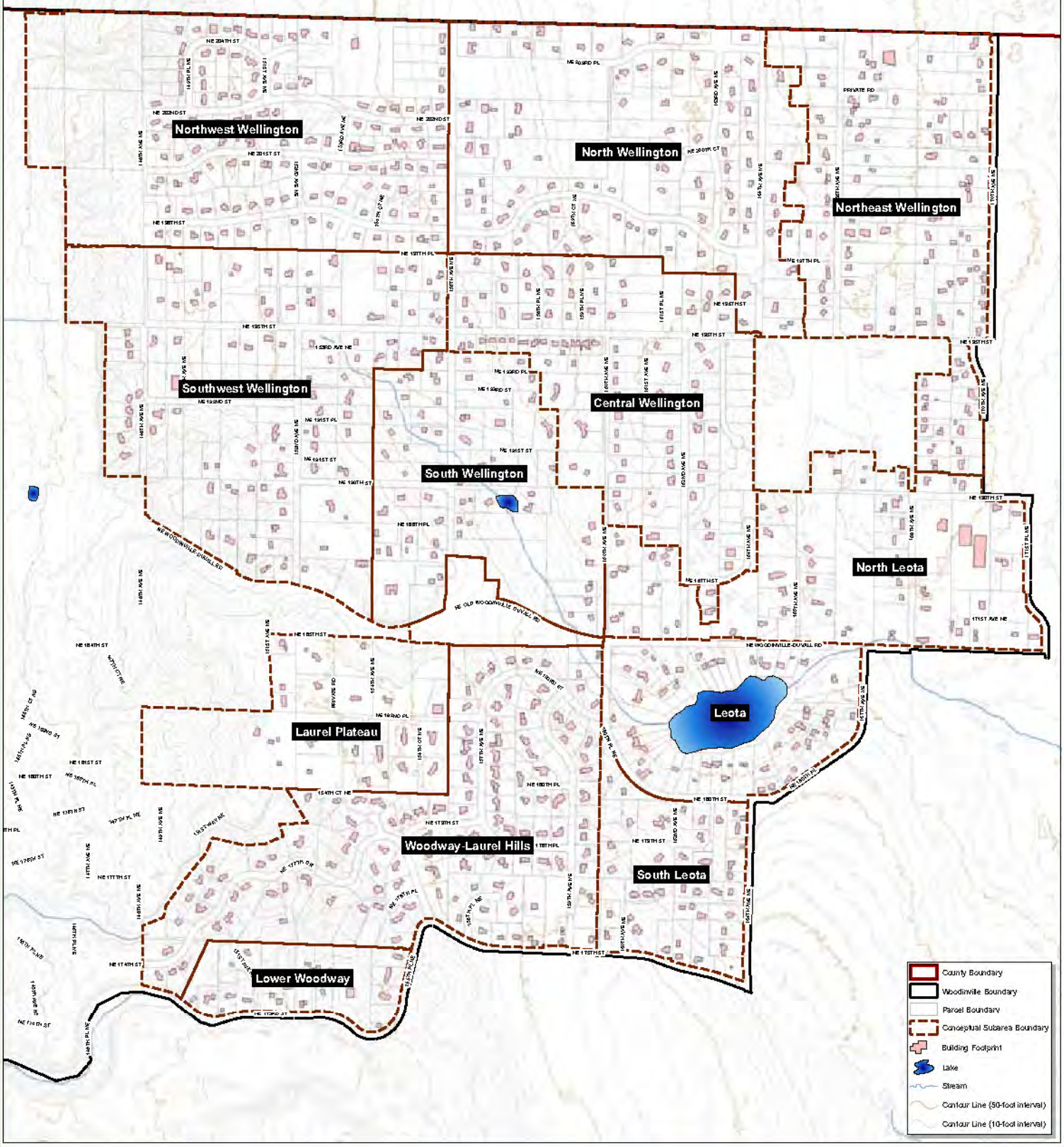

Conceptual Subareas

Figure 9

0 500 1,000
Feet

Northeast Wellington

This is a neighborhood defined primarily by the constricted nature of access. There is only one way in and one way out via 168th Avenue NE. It is further isolated by school property occupying the major portion of its southern extremity.

North Leota

North Leota is characterized by its adjacency to Woodinville-Duvall Road and by its broad range of lot sizes. There is no connectivity in any sense of the term, but this neighborhood occupies the greatest extent of the Leota outwash plain niche.

Leota

This neighborhood is the best defined in the study area. Common views, common access, lot configuration enclosure, and wooded nature make this one of Woodinville's most distinct places.

South Leota

This is a well-defined neighborhood, all on an even grade, facing northeast, shaded in the afternoon, wooded slope. Political boundaries and transportation network provide strong elements to boundary definition.

Laurel Plateau

Terrace-flat topography defines this neighborhood. Steep slopes and formal subdivision boundaries confine this area into one neighborhood.

Woodway-Laurel Hills

This neighborhood predominantly consists of two formal subdivisions that have similar street networks and topography. Ridge and slope topography characterize its common physiographic niche, and its richly manicured landscape amidst tall woods creates a common definitive sense of place.

Lower Woodway

This neighborhood located in the southwest fringe of the study area has common access off of NE 173rd Street. Steep slopes are common throughout. Its identity is

defined by its adjacency to its neighbor and by its isolation because of topography and access limitations.

2.2. Step 3 Determining Neighborhood Character

Defining neighborhood character is the next step (Step 3 shown on Figure 1) in this process whereby evaluations are made from visual surveys, physical and environmental data, and other inventory information assembled and ranked by order.

Character may be described as the aggregate of qualities that distinguishes one place from another; thus an area having good commonality and distinguished qualities may be described as an area of high character.

The neighborhood subareas defined in the previous section of this report have various degrees of image and character in their respective aggregate patterns. These aspects depend on such things as views, topography, streets, building form, and landscaping. These patterns give an organization and sense of place, denote their special nature, and often help make human activity and interactions an important part of the neighborhood subarea. The pattern also assists orientation for travel. Neighborhood patterns that affect the vitality and character of neighborhood subareas should be recognized and enhanced.

This study applies 12 indicators of neighborhood character to the 12 neighborhood subareas mentioned above in Step 2 (Figure 10). Some indicators were more or less important to some neighborhood subareas over others. This analysis did not discriminate among indicators. Nor, did it assume that the indicators were inclusive. The study consulted prominent urban design sources such Paul Spreiregen, *Urban Design: The Architecture of Towns and Cities*, and Christopher Alexander, *A Pattern Language*.

Neighborhood character for purposes of this study is described as the degree of presence and relative aggregate of qualities perceived from visual surveys and high commonality of data. The impression of their relative presence in neighborhood subareas from high association to low association is the result of this analysis. The neighborhood character indicators used in this evaluation are defined below followed by an explanation of how they were applied in the analysis to determine their levels of consistency and commonality throughout the conceptual neighborhood subareas. The methodology of applying neighborhood character indicators to the R-1 area to come up with a ranking of neighborhood character association in each subarea is detailed below. City staff (Bob Wuotila, Senior Planner) toured the study area and reviewed maps and other visual images of the area to develop his recommendations for neighborhood character.

R-1 AREA Neighborhood Characteristic Typologies	INDICATORS	Physiographic Niche	Canopy Cover > 75%	Manicured Landscape	Common View shed	Circulation Connectivity	Parcel Accessibility	Cohesive Block Configuration	Areas of Common Parcel Size	Sense of Scale and Fabric	Cohesive Street Presence	Building Texture/ Rhythm	Low Infill Potential
NEIGHBORHOODS													
Northwest Wellington*	32												
Southwest Wellington*	24												
North Wellington*	33												
Central Wellington	19												
South Wellington	15												
Northeast Wellington	16												
North Leota	16												
Leota*	25												
South Leota	23												
Laurel Plateau	21												
Woodway Laurel Hills*	33												
Lower Woodway	19												

= HIGH ASSOCIATION = MEDIUM ASSOCIATION = LOW ASSOCIATION

* Recommended for Neighborhood Character Protection

Neighborhood Characteristic Typologies **Figure 10**

2.2.1. Physiographic Niche

Niches may be ridges, terraces, plateaus, plains or slopes. The relative impression that they contribute to a sense of place defines character, including assessing high order or commonality for the neighborhood subareas once the subareas were defined. A review of maps showing physiographic features, as well as follow-up reconnaissance visits were used as the principle means of rating physiographic niche of each neighborhood subarea (Figures 3, 4, and 6 were also used to evaluate the physiographic niche indicator, as well as originally helping to define the neighborhood subarea).

2.2.2. Canopy Cover: > 75% of the parcels with canopy cover >%50

Presence of tall native conifers provides shade and shadows; add timeless beauty to the place and maintains "Woodland Character." Visual observation identified those parcels within each subarea having >%50 vegetative cover. Then an analysis was made to determine if those parcels constituted more than 75% of the parcels in the subarea. Figure 5 shows the parcels within the R-1 area that have low vegetation/canopy cover. The neighborhood subareas map (Figure 9) was overlaid on Figure 5 to develop a composite map (Figure 11) showing which neighborhood subareas had greater than 75% of their parcels with greater than 50% cover.

2.2.3. Manicured Landscape

Visual impression of pruned shrubs, expansive, neat lawns and groomed appearance could add value and identity to the neighborhood. A reliance on field surveys of the various neighborhood subareas was used to indicate high, moderate, and low association of manicured landscape for each subarea. There was not a map created for this neighborhood indicator. The study's author made use of field reconnaissance and local knowledge to develop his assessment for manicured landscape.

2.2.4. Common Viewshed

Presence of available viewshed to significant local or regional features, such as mountain, lake, or city views of significant local or regional features. An example of a significant local feature is Lake Leota, while a significant regional feature would be the Cascade mountain range. The neighborhoods with the most parcels with common view sheds of these significant features, such as the Leota neighborhood subarea, were noted for their common view shed and had higher common view shed numeric values.

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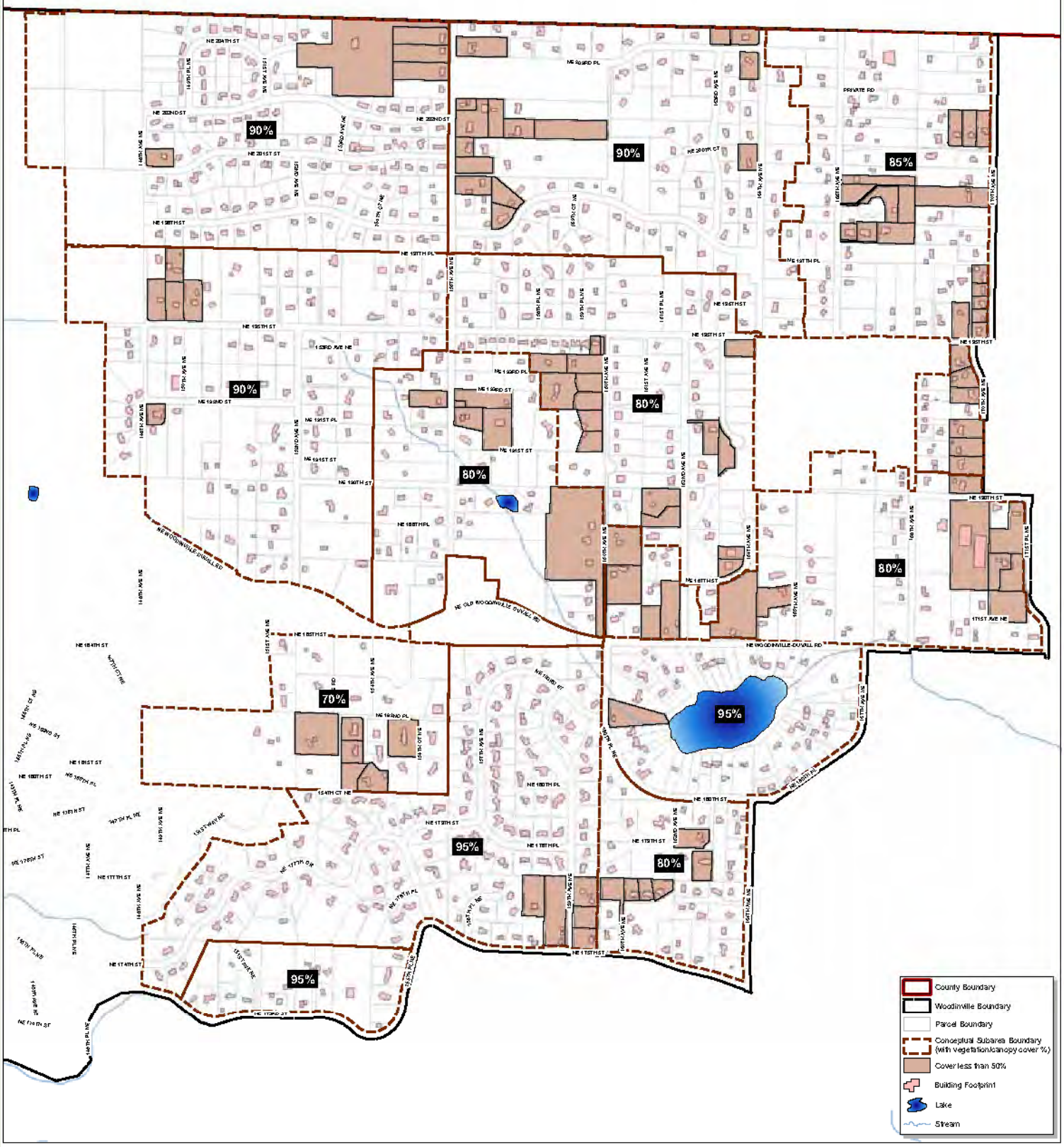

Figure 11

Vegetation/Canopy Cover by Neighborhood Subarea

(Percentages shown are percent of parcels in each subarea with greater than 50% canopy cover)

0 500 1,000
Feet

2.2.5. Circulation Connectivity

Presence of good, easy access available throughout the neighborhood subarea -- good orientation, no confusion. A map was created (Figure 12) that overlays public roads with neighborhood subareas to show subareas with higher areas of circulation connectivity.

2.2.6. Parcel Accessibility

Presence of well-defined roads with consistent right-of-way width and an inviting sense of circulation. Figure 12 is also useful as part of the analysis of areas with higher and lower parcel accessibility. Other parts of this analysis required review of maps and field visits to assist in determining topographic features (such as slopes) that contribute to poor parcel accessibility.

2.2.7. Cohesive Block Configuration

Roads laid out with sensitivity to contour, repetitive scale between intersections, and unified edge treatment. There was no single figure created for cohesive block configuration; however, Figure 12 and field surveys were used as a means of assessment.

2.2.8. Areas of Common Parcel Size

Presence of lots of similar size, repetition, and spatial order. Pattern offers a sense of security, stability, and harmony. Figure 7 was developed and used to help determine which neighborhood subareas had higher association in terms of common parcel sizes than others. An overlay of neighborhood subareas on this map helped provide information on which subareas had higher common parcel size associations than others as depicted on Figure 13.

2.2.9. Sense of Scale and Fabric

Impression that neighborhood is serene and orderly due to house setbacks and repetition of form, presence of shrubs, and shadow from canopy trees. Neighborhoods with common setbacks, repetition of form, and similar features had higher association for sense of scale and fabric. This indicator relied heavily upon the city's field surveys of the neighborhood subareas (Wuotila). No figure was created for this indicator.

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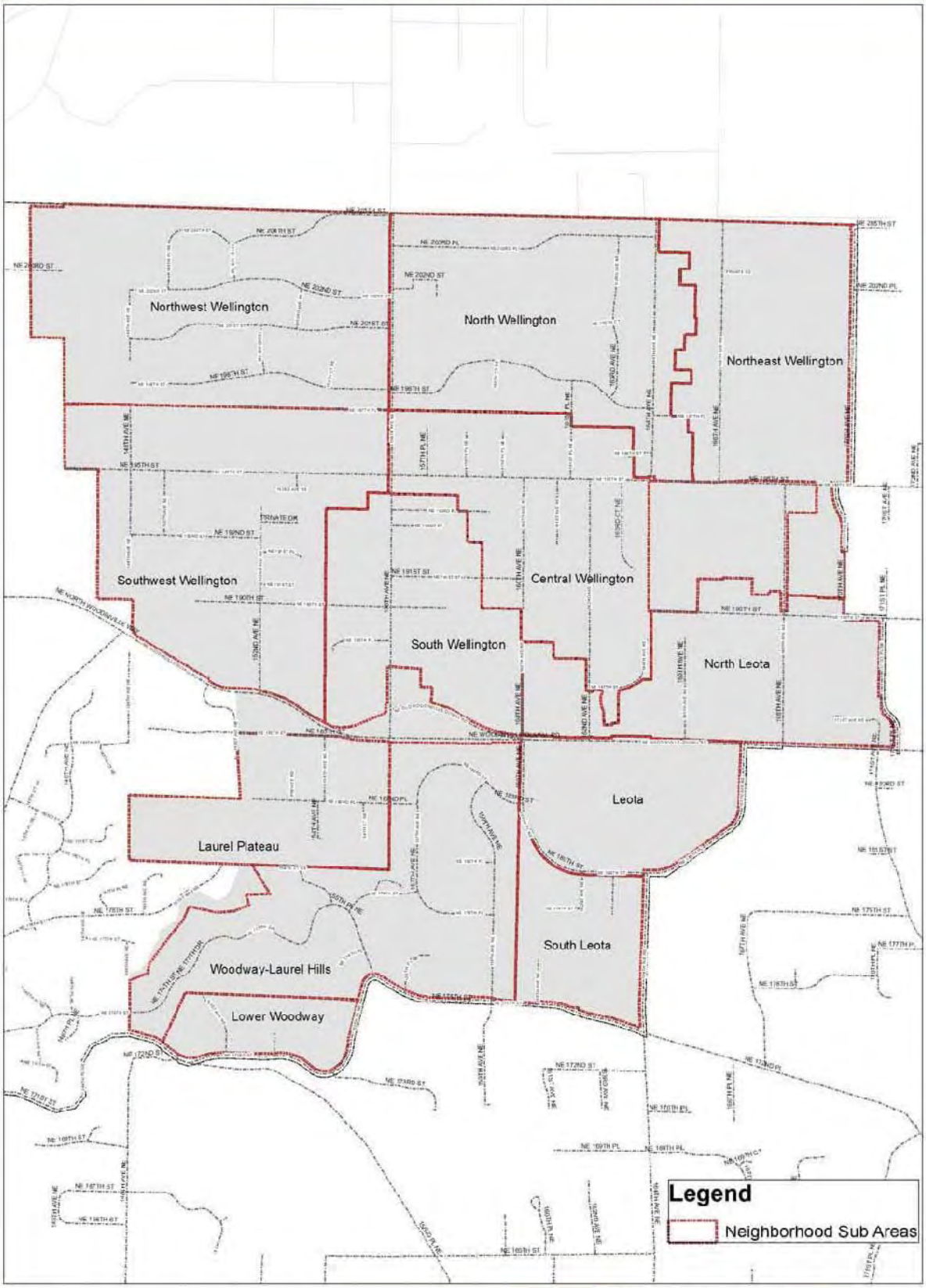

Circulation Connectivity

Figure 12

1 inch equals 456 feet

File Name: R: Zone -Street ROW.mxd

NO	DESIGN/REVISION	DATE	BY
1			
2			
3			
4			
5			

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17301 - 133rd Ave NE
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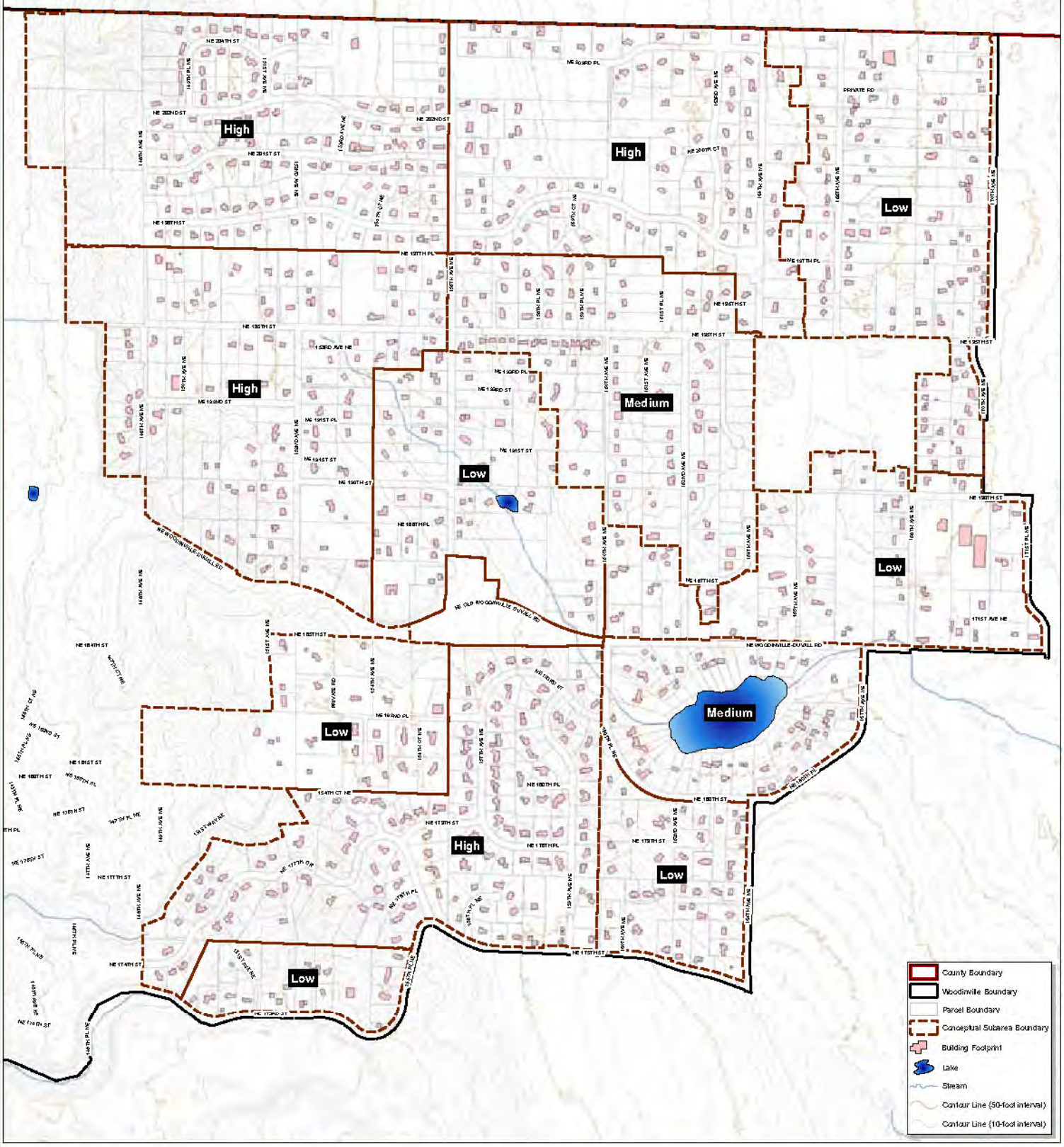

Areas of Common Parcel Size by Neighborhood Subarea

Figure 13

0 500 1,000
Feet

2.2.10. Cohesive Street Presence

Streets that have common motif: street lighting, street landscaping and street roadway profiles (i.e., roadway sections, walks and edges). Streets that have higher association with cohesive street presence have a higher indicator value. No figure was created for this indicator, which relied heavily on field surveys of the various neighborhood subareas.

2.2.11. Building Rhythm and Order

Presence of orderly texture exhibited by building spacing and orientation and magnitude of repetition. Figure 8 was used as the basis for assessing which areas had higher association of building rhythm and order than others. Review of this figure with an overlay of neighborhood subareas provided the basis for this indicator's rating found on Figure 14.

2.2.12. Low In-Fill Potential

Due to patterns of building and parcel layout, most lots in the neighborhood lose visual privacy; acoustical privacy; and feeling of security, safety, and social association if infill is allowed. A sense of whether in-fill development would infringe upon visual and acoustical privacy on surrounding parcels was the factor taken into account for this indicator's effect on neighborhood character. Figures 15 and 16 were developed to show both an existing neighborhood development pattern and an example of how development of a parcel within the neighborhood would impact neighborhood character. These figures also show the process and thinking behind the assessment of this indicator within the neighborhood subareas.

Figures 15 and 16 show one theoretical example of infill development that may or may not affect the five neighborhoods with distinctive character. In the "after" example in Figure 15, new development could potentially occur in a yard or lot having sufficient area and space to accommodate allowable density under R-4 zoning. Public or private roads may be constructed into rear or side yards of existing lots. Dependent on the design and layout of infill development, visual and acoustical privacy, trees and vegetation, balance, unity, spatial order, and social associations could be redefined, and require careful consideration. These issues were espoused by Chermayeff in Community and Privacy and by Alexander in A Pattern Language years ago and remain valid now and in the future.

As stated, all of the above indicators were given the same value or importance to contributing to the neighborhood character in the R-1 area. Different strategies, such as ranking or weighting variables, would result in different impressions.

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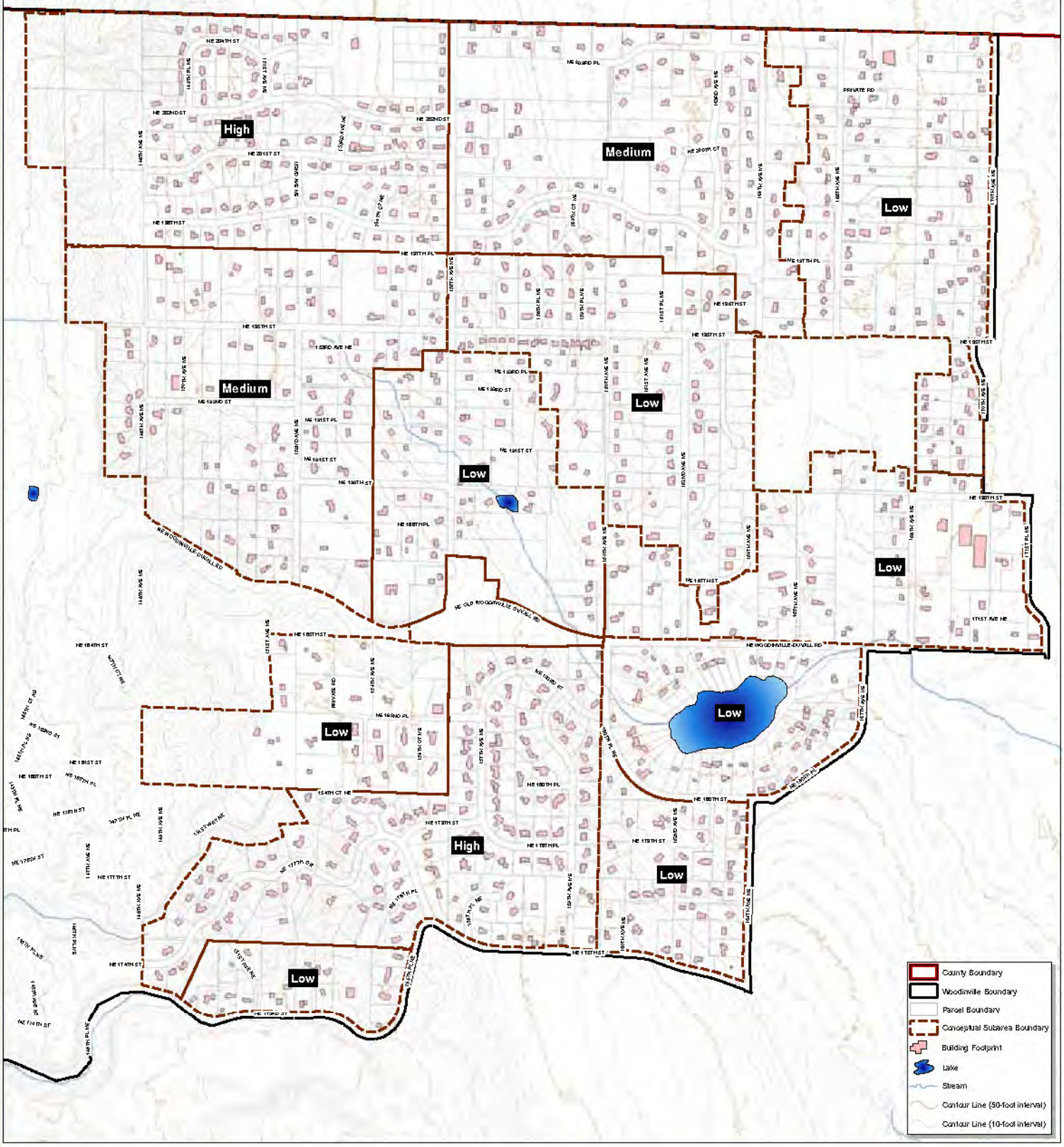

Building Texture and Rhythm by Neighborhood Subarea

Figure 14

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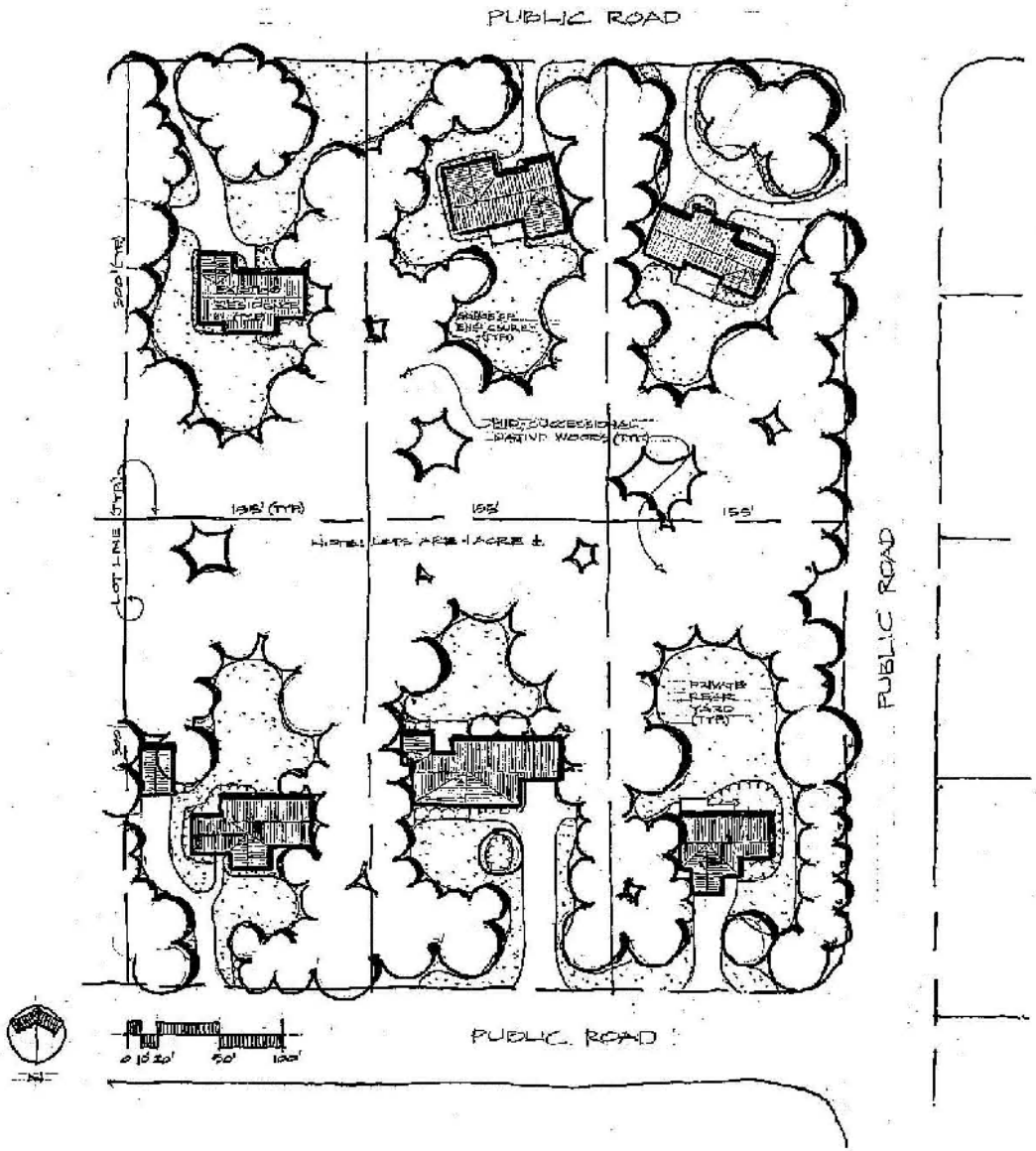
Feet

TYPICAL EXISTING DEVELOPMENT PATTERN
R-1 AREA

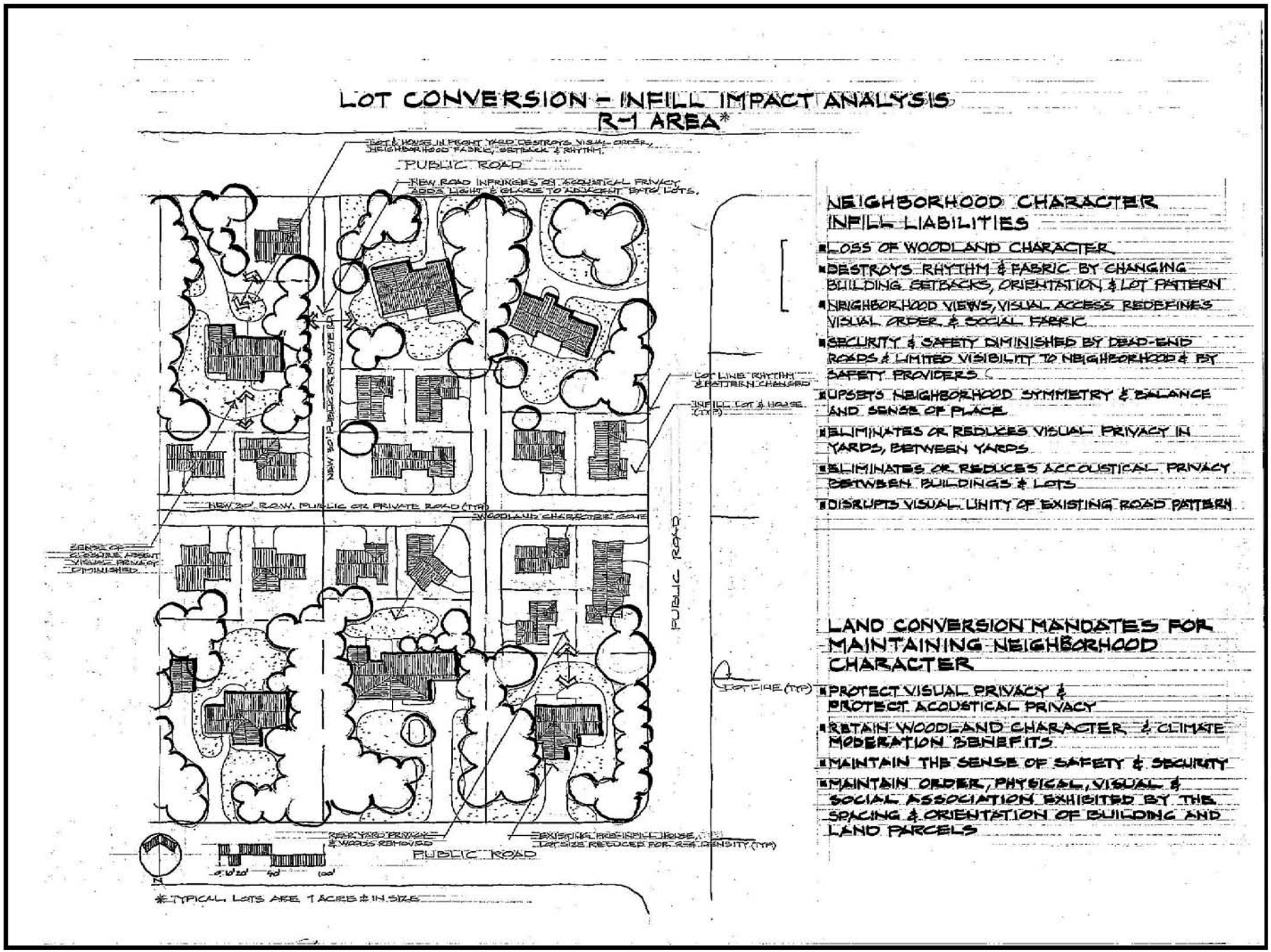


ATTRIBUTES OF EXISTING LOTS

- WOODLAND CHARACTER (50-75% CANOPY)
- CLIMATE MODERATION OF WIND & SUN BY PRESENCE OF TREES
- REPETITIVE BUILDING & LOT PATTERN PROVIDES BALANCE AND SENSE OF SERENITY & COMFORT
- VISUAL PRIVACY
- ACOUSTICAL PRIVACY
- SENSE OF ENCLOSURE
- EASE OF ACCESS & ROAD VISIBILITY PROVIDES SENSE OF SAFETY & SECURITY
- SPATIAL ORDER PROMOTED BY BUILDING SETBACKS AND COMMON ORIENTATION PROVIDES SENSE OF SYMMETRY & TRANQUILITY
- COMMON ROAD TREATMENT (WIDTH, SHOULDER, SWALE) CREATES SENSE OF PLACE THAT UNIFIES NEIGHBORHOOD & ENHANCES SOCIAL FABRIC

Typical Existing Development Pattern

Figure 15



Lot Conversion - Infill Impact Analysis

Figure 16

Figure 10 is a matrix of the 12 neighborhood character indicators shown on the horizontal axis and the 12 neighborhood subareas on the vertical axis. Each indicator was evaluated for its relative presence in each subarea and each relationship was tested by visual survey and map evaluations. The application of formal urban design criteria, together with personal judgment and experience, produced a range of impressions and relationships that ranged from high to low association or order. Other means, such as value settings by neighborhood residents may refine the results found in Figure 10, *Neighborhood Characteristic Typologies*.

Figure 10 presents a point scale -- three points for high association, two points for medium association and one point for low association for each indicator for each subarea. Additionally, the point scale was used to determine which areas profited most or least from maintaining a sufficient degree of sense of place and character. After ranking or ordering each subarea by neighborhood character, those with the highest order were overlain by parcel size (Figure 18) to determine what prevalent density existed in the subarea. Step 4 applies densities to each of the subareas.

2.3. Step 4: Applying Densities to Neighborhood Subareas

The final step in this neighborhood character analysis was to calculate the point total for each subarea, and to select a ceiling limit (24 or more of 36 possible points) that would call out subareas that have a greater commonality and therefore would be more supportive of maintaining current prevalent densities to ensure their established character was maintained. Neighborhood subareas that had less commonality would be less supportive of maintaining prevalent densities.

Figure 10, presents values assigned to each indicator in each neighborhood subarea, resulting in total numeric values. Under this system, five of 12 neighborhood subareas were deemed to have high enough order and sense of commonality to qualify for neighborhood character recognition (see Figure 17). Recognition of neighborhood subareas with high order of neighborhood character would lend itself to maintenance of the predominant parcel size in those subareas in order to avoid incompatible infill development that could negatively affect neighborhood character. The following subareas had the highest association of neighborhood character indicators:

- Northwest Wellington
- Southwest Wellington

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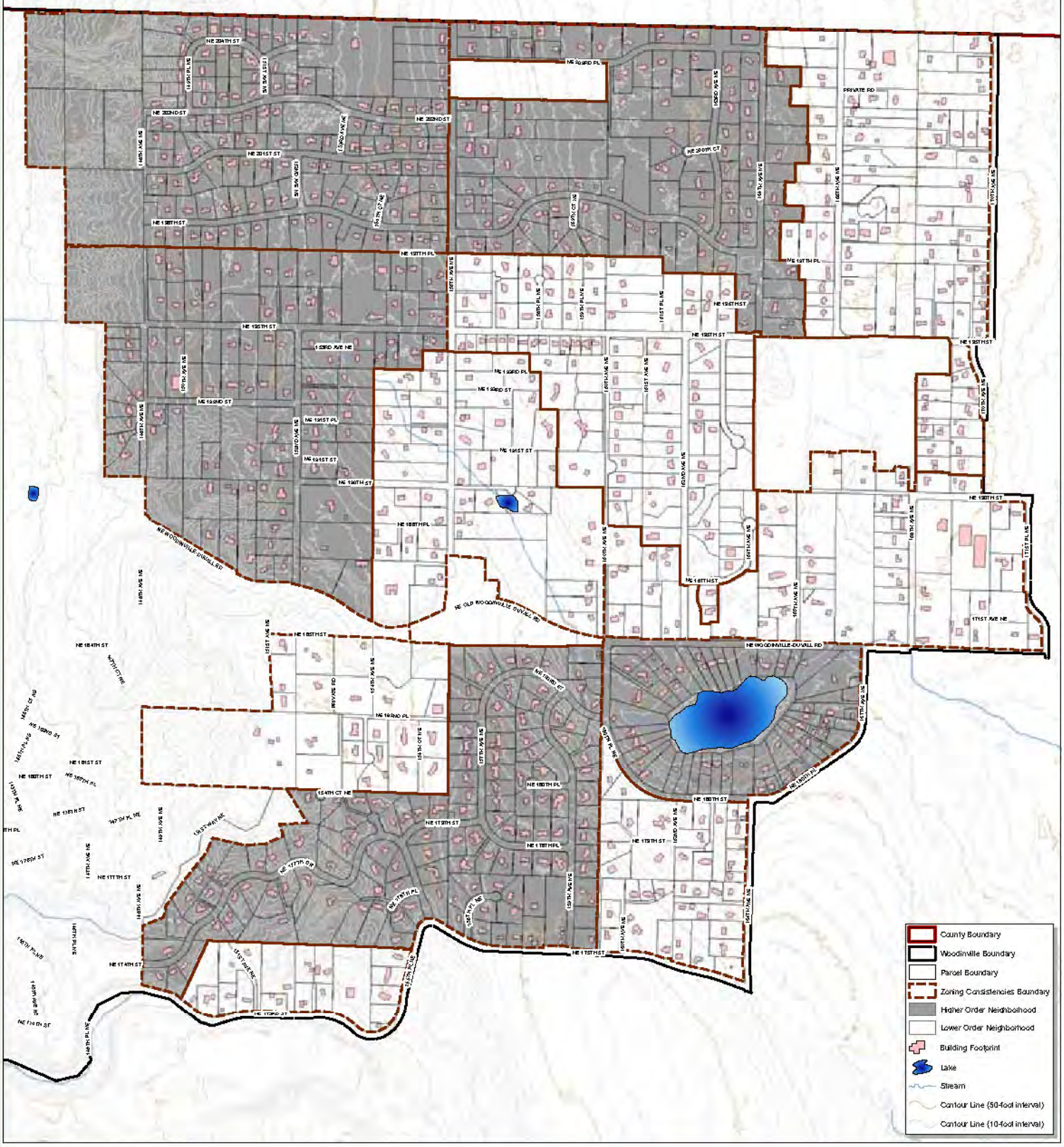

Neighborhoods of Higher Order

Figure 17

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Feet

City of Woodinville

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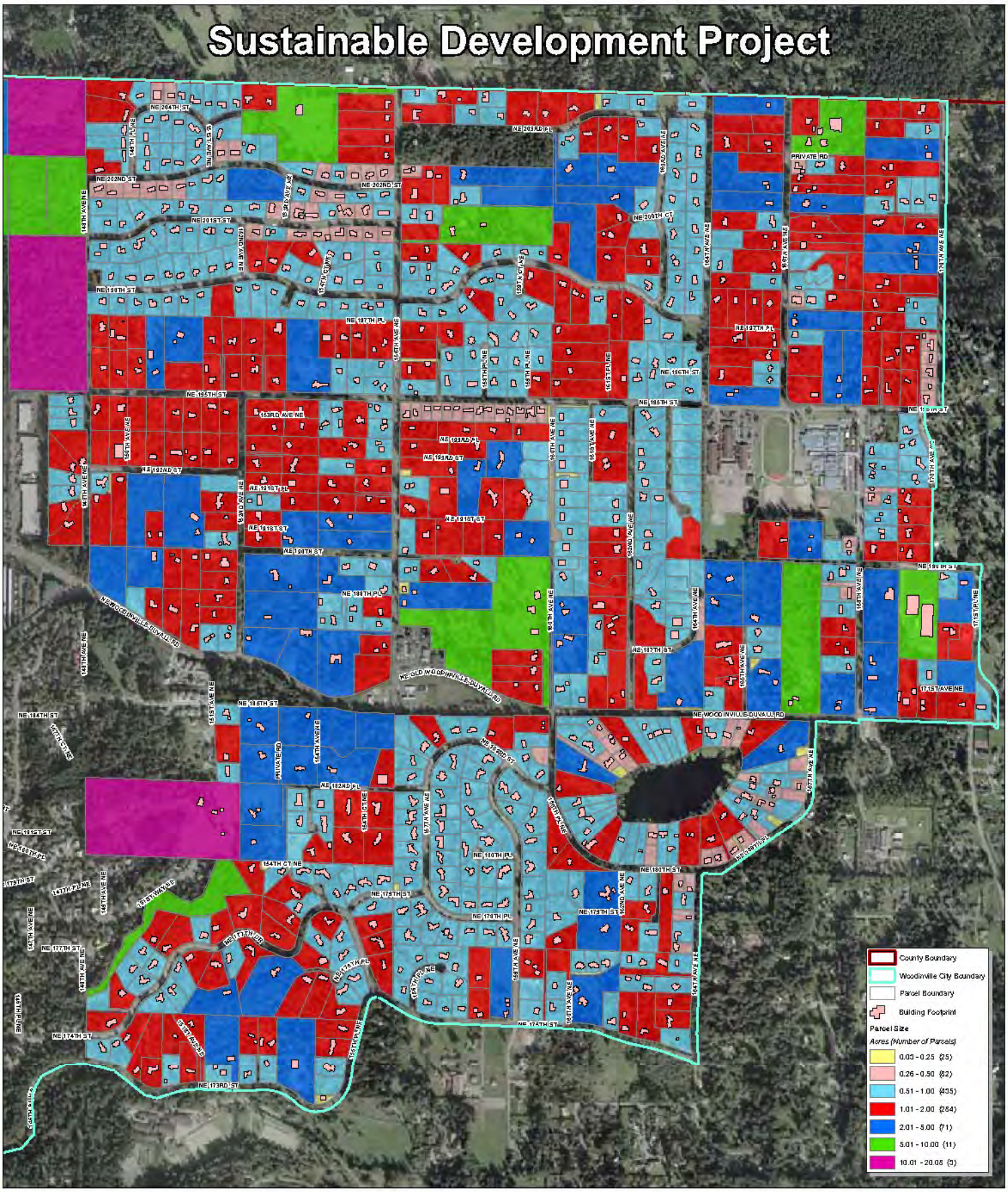

Parcel Size

Figure 18

0 500 1,000
Feet

- North Wellington
- Leota
- Woodway-Laurel Hills

Figure 19, *Zoning Consistencies with Neighborhood Character*, shows these five neighborhoods highlighted with the prevalent current zoning patterns. Those neighborhoods without recognition of high neighborhood character attributes are not shaded and were designated with R-4 zoning. The resulting zoning designations shown in Figure 19 are those that would be applied if only neighborhood character were taken into account. This does not account for the findings of the Environmental, Transportation, or Capital Facilities reports.

Neighborhood character is qualitative in nature, therefore the city conducted an independent follow-up review of neighborhood character, applying well-defined metrics to the neighborhood character indicators within each identified neighborhood subarea. The results of this independent follow-up analysis can be found in Appendix B of Attachment B. Results were similar in all cases but two of the 12 subareas. These differences are discussed in Appendix B.

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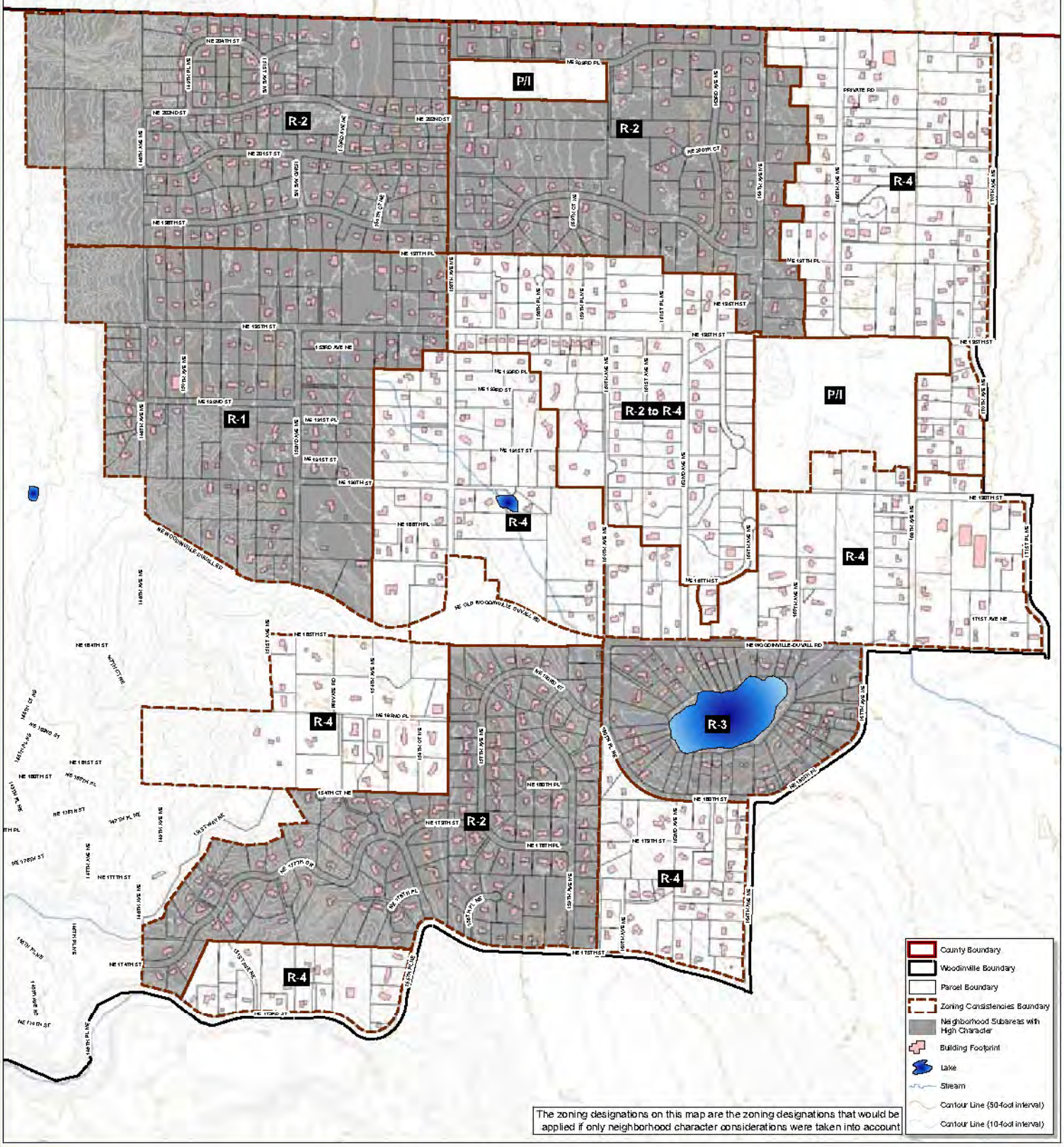

Figure 19

Zoning Consistencies with Neighborhood Character

(Version 1)

0 500 1,000

Feet

Chapter 3. Housing Allocation & Carrying Capacity

With or without neighborhood character it is important to evaluate appropriate residential densities for all neighborhoods, including density and carrying capacity for the entire city. GMA stipulates each city and county (required to plan under the Act) must develop a comprehensive plan and zoning to accommodate their fair share of the State's anticipated growth. This is expressed at the local level in terms of housing units and jobs. Population and employment projections are developed by the Washington State Office of Financial Management. These growth projections are divided into regions and then down to the county level. Each county and the cities therein divide up the growth allocated to the county according to established criteria including the "carrying capacity" (potential for accommodating growth) for each city and the county for a twenty-year planning period. The City's Housing Allocation for the current planning period, 2001 to 2022, is 1,869 dwelling units. This allocation can be accomplished under existing Comprehensive Plan and zoning designations according to a 2001 Residential Carrying Capacity analysis (done as part of the 2002 Comprehensive Plan Update).

To measure how each city in the County is doing as far as actually achieving their assigned housing targets, a report is published ever five years that summarizes, city by city, the number of additional housing units that have been built for the past 5 year period. The King County 2005 Buildable Lands Report indicates the City gained 497 new dwellings from 2001 to 2005. Another 41 dwelling units were added in 2006 according to the City's Building Permits records. This leaves a Housing Allocation balance of 1,331 dwelling units to be provided over the next 15 years.

Table 1. Housing Allocation and Permits Issued

Housing Allocations and Permits	Housing Units
2001 – 2022 Housing Allocation	1,869
2001 – 2006 Housing Permits Issued	-538*
Housing Allocation Balance	1,331

*Includes both Residential Zone Projects and known Commercial Zone Projects

Using as a base line the 2001 Residential Carrying Capacity analysis, the following table indicates there remains sufficient capacity to accommodate the remaining Housing Allocation under current zoning.

Table 2. Residential Capacity Analysis

Residential Carrying Capacity*	R-1	R-4	R-6	R-8	Multi-Family (R-12 thru R-48/O)	Commercial Zones	Totals
A. 2001 Dwelling Unit Capacity**	158	497	598	170	524	y***	1,947 + y
B. 2001 – 2006 Permitted Units (capacity consumed)	50	77	191	120	1	99	538
Current Capacity (A minus B)	108	420	407	50	523		1,409 + y

*Capacity = land available for development or redevelopment current zoning
**2001 Carrying Capacity Analysis conducted for the 2002 Comprehensive Plan Update
***y = Undetermined capacity in Commercial Zones (CBD & TB)

As Table 3 below indicates, with a current capacity of capacity of 1409 housing units (Table 1) in all residential zones and an allocation balance of 1331 (Table 2) this leaves a surplus capacity of 78 housing units not including any residential capacity in any commercial zone.

Table 3. Housing Allocation Surplus

Current Carrying Capacity	1409
Housing Allocation Balance	-1331
Housing Allocation Surplus	78

Neither the 2001 analysis nor the table above identify the capacity in the Central Business District (CBD) and Tourist Business (TB) zones to accommodate housing units. Both of these zones allow residential development. Since 2002, 99 units have been permitted for three relatively small projects located in the CBD zone. There are

two projects currently undergoing building permit review (permits not issued yet) that could provide another approximately 700 to 720 housing units. One of these projects will be constructed in the TB zone and the other in a Multi-family/Office zone next to downtown. If both of these projects are approved for the number of units submitted, then the Housing Allocation balance (units to be provided) would be reduced to just over 600 units. The redevelopment of a 20-acre mobile home park in downtown and other development currently being discussed for various locations in the CBD zone indicates there is a potential for all of the City's remaining GMA Housing Allocation to be provided by mixed-use commercially zoned projects. This reduces, if not eliminates, the need to rely on the residential zoned areas to fulfill the City's housing obligation under the State's GMA and King County's Countywide Planning Policies for more than 15 years.

Since incorporation in 1993, it has been an expressed goal and vision of the City to preserve "our Northwest woodland character." The R-1 Zone area represents approximately 30% of the total acres of the City, and approximately 50% of the residentially zoned land. It also contains a significant amount of the City's native tree cover and wooded hillsides, the primary elements that define Northwest woodland character. While the City strives to fulfill its obligation to provide housing, it will be important to take advantage of the carrying capacity outside of the R-1 Zone area in order to retain these important and unique elements for future generations.

In addition, the city's Comprehensive Plan Map indicates an area of annexation. This annexation area is already heavily developed with commercial and industrial. Limited residential, if any, would contribute to the city's capacity.

Chapter 4. Conclusion

This report on neighborhood character reveals that the R-1 Area of Woodinville has five neighborhood subareas with distinctive character that could be diminished if redevelopment occurred at higher than existing densities, which for the most part are zoned R-1. This conclusion is based on methods of character identification that included visual surveys and overlay mapping iterations of human-made, physical, and environmental phenomena. This analysis was performed with the intent of identifying neighborhood character and validating its importance as a vital element in certain neighborhoods of Woodinville.

There is no great difference of opinion as to what makes a neighborhood a good place to live from an urban design standpoint. People wish to have a comfortable living environment, be in touch with the beauty of nature, and to be safe and free from stress. Many of the elements that make up such an environment have been considered in this report. People also wish to know that their neighborhoods will be guarded against physical deterioration and against loss of safety, privacy, and security. Preservation of existing character supports these objectives and promotes neighborhood loyalty and pride.

In conclusion, neighborhood character has an important place along with environment, transportation, and capital facility concerns in the Sustainable Development Study.

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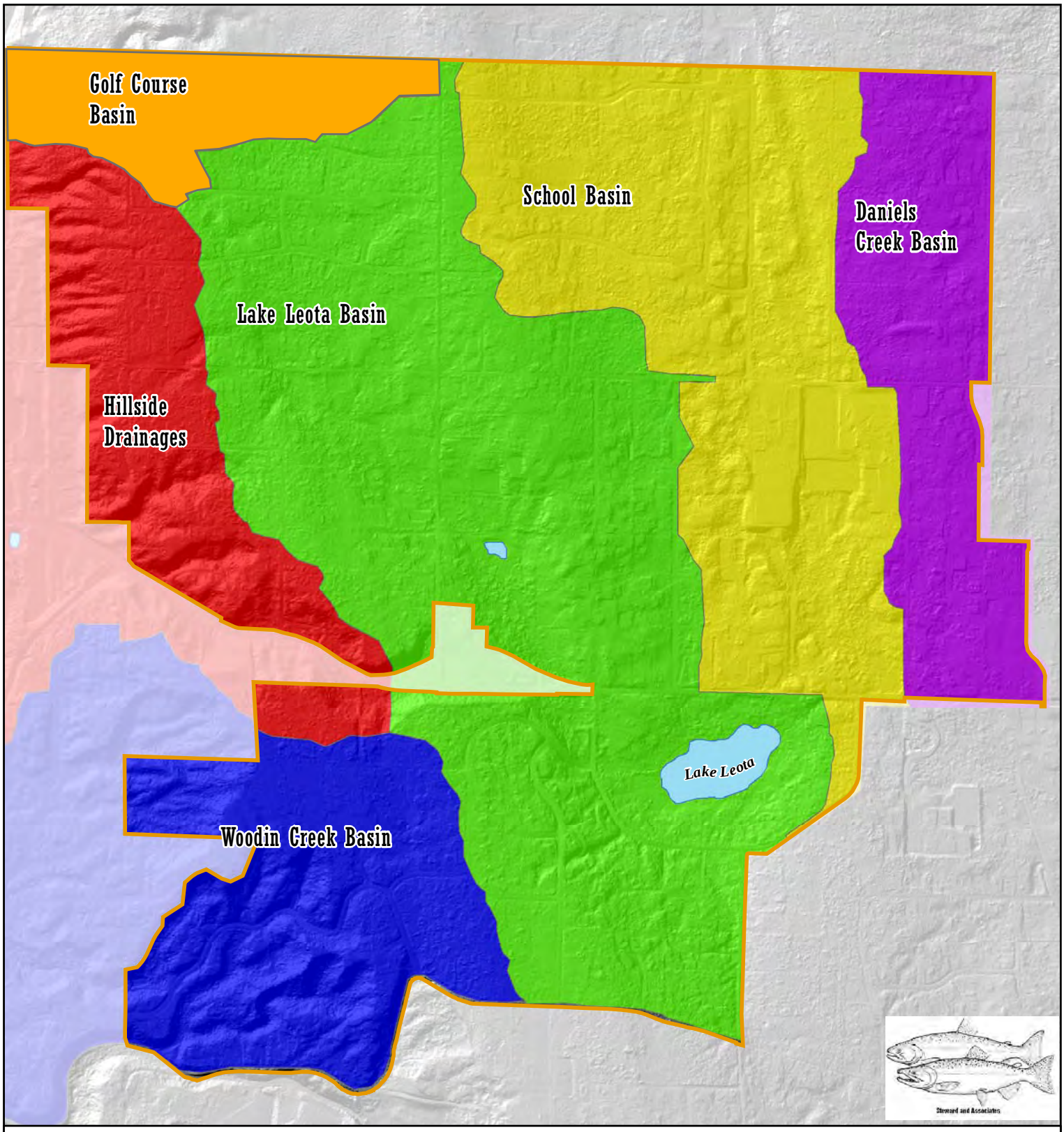
Appendix A

Woodinville Drainage Areas



Appendix A. Woodinville Drainage Areas

Drainage areas

- Hillside Drainages
- School Basin
- Daniels Creek Basin
- Woodin Creek Basin
- Lake Leota Basin
- Golf Course Basin
- R-1 boundary
- Waterbodies

0 0.5 Miles

N W E S

1:13,500

Appendix B

Independent Second Assessment of Neighborhood Character

Appendix B. Independent Second Assessment of Neighborhood Character

B.1. Introduction

Following an initial analysis by Bob Wuotila, Senior Planner, City of Woodinville, other city staff conducted a follow-up analysis of neighborhood character using a well-defined system of how numerical values were assigned to each of the twelve neighborhood indicators outlined in the Neighborhood Character report in Attachment B. After developing the methodology for how numeric values are allocated, city staff made field reconnaissance of the neighborhood subareas and applied the methodology to allocate numeric values in each of the twelve neighborhood subareas in the R-1 area. This appendix does the following:

1. Outlines the methodology of allocating numeric values among neighborhood subareas;
2. Shows the results of the neighborhood character reconnaissance conducted by city staff;
3. Shows a revised matrix (Figure B-1, a revised version of Figure 10 from Attachment B); and
4. Shows a revised version of Figure 19 from Attachment B, showing the neighborhoods with high enough numeric value to rank as being recognized for neighborhood character.

The results of the analysis, though different in the ultimate numeric value totals for each neighborhood subarea, are generally the same. Only two neighborhood subareas changed in ranking of recognition for neighborhood character. Four of the five neighborhood subareas that were recognized as having important neighborhood character in Bob Wuotila's analysis retained that recognition in the city's follow-up analysis. One of the five neighborhoods recognized for neighborhood character had its score drop enough that it was no longer recognized for its neighborhood character (Southwest Wellington), while another neighborhood subarea that was not recognized for neighborhood character in Bob Wuotila's analysis (South Leota) rose to a high enough score to gain recognition in this follow-up. The resulting analysis points both to the qualitative nature of this neighborhood character analysis, but also the level of commonality between the two analyses: four of the twelve neighborhood subareas retain high ranking neighborhood character rankings in two independent neighborhood character analyses.

B.2. Methodology of Applying Indicators to Neighborhood Character Evaluation:

The methodology of applying indicators of neighborhood character to the individual neighborhood subareas is outlined below. The methodology indicates how staff judged whether or not a specified indicator received a certain score.

Physiographic Niche (PN)

See Figure 4 of Attachment B.

- One indicator of PN is ranked a “3”,
- Two PN indicators would rate a “2” and
- Three types or more of PN would be rated a “1”.

Canopy Cover > 75% (CCov)

Each parcel on the parcel map was reviewed to see where parcels with 50% canopy cover existed. A figure was created that shows parcels with less than 50% canopy cover in brown (see Figure 11).

- Neighborhoods with 75% or greater canopy cover was ranked a “3”;
- Neighborhoods with 50% - 74% canopy cover was ranked a “2”.
- There were no neighborhoods less than 50% canopy cover.

Manicured Landscape (ML)

- Neighborhoods with 90% or greater ML was rated a “3”,
- Neighborhoods with 70%-89% ML rated a “2” and
- Neighborhoods with less than 70% ML rated a “1”.

Common View Shed (CVS)

Views of significant features such as lakes and mountains were rated.

- Neighborhoods with multiple views CVS rated a “3”,
- Neighborhoods with one view CVS rated a “2”, and
- Neighborhoods with no view rated a “1”.

Circulation Connectivity (CCon)

- More than two interior connections rated a “3”,
- Two connections rated a “2”, and
- One connection rated a “1”.

Parcel Accessibility (PA)

In addition to presence of well-defined roads with consistent rights-of-way, this indicator also includes consistent spacing of driveway accesses.

- A neighborhood that had 90% or more PA spacing characteristic was rated a “3”,
- A neighborhood with 70% - 89% PA was rated a “2”, and
- A neighborhood with less than 70% PA was rated a “1”

Cohesive Block Configuration (CBC)

- Neighborhoods with 90% or more CBC characteristic was rated a “3”,
- Neighborhoods with 70% - 89% CBC was rated a “2”, and
- Neighborhoods with less than 70% CBC was rated a “1”

Pattern of Lot Size (PLS)

See Figure 13 of Attachment B.

- Neighborhoods with 90% or more PLS was rated a “3”,
- Neighborhoods with 70% - 89% PLS was rated a “2”, and
- Neighborhoods with less than 70% PLS was rated a “1”

Sense of Scale and Fabric (SSF)

- Neighborhoods with 90% or more SSF were rated a “3”,
- Neighborhoods with 70% - 89% SSF was rated a “2”, and
- Neighborhoods with less than 70% SSF was rated a “1”

Cohesive Street Presence (CSP)

- If a neighborhood had streets with three types of CSP was rated a “3”,
- If a neighborhood had two characteristics of CSP, it was rated “2”, and

- If a neighborhood had one characteristic of CSP it was rated a “1”

Building Rhythm and Order (BRO)

See Figure 14 of Attachment B.

- If 90% or more of neighborhoods had BRO, it was rated a “3”,
- If 70% - 89% of neighborhoods had BRO, it was rated a “2”, and
- If less than 70% of neighborhoods had BRO, it was rated a “1”

Low In-Fill Potential (LIFP)

- If 90% or more of neighborhoods had LIFP, they were rated a “3”,
- If 70% - 89% of neighborhoods had LIFP, they were rated a “2”, and
- If less than 70% had LIFP, they were rated a “1”

B.3. Results of City Field Survey pf Neighborhood Character

This section represents the results of a field survey conducted by Ron Braun, Plans Examiner, City of Woodinville Development Services Department. Mr. Braun’s field survey used the methodology outlined in the section above to allocate numeric values to the neighborhood subareas found in Attachment B. To provide context, the neighborhood descriptions for each subarea leads into the results of the field survey for each subarea.

B.3.1. Northwest Wellington

The neighborhood is heavily wooded, has excellent spatial order and building texture, cohesive circulation, and is visually cohesive in terms of buildings, block patterns and streets that together crisply define neighborhood boundaries.

1. PN: Gentle slopes and plains. The western edge is an undeveloped ice scoured slope.
2. CC: 90% of area
3. ML: 85% of area
4. CV: The western edge does have potential view of Cascades/Olympics
5. CC: Many roads connect internally
6. PA: Roads are consistent in configuration in this planned development
7. CBC: Roads follow contours, spacing of development roads are consistent

8. PLS: 80% of neighborhood falls within ½ to 1 acre lots – two proposed development areas are the exceptions.
9. SSF: The development configuration is similar in house setbacks, landscape design, house size and building materials consistency.
10. CSP: Streets are consistent with roadway profiles and lighting – no street landscaping
11. BRO: Neighborhood homes are consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is no potential for infill other that the two proposed development areas.

B.3.2. Southwest Wellington

Accessibility and lot configuration go far in defining this neighborhood. External access is limited, which makes for an enclave-like place. The wooded setting adds immensely to a sense of place.

1. PN: Gentle slopes and plains. The western undeveloped area ice scoured slope.
2. CC: 90% of area
3. ML: 25% of area
4. CV: The western edge does have potential view of Cascades/Olympics
5. CC: There are no through roads. This neighborhood is cut in half with separate access points.
6. PA: several choke points because of slopes
7. CBC: Roads follow a grid pattern – not connected
8. PLS: 20% of neighborhood falls within ½ to 1 acre lots, 40% of neighborhood falls within 1 to 2 acre lots & 40% of neighborhood falls within 2 to 5 acre lots.
9. SSF: Older developments with newer short plat build-outs. Each type of development has its own character.
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are semi-consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is great potential for infill

B.3.3. North Wellington

With few exceptions, this neighborhood is defined by its location in a physiographic plain and by the degree of road connectivity. External accessibility also goes far in defining boundaries and enclosing the neighborhood.

1. PN: Gentle slopes and plains.
2. CC: 90% of area
3. ML: 80% of area
4. CV: none
5. CC: Many roads connect internally
6. PA: Roads are consistent in configuration in this planned development
7. CBC: Roads follow contours, spacing of development roads are consistent
8. PLS: 80% of neighborhood falls within ½ to 1 acre lots – with the exception of a central cluster of older homes on larger lots
9. SSF: The development configuration is similar in house setbacks, landscape design, house size and building materials consistency.
10. CSP: Streets are consistent with roadway profiles and lighting – no street landscaping
11. BRO: Neighborhood homes are consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is some potential for infill in the central cluster area

B.3.4. Central Wellington

There is only one major access into this neighborhood, NE 195th Street. Other minor roads connect from different directions and are closed off or dead ends. It is somewhat more defined by adjacent neighborhoods than it is unto itself.

1. PN: Gentle slopes and plains.
2. CC: 80% of area
3. ML: 70% of area
4. CV: none
5. CC: There are no through roads. This neighborhood is cut in half with separate access points.

6. PA: Roads are inconsistent in configuration with planned development, there is a chokepoint on 195th
7. CBC: Roads generally follow a grid pattern – not connected
8. PLS: 60% of neighborhood falls within ½ to 1 acre lots – 30% of neighborhood falls within 1 to 2 acre lots & 10% of neighborhood falls within ¼ to ½ acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 70% very high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and variations of street lighting, street landscape
11. BRO: Neighborhood homes are mostly consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is some potential for infill along two of the outer edges

B.3.5. South Wellington

This area is commonly accessed off of 156th Avenue NE. It contains many unimproved or private roads which are the result of short plat activity. Its boundaries, like Central Wellington, are easily defined by adjacent neighborhoods.

1. PN: Gentle slopes and plains.
2. CC: 80% of area
3. ML: 20% of area
4. CV: none
5. CC: There are no through roads. This neighborhood is fronts 156th and old Wood-Duvall Rd.
6. PA: Roads are inconsistent in configuration in this planned development with many gravel roads
7. CBC: Roads generally follow a grid pattern – not connected
8. PLS: 20% of neighborhood falls within ½ to 1 acre lots – 30% of neighborhood falls within 1 to 2 acre lots, 30% of neighborhood falls within 2 to 5 acre lots & 20% of neighborhood falls within 5 to 10 acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 20% high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are inconsistent in placement using topography to their advantage for placement and orientation.

12. LIP: There is great potential for infill

B.3.6. Northeast Wellington

This is a neighborhood defined primarily by the constricted nature of access. There is only one way in and one way out via 168th Avenue NE. It is further isolated by school property occupying the major portion of its southern extremity.

1. PN: Gentle slopes and plains.
2. CC: 85% of area
3. ML: 30% of area
4. CV: none
5. CC: There are no through roads. This neighborhood must travel through 168th to get to Woodinville Duvall rd.
6. PA: Roads are inconsistent in configuration in this planned development with many gravel roads
7. CBC: Roads generally follow a grid pattern – not connected
8. PLS: 20% of neighborhood falls within ½ to 1 acre lots – 50% of neighborhood falls within 1 to 2 acre lots, 20% of neighborhood falls within 2 to 5 acre lots & 10% of neighborhood falls within 5 to 10 acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 30% high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are semi-consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is great potential for infill

B.3.7. North Leota

North Leota is characterized by its adjacency to Woodinville-Duvall Road and by its broad range of lot sizes. There is no connectivity in any sense of the term, but occupies the greatest extent of the Leota outwash plain niche.

1. PN: Gentle slopes and mainly plains.
2. CC: 80% of area
3. ML: 15% of area

4. CV: none
5. CC: There are no through roads. This neighborhood must travel through 168th to get to Woodinville Duvall Rd.
6. PA: Roads are inconsistent in configuration in this planned development with many gravel roads
7. CBC: Roads generally follow a grid pattern – not connected
8. PLS: 20% of neighborhood falls within ½ to 1 acre lots – 20% of neighborhood falls within 1 to 2 acre lots, 30% of neighborhood falls within 2 to 5 acre lots & 30% of neighborhood falls within 5 to 10 acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 10% high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are inconsistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is great potential for infill

B.3.8. Leota

This neighborhood is the most definitive in the study area. Common views, common access, lot configuration enclosure and wooded nature make this one of Woodinville's most distinct places.

1. PN: Gentle slopes and plains.
2. CC: 95% of area
3. ML: 50% of area
4. CV: Lake Leota
5. CC: There is internal circulation
6. PA: Roads are consistent in configuration with planned development
7. CBC: Roads follow contours, spacing of development roads are consistent
8. PLS: 40% of neighborhood falls within ½ to 1 acre lots – 30% of neighborhood falls within ¼ to ½ acre lots, 25% of neighborhood falls within 1 to 2 acre lots & 5% of neighborhood falls within .03 to ¼ acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 30% high order building types/scale/landscaping

10. CSP: Streets are consistent with roadway profiles and lighting – no street landscaping
11. BRO: Neighborhood homes are inconsistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is some potential for infill

B.3.9. South Leota

This is a very definitive neighborhood, all on an even grade, northeast facing, afternoon shaded, wooded slope. Political boundaries and transportation network provide strong elements to boundary definition.

1. PN: Gentle slopes
2. CC: 80% of area
3. ML: 30% of area
4. CV: Lake Leota
5. CC: There is internal circulation
6. PA: Roads are semi-consistent in configuration with planned development
7. CBC: Roads follow contours, spacing of development roads are consistent
8. PLS: 15% of neighborhood falls within ¼ to ½ acre lots – 35% of neighborhood falls within ½ to 1 acre lots, 25% of neighborhood falls within 1 to 2 acre lots & 25% of neighborhood falls within 2 to 5 acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 30% high order building types/scale/landscaping
10. CSP: Streets are consistent with roadway profiles and lighting – no street landscaping
11. BRO: Neighborhood homes are inconsistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is potential for infill

B.3.10. Laurel Plateau

Terrace-flat topography defines this neighborhood. Steep slopes and formal subdivision boundaries confine this area into one neighborhood.

1. PN: Gentle slopes and plains. The western edge is an undeveloped ice scoured slope.
2. CC: 70% of area

3. ML: 30% of area
4. CV: The western edge does have potential view of Cascades/Olympics
5. CC: There is no internal circulation
6. PA: Roads are inconsistent in configuration with planned development – many gravel roads – substandard access road
7. CBC: Roads generally follow a grid pattern – not connected
8. PLS: 20% of neighborhood falls within ½ to 1 acre lots, 20% of neighborhood falls within 1 to 2 acre lots, 30% of neighborhood falls within 2 to 5 acre lots & 30% of neighborhood falls within 10 to 20 acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 30% high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are inconsistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is great potential for infill in the central cluster area

B.3.11. Woodway-Laurel Hills

This neighborhood predominantly consists of two formal subdivisions that have similar street networks and topography. Ridge and slope topography characterize its common physiographic niche, and its richly manicured landscape amidst tall woods create a common definitive sense of place.

1. PN: Gentle slopes and plains and ice scoured slopes
2. CC: 95% of area
3. ML: 90% of area
4. CV: A few see Lake Leota
5. CC: Many roads connect internally. There is one gravel road
6. PA: Roads are consistent in configuration in this planned development
7. CBC: Roads follow contours, spacing of development roads are consistent
8. PLS: 75% of neighborhood falls within ½ to 1 acre lots, 15% of neighborhood falls within 1 to 2 acre lots & 10% of neighborhood falls within 2 to 5 acre lots

9. SSF: The development configuration is similar in house setbacks, landscape design, house size and building materials consistency.
10. CSP: Streets are consistent with roadway profiles, lighting – no street landscaping
11. BRO: Neighborhood homes are consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is little potential for infill in given the terrain features (3 lots)

B.3.12. Lower Woodway

This neighborhood located in the southwest fringe of the study area has common access off of NE 173rd Street. Steep slopes are common throughout. Its identity is achieved by its adjacent neighbor, and its isolation due to access and topography.

1. PN: Ice scoured slopes
2. CC: 95% of area
3. ML: 50% of area
4. CV: none
5. CC: Single access road
6. PA: Roads are inconsistent in configuration with a planned development, seem narrow because of slopes
7. CBC: Roads follow contours
8. PLS: 30% of neighborhood falls within ½ to 1 acre lots, 40% of neighborhood falls within 1 to 2 acre lots, 25% of neighborhood falls within 2 to 5 acre lots & 5% of neighborhood falls within ¼ to ½ acre lots
9. SSF: The neighborhood is divided in types in the percentages described above with 30% high order building types/scale/landscaping
10. CSP: There is no consistency with street roadway sections and little street lighting
11. BRO: Neighborhood homes are semi-consistent in placement using topography to their advantage for placement and orientation.
12. LIP: There is some potential for infill

B.3.13. Neighborhood Character Typologies Resulting from Field Survey

The results of the supplemental review of neighborhood character, applying the methodology outlined in this appendix is shown in Figure B-1 on the following page. Although there were slight variations in the scores received by most neighborhood subareas in comparison to the analysis conducted by Bob Wuotila, Senior Planner, in the body of the Neighborhood Character report, for the most part, changes were small. The main differences with regards to neighborhood character were that Southwest Wellington's score was lowered by eight points, removing it from classification as a neighborhood with high enough character value to obtain recognition. In addition, South Leota neighborhood subarea gained one point, pushing it into the range at which neighborhood subareas are recognized for their neighborhood character. A revised Figure 19 (shown as B-19), with shading based upon the revised neighborhood character analysis contained in this appendix follows Figure B-1.

Figure B-1. Neighborhood Characteristic Typologies

R-1 AREA NEIGHBORHOOD CHARACTERISTIC TYPOLOGIES

NEIGHBORHOODS	INDICATORS	PHYSIOGRAPHIC NICHE	CANOPY COVER > 75%	MANICURED LANDSCAPE	COMMON VIEW SHED	CIRCULATION CONNECTIVITY	PARCEL ACCESSIBILITY	COHESIVE BLOCK CONFIGURATION	PATTERS OF LOT SIZES	SENSE OF SCALE AND FABRIC	COHESIVE STREET PRESENCE	BUILDING RHYTHM AND ORDER	LOW INFILL POTENTIAL
Northwest Wellington*	30		■	▒	▒	■	■	■	▒	■	▒	■	■
Southwest Wellington	16		■		▒							▒	
North Wellington*	30		■			■	■	■	■	■	▒	■	▒
Central Wellington	19		■	▒									▒
South Wellington	15		■										
Northeast Wellington	16		■									▒	
North Leota	15		■										
Leota*	24		■		▒	■	■	■			▒		▒
South Leota*	24	▒	■		▒	■	▒	■			▒		▒
Laurel Plateau	14		▒		▒								
Woodway Laurel Hills*	32		■	■	▒	■	■	■	■	■		■	■
Lower Woodway	20	▒	■					■				▒	▒

* Recommendation for Neighborhood Character Protection

■ = HIGH ASSOCIATION ▒ = MEDIUM ASSOCIATION □ = LOW ASSOCIATION

FIGURE B-1: NEIGHBORHOOD CHARACTER TYPOLOGIES BASED UPON APPENDIX B METHODOLOGY

City of Woodinville

Sustainable Development Project

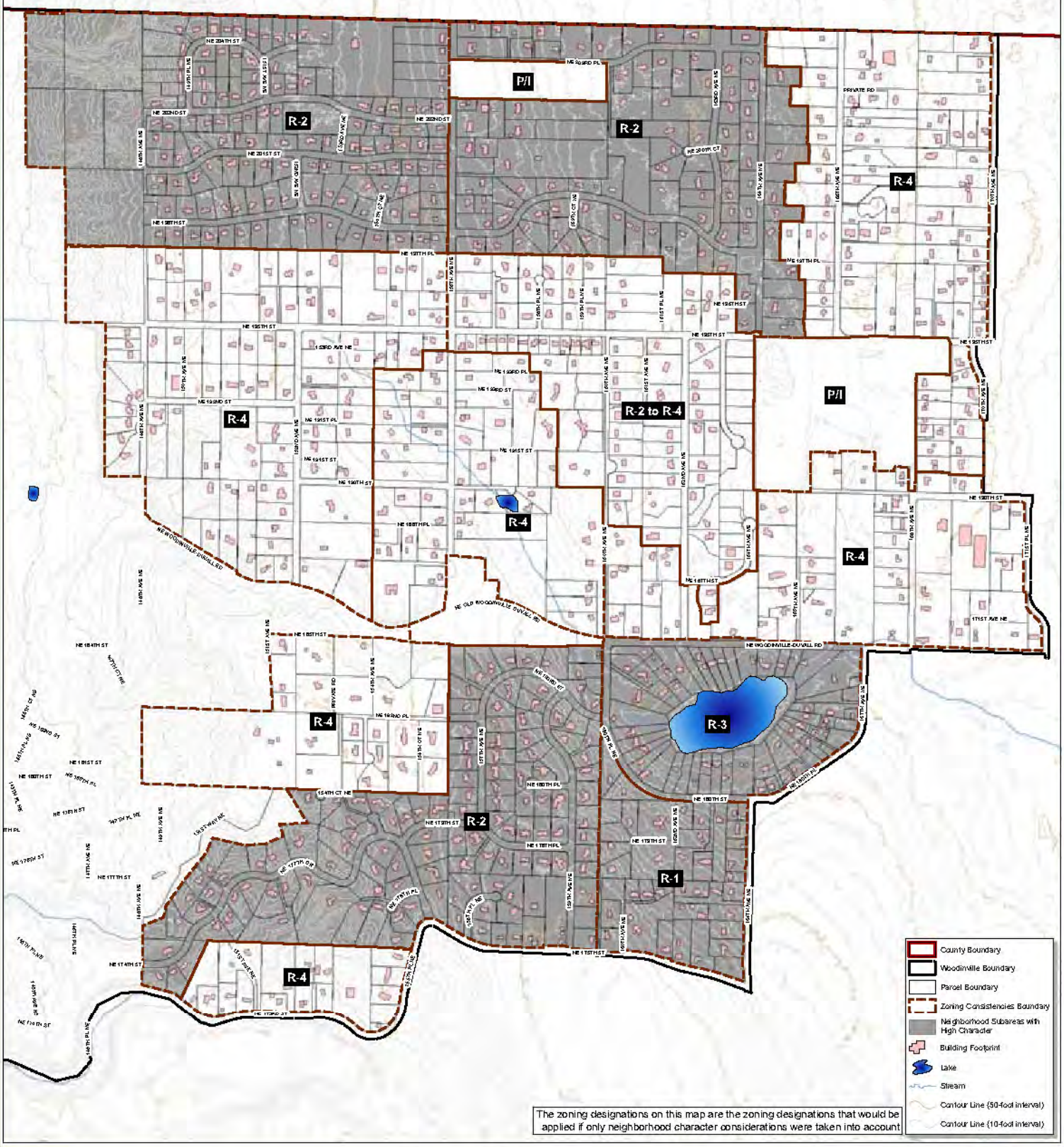


Figure B-19

Zoning Consistencies with Neighborhood Character

(Version 2)

0 500 1,000

Feet

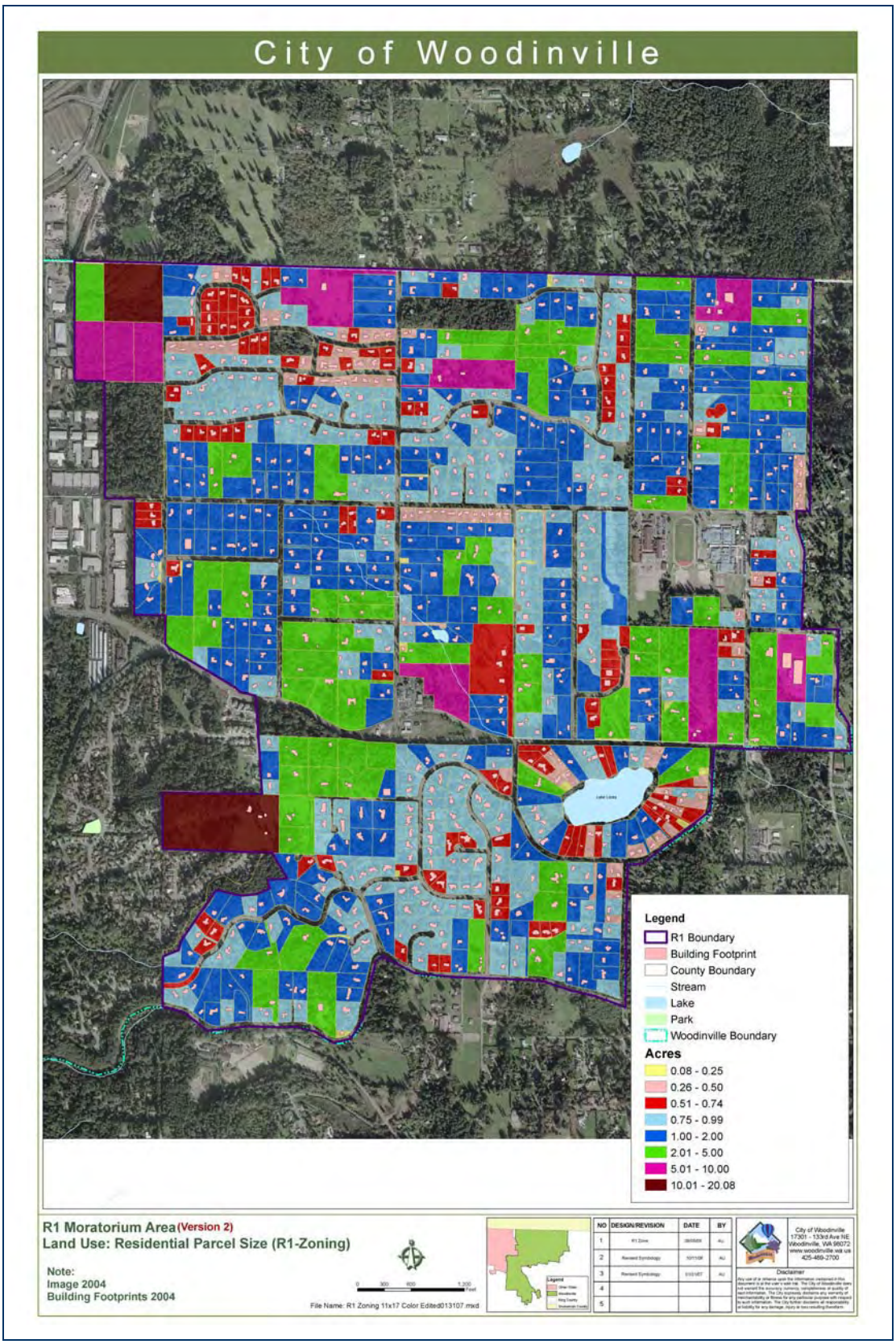
Appendix C

Additional Parcel Size Map

Appendix C.Additional Parcel Size Map

An additional parcel size map has been provided to add further detail to the parcels of less than one acre. Figure 18 in the body of the Neighborhood Character Report (Attachment B) breaks down parcel sizes by 0-0.25 acres; 0.26-0.5 acres; and 0.51-1.00 acres. This new parcel size map breaks up the 0.51-1.00 acre category into two new categories: 0.51-0.75 acres and 0.76-1.00 acres. The new map is provided as a reference point and to help refine the distinctions for lots under one acre in size in the R-1 area.

Figure C-1. Parcel Size Map Version 2



Attachment C. Transportation Report

Transportation (City of Woodinville)

Transportation
City of Woodinville

January 2007
Revised February 2007

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List of Acronyms

CIP	Capital Improvement Program
City	City of Woodinville
HD	High-Density
LOS	Level of Service
LW	Low-Density

1. Introduction

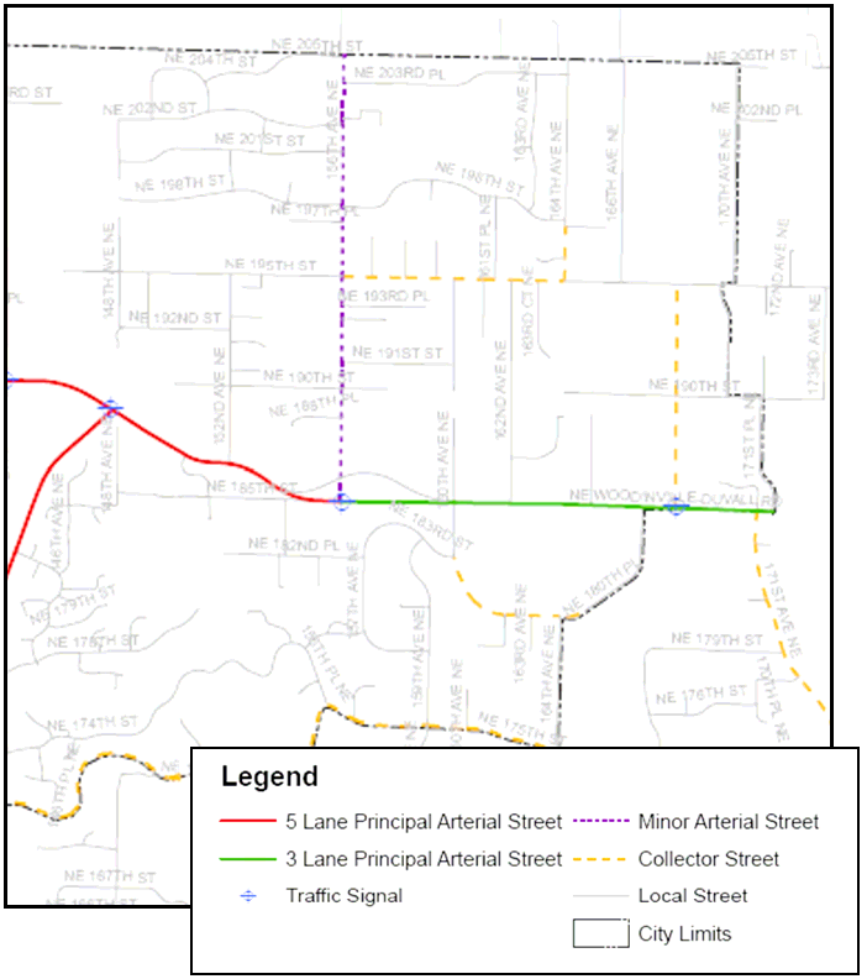
This section reviews the motorized vehicle transportation system within Woodinville's R-1 zone that includes the existing roadway system: physical characteristics, current standards design comparison, intersection level of service, and circulation. It then discusses the potential for future needs and possible alternatives to address any future needs within the R-1 zone.

The R-1 zone is served by one major east-west arterial (Woodinville-Duvall Road), a minor north-south arterial (156th Avenue NE), and several collector arterial roadways. The roadway classifications are shown on Figure 1. All other roadways in this zone are residential classification (shown as local streets). With the exception of Woodinville-Duvall Road, west 160th Avenue NE and the approximately 300 feet of the southern terminus of 156th Avenue NE, all roadways are two-lane road ways. Most trip generators (e.g., trip destinations that attract multiple travelers such as a shopping center) are to the west of the R-1 zone. Included are both employment and shopping/service establishments.

A citywide traffic model had been prepared by the City of Woodinville (City) for a 20-year travel demand forecast as part of the City's Traffic Impact Fee program, adopted in 2004. The deficiencies identified from this effort have been included in the City's Capital Improvement Program and are discussed later in this section.

Most roads within the R-1 zone area were developed under King County development standards (Pre-City incorporation).

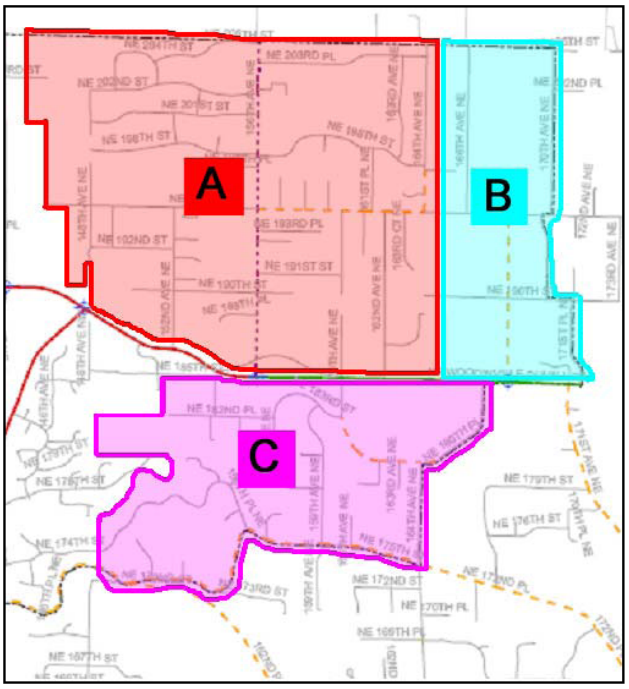
Figure 1. Roadway Classifications



2. Existing Roadway Systems

In the R-1 zone, there are three distinctive roadway systems. These are defined by sharing common arterial/collector service roadways and are shown in Figure 2.

Figure 2. R-1 Area Roadway Systems



2.1. System A

Located in the northwesterly area, most properties are accessed by 156th Avenue NE, which is classified as a minor arterial street. The properties not serviced by 156th Avenue NE are accessed to the south along Woodinville-Duvall Road.

The general characteristics of these roads are asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The terrain generally has gentle grade changes except at some sections of the far west edge and south-west slope. All grades in this section appear to be below the 15% grade slope standard. The layout is typically long block sections with some gentle curves. Only a very small percentage of streets in this area have curbs and gutters or sidewalks.

Internal circulation is possible in the northwesterly and northeasterly neighborhoods. Most other roadways are non-through streets with the exception of NE 195th Street which has a gate across the public roadway. Ingress and egress travel from these neighborhoods is possible from both the north and south travel along 156th Avenue NE.

Some restricted vertical sight distance[1] conditions have been identified in this area in the northwesterly neighborhoods.

2.2. System B

Located in the northeasterly area, the only City-identified collector road is 168th Avenue NE. However, there are other roadways providing ingress and egress from this area. There is a public school zone within this area.

The general characteristics of these roads are asphalt pavement with some areas of gravel shoulders and a mixture of open ditch or open shoulder drainage. The terrain has gentle grade changes. All grades in this section appear to be below the 15% grade slope standard. The layout is typically long, straight, aligned block sections. Only a very small percentage of streets in this area have curbs and gutters or sidewalks. Most sidewalk sections are in the newer development constructed after the City's incorporation.

Internal circulation is possible but is poor as there is only one route possible in all cases without having to enter onto a major arterial.

One restricted vertical sight distance concern has been identified in this area.

2.3. System C

Located in the southerly area, this area is serviced by Woodinville-Duvall Road to the north and NE 171st/175th Street to the south. Several properties in this area have access directly off Woodinville-Duvall Road and NE 171st/175th Street.

The general characteristics of these roads are asphalt pavement with some areas of paved shoulders along one side and a mixture of open ditch or open shoulder drainage. The terrain has gentle to moderate (hill slope) grade changes. Some grades

[1] Sight distance is defined as the distance in which two approaching vehicles have a visual fix on each other's vehicles sufficient for a safe reaction time for the posted speed limit. A restricted sight distance means that the distance is not sufficient for a safe reaction time.

in this section appear to be the 15% grade slope standard. The layout is typically long block sections with gentle to moderate curve sections. No streets were identified in this area to have sections with curbs and gutters or sidewalks.

Internal circulation is fair.

No sight distance concerns have been identified in this area.

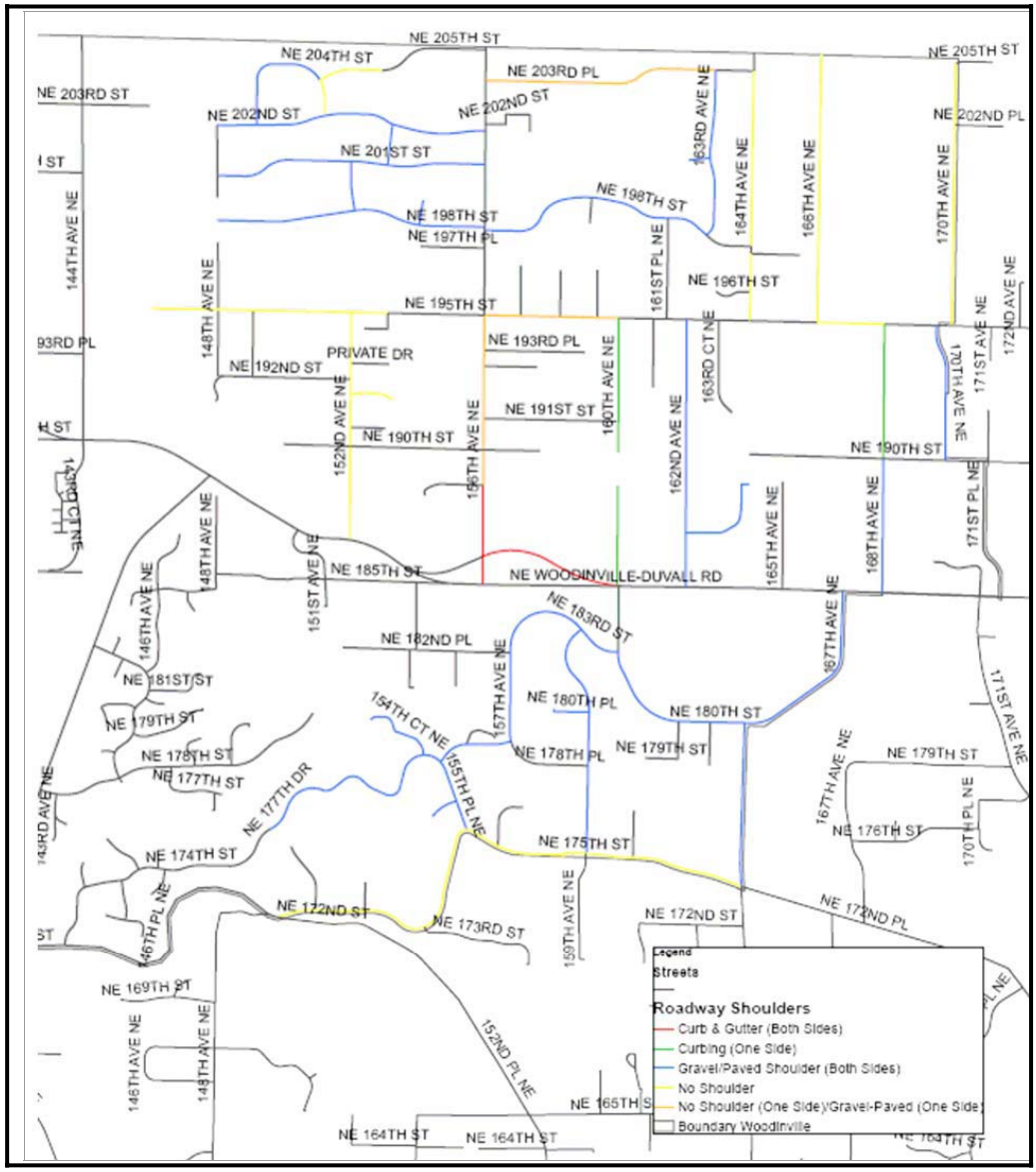
3. Road Standards

The existing roads within all three zones had been reviewed to determine if current road standards are met and, in any sub-standard areas, to assess what measures would be necessary to bring a roadway into compliance. Included is an analysis of the physical cross-section of the existing roadway including shoulders, drainage, and sidewalks (designated walking surface). Variations to the existing standards, such as shoulder material (paved or gravel), location of the walkway (set back or adjacent to roadway lane edge), and drainage system (underground or open ditch) are allowed under current standards and were taken into consideration in this review. Sight distance standards were not specifically reviewed in this document but there are several recognized vertical conditions that are currently under study by the City.

Initial review was performed with a “windshield” inspection of all roads that looked at widths, shoulder treatment, and pedestrian facilities. The condition of the pavement was not taken into consideration since this is a maintenance issue and does not significantly change whether the road meets standards.

The results of this review are shown on the map in Figure 3. The overview found that there is roughly an even split between shouldered and non-shoulder area with only a very small fraction of streets having curbs, gutters, or sidewalks. Most drainage was above ground in either open ditches or shoulder runoff, entering into open spaces off the roadway. Pavement width varied but most travel lane paved surfaces were at least 20 feet wide.

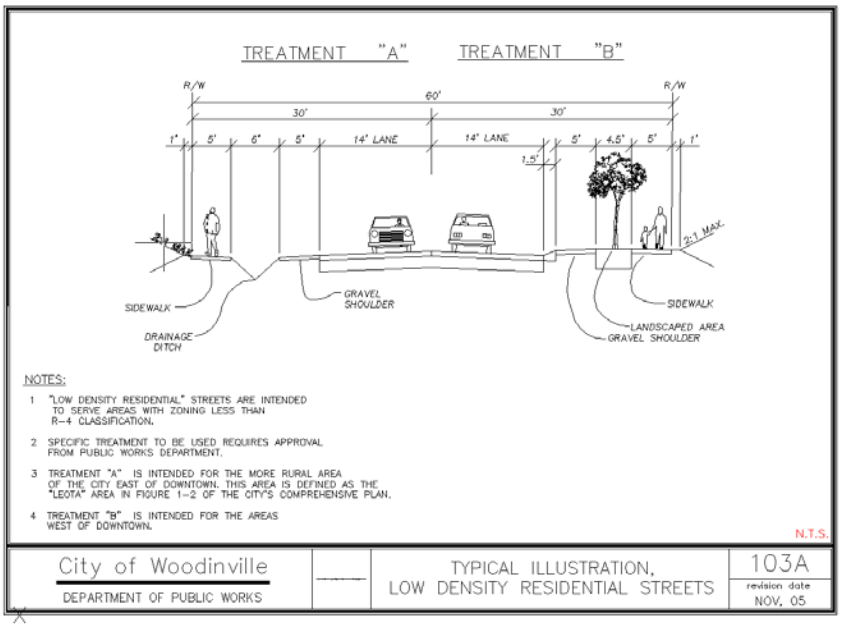
Figure 3. Existing Roadway Conditions



3.1. R-1 Zoning Local Road Standards

Local road standards for areas with zoning less than R-4 classification is defined under the "Low Density Residential Streets" standard 103A. This standard is shown in Figure 4. Typically Treatment "A" is used in the R-1 zone and was used in reviewing the current roadway cross-sections.

Figure 4. "Low Density Residential Streets" standard 103A



3.2. Local Road Findings

Most streets classified as local did not provide any pedestrian facilities. Approximately 50% did have some type of shouldering with about 50% of these areas having a shoulder width narrower than 5 feet. In some areas without shoulders, open ditches were adjacent to the edge of the pavement.

Driving lane widths varied greatly from 10 to 14 feet. Most local roads lanes in System A and System B were narrower than 14 feet in width. In System C, about 30% had driving lanes of14 feet in width.

Based on setting the standard at driving lane width, sidewalk (pathway) being provided on one side, and having a shoulder width of 5 feet (as defined in 103A), the majority of roads are considered to be substandard. Under life safety requirements of a minimum pavement width of 20 feet, the large majority of roadways meet this standard.

3.3. Arterial and Collector Road

These classifications of roadways are established in the Comprehensive Plan and are not specific to land zoning. These types of roadways are shown in Figure 1.

The standards for these roads are:

- 5-Lane Principal Arterial – Figure 5
- 3-Lane Principal Arterial – Figure 6
- Minor Arterial – Figure 7
- Collector – Figure 8

Figure 5. 5-Lane Principal Arterial with Bike Lanes Standards

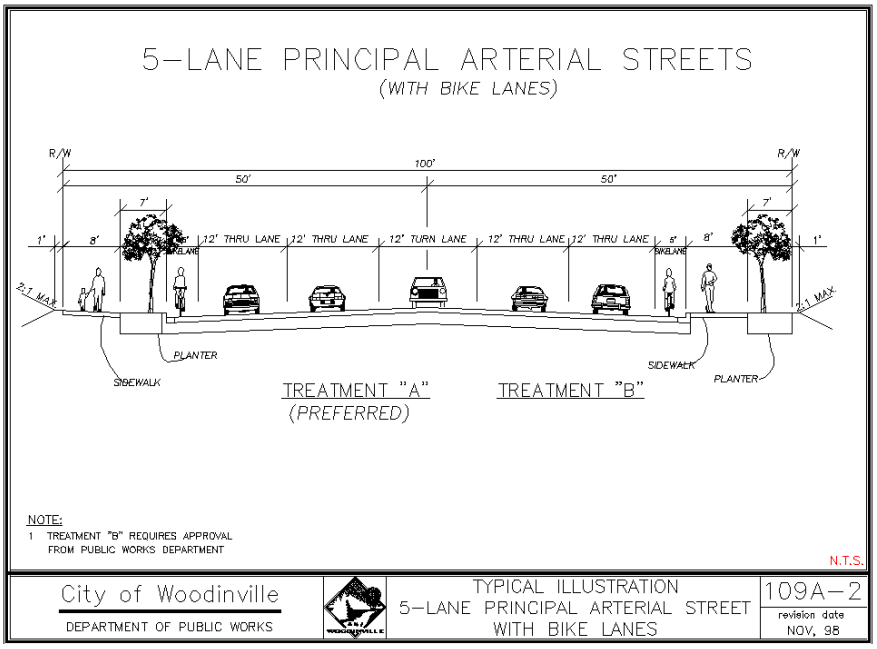


Figure 6. 3-Lane Principal Arterial with Bike Lanes Standards

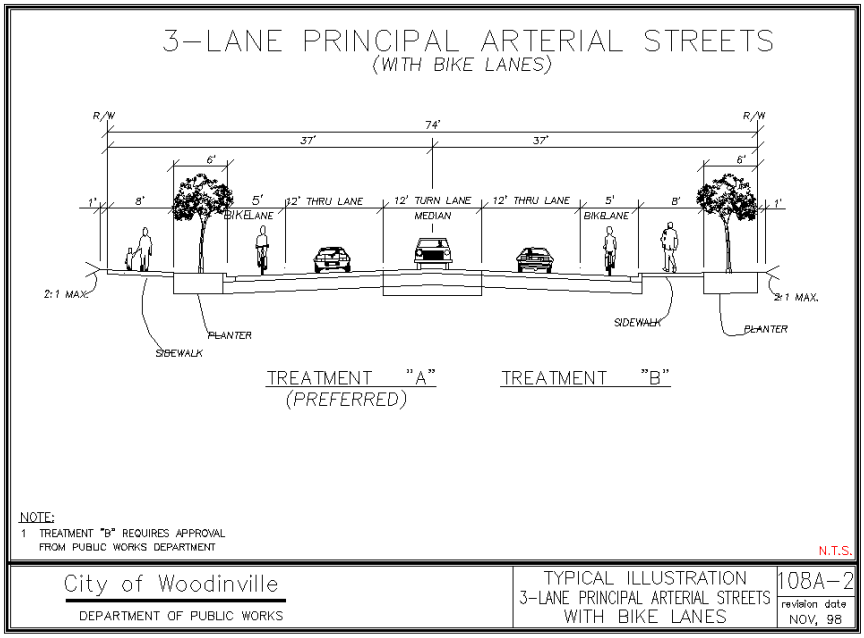


Figure 7. Minor Arterial with Bike Lane Standards

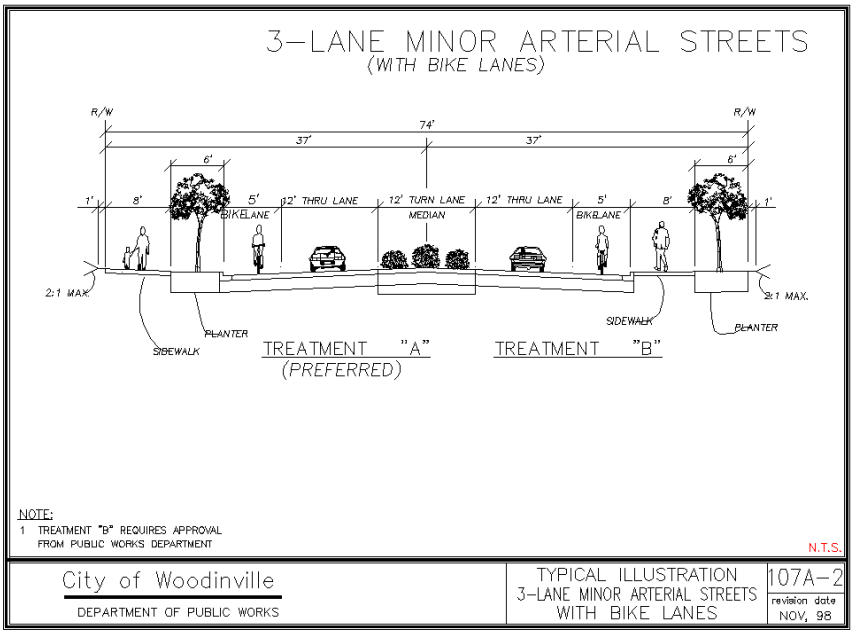
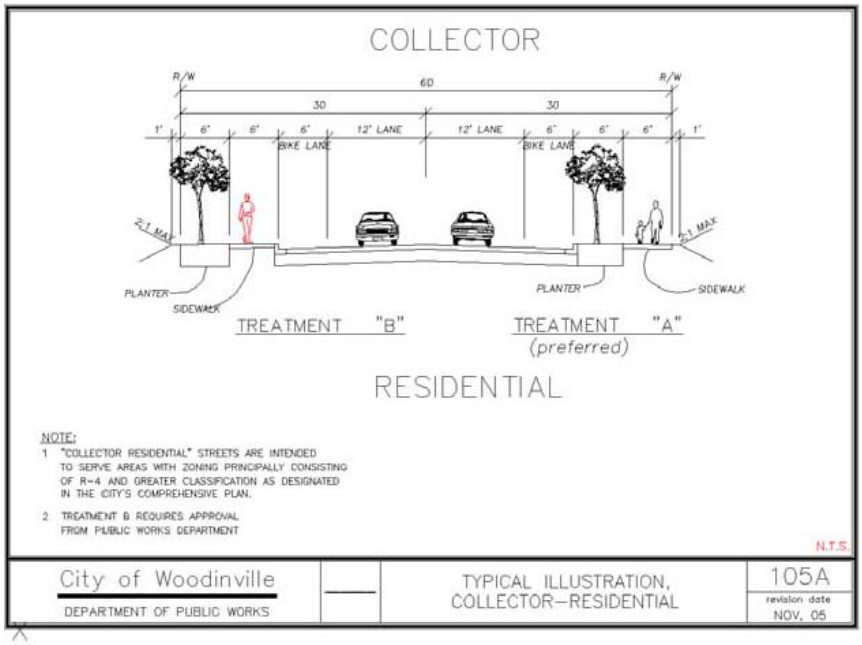


Figure 8. Collector with Bike Lane Standards



3.4. Arterial Findings

Woodinville-Duvall Road, west of 156th Avenue NE is classified as a 5-lane principal arterial designated with bike lanes. The current roadway configuration was performed under a City road improvement project in 1998 and a developer improvement in 2002. The road varies in lane configuration from 3 to 5 lanes. The shoulders are paved providing a mix of use for both bike and pedestrian travel.

This road segment does not meet current standards and has been included in the City's 20-year Capital Improvement Program (CIP). Future improvements are expected to bring the road up to a full 5-lane section over the entire length.

Woodinville-Duvall Road, east of 156th Avenue NE is classified as a 3-lane principal arterial designated with bike lanes. Additional intersection approach lanes and signal improvements were performed at the NE 156th Avenue NE and the 168th Avenue NE intersection under a City road widening project in 1998. The section between these two intersections is 2 lanes. The shoulders are paved, providing a mix of use for both bike and pedestrian travel. This road segment does not meet current standards and has been included in the City's 20-year CIP. Future improvements are expected to bring the road up to a full 3-lane section over the entire length.

156th Avenue NE is classified as a 3-lane minor arterial designated with bike lanes. Additional intersection approach lanes and signal improvements were performed

under a City road widening project in 1998. The section north of the intersection improvements is 2 lanes. The shoulder is paved along the west side of the road providing a mix of use for both bike and pedestrian travel. This road segment does not meet current standards and has been included in the City's 20-year CIP. Future improvements are expected to bring the road up to a full 3-lane section over the entire length.

NE 171st/NE 175th Street and the other collector roads are classified as 2-lane collector residential type roads with bike lanes. Since incorporation of the City, no known travel lane improvements to these roads have occurred. All collector roads are 2 lanes with a mixture of areas of shoulder and non-shoulder sections. The lane widths vary from 10.5- to 12-foot lanes. A few areas have minimal paved shoulders (narrower than 4 feet typically) with no designated area for bike travel. These road segments do not meet current standards. One segment, NE 171st/NE 175th, has been included in the 20-year CIP. Improvements to the other roads are expected at the time of redevelopment frontage improvements. Future improvements are expected to bring the roads up to a full 2-lane section over the entire length with possible turn lanes at key intersections.

3.5. R-4 and Greater Road Standards

Increasing the R-1 zoning to R-4 or higher (more density) affects only the residential road standard classification. Differing from residential road standards, collector and arterial road standards are not established by land use but by the traffic volume capacity needs. These road classifications were initially determined by modeling with a maximum density of R-4 within the R-1 zone area. This information indicates that the designated arterial and collector roads standards have sufficient capacity for future development of the R-1 zone to an R-4. Therefore, no further review of capacity for these classes of roadways is necessary.

In regard to constructability of this classification of roads, there is sufficient right of way for the construction of the full standard for the collector classification roadways. The current adopted arterial road standards, as shown in Figure 5, 6, and 7, cannot be constructed within the existing right of way width in most road sections. How to address this condition is discussed in the Low Impact Arterial Standard section of this report.

In regard to constructability of local roads, there is sufficient right of way, and this is discussed in Local Road Standards section of this report.

3.5.1. Low Impact Arterial Standards

To address arterial capacity and non-motorized facilities features of the current adopted Arterial standards within the existing right of way, a "low impact" standard has been proposed. This is based on a draft standard that was prepared for the City Council during the 2004-2010 CIP to allow for 3 lanes arterial road section within a 60 foot right of way for 156th Avenue NE and Woodinville-Duvall Road. It was also intended to have a minimum impact to adjacent properties and roadside vegetation (i.e. trees).

The Standards, shown in Figure 9 and Figure 10, are proposed standards. Treatment "A" matches the current adopted road standard section while Treatment "B" is the "low impact" section. It is likely that new development adjacent to one of these roadways would be required to construct to Treatment "A". Treatment "B" would like be the section used in the event that improvement were constructed either by the City or by a development as off-sight improvements.

In both proposed standards, the full capacity and function of the current adopted standards can be provided.

Figure 9. 156th Avenue NE with Bike Lane LI Standards

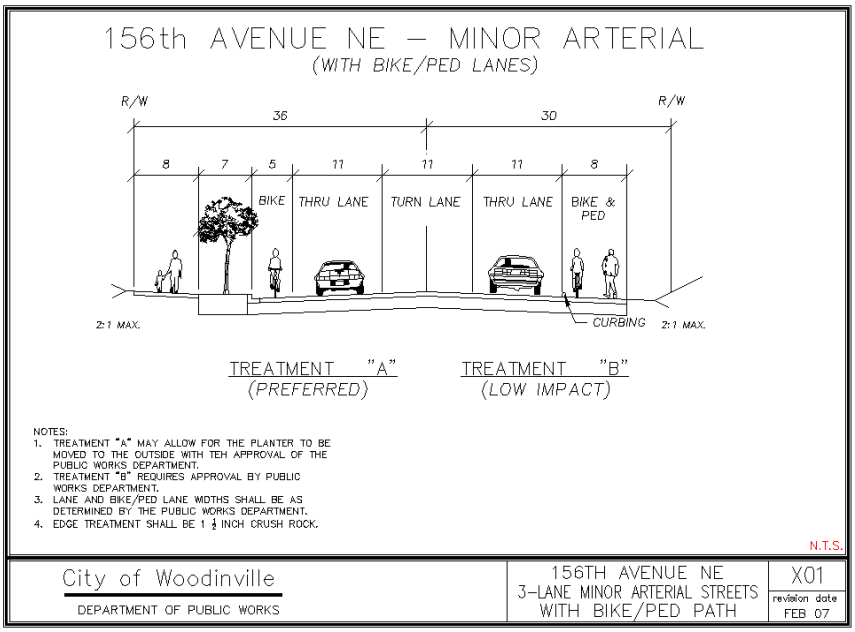
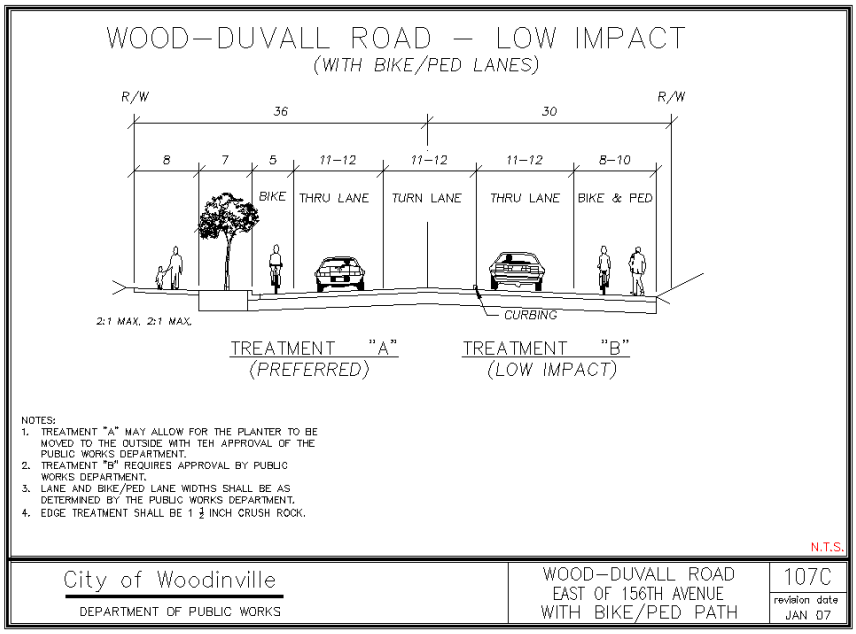


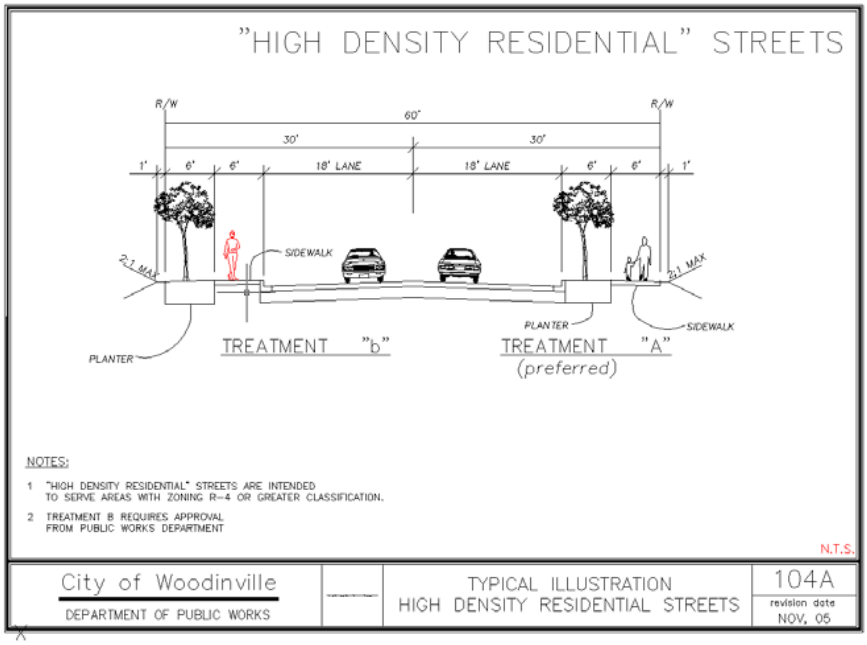
Figure 10. Wood-Duvall Road with Bike Lane LI Standards



3.5.2. Local Road Standards

In zoning of R-4 or higher, local road standards are defined under the "High Density Residential Streets"[2] standard 104A. This standard is shown in Figure 11. A comparison of the low- and high-density road standard is provided in Table 1.

Figure 11. "High Density Residential Streets" standard 104A



The main purpose for the High-Density (HD) road standard is for providing on-street parking and stormwater collection and treatment. It is also a frontage finish identified with an urban neighborhood that allows for a buffer between vehicles and pedestrians and a dressed frontage with a planter strip. In HD neighborhoods, lot size often limits on-site parking space so on-street parking is needed. As a rule of thumb, there is typically one on-street parking space needed for each unit.

Table 1. Comparison of Low- and High-Density Road Standards

Description	Low Density	High Density
Right-of-way	60	60
Pavement width	28	36
Driving lane width	12	11

[2] Under the City of Woodinville Comprehensive Plan, 4 dwelling units per acre is designated at "Low Density Residential" (section 3.4.1 Land Use Designation and Location Criteria). The "High Density Residential Street" is a reference only to this design standard.

Description	Low Density	High Density
Paved shoulder	3	NA
Paved parking	NA	7
Gravel Shoulder	5	NA
Sidewalk	Yes	Yes
Curb & Gutter	No	Yes
Capacity Range (ADT)[3]	800-2,400	800-2,400

Capacity between the Low-Density (LD) and HD standards is very similar and can be considered equal, although typically the HD road can have a slightly lower capacity due to the higher concentration of driveways and on-street parking. Both have similar driving lane widths and typically have similar roadway alignments (both vertical and horizontal).

In summary, the LD and HD road standards are very similar when compared using vehicle carrying capacity. The roadway alignments use the same standard for design and both must meet the same requirement for life safety services. There is a "feel" difference between the two. LD typically provides a more open feeling and is sometime more prone to have vehicle speeding problems. HD roads, when on-street parking is fully used, can create a tunnel effect with a feeling of traveling at a higher speed than actual travel speed and resultant slowing of movement. Conversely, on HD roads when on-street parking is not used, a much wider driving surface is provided, which can be more prone to speeding problems similar to the LD road.

[3] Capacity is an estimated value only and is based on a number of factors that includes driveway spacing and numbers, topography, road alignment, sight distance, road speeds, on-street parking, and land uses. For the purpose of evaluating a residential street, the City uses a peak hour value in the range of 80 to 240 vehicles (800 to 2,400 average daily trips).

4. Level of Service

A measurement used to determine acceptable operations of a roadway system is referred to as Level of Service (LOS). It is standard practice in the transportation industry to measure LOS at intersections. These are the points where some or all vehicle entering an intersection have some delay time passing through the intersection. Table 2 shows the standard used by the City (Highway Capacity Manual 2000).

Table 2. Level of Service Criteria for Unsignalized Intersections

Level of Service Criteria for Unsignalized Intersections	
Level of Service	Average Control Delay (sec/veh)
A	0 - 10
B	>10 - 15
C	>15 - 25
D	>25 - 35
E	>35 - 50
F	>50

Due to the low trip volumes within residential neighborhoods, LOS is typically very high (in the range of A or B). Intersections along most local streets would likely see a wait of less than 15 seconds before passing through the intersection.

Where local streets intersect with arterial and collectors, LOS can vary greatly throughout each day. Arterial and collector class roads generally have higher trip volumes, often several times greater than the approaching local street volume. During peak hours and special local activities, it is common to see LOS in the range of C to F.

To review a density change from R-1 to R-4, a model was run for the System A area. This area was selected as the majority of the neighborhood roads have no other option than to access off 156th Avenue NE. System B and System C area have internal route options so the LOS for these areas was not reviewed at this time.

4.1. System A Level of Service projection

The LOS projections for 156th Avenue NE intersections, from the east and west side public local roads, were performed with 2008 as the baseline[4] condition. A 20-year

[4] Baseline is a reference point to provide a comparison against the 20-year LOS forecast.

forecast (2028) was used as the review year for R-1, R-2, and R-4 zoning. This was modeled for the PM peak hour period, which would be considered the worst-case scenario. The model used the City's current developed traffic circulation model and assumed a regional annual growth rate of 2.5% (used for pass-through trips) with approximately 50% of available building lots in the R-1 accessing 156th Avenue NE being developed at the designated zoning. No improvements to either the local or arterial roads were assumed to have been made over the existing conditions. This is believed to be a conservative approach and actual history does not support this rapid a growth rate. Table 3[5] shows the result of this model[6].

Table 3. 156th Avenue NE Public Roadway Intersections Level of Service

Weekday PM Peak Hour	2008 Baseline Conditions			2028 R-1 Zoning			2028 R-2 Zoning			2028 R-4 Zoning		
(156th Ave NE)	LOS[1]	Delay[2]	Leg	LOS[1]	Delay[2]	Leg	LOS[1]	Delay[2]	Leg	LOS[1]	Delay[2]	Leg
NE 204th Street	N/A	N/A	N/A	C	16.9	EB	C	17.6	EB	C	19.0	EB
NE 203rd Place	B	10.1	WB.	C	17.0	WB	C	18.1	WB	C	21.0	WB
NE 203rd Street	N/A	N/A	N/A	C	15.4	EB.	C	15.6	EB.	C	17.5	EB
NE 202nd Street	B	10.2	EB.	C	21.2	WB	D	25.8	WB	D	28.2	WB
/NE 201st Street	B	10.6	EB.	C	24.7	WB.	D	26.8	WB	D	33.7	WB
NE 198th Street	B	11.8	WB	E	40.2	WB.	E	47.6	WB	**F**	**79.1**	**WB**
NE 195th Street	B	12.8	WB	E	37.2	WB	E	42.9	WB.	**F**	**63.8**	**WB**

4.2. Mitigating Level of Service Deficiency

The City's adopted LOS for all intersections is E. Therefore, those intersections that fall below LOS E are considered to be deficient. According to this model under the R-4 zone, NE 195th and NE 198th intersection for westbound will be operating at LOS F (greater than a 50-second delay) during the PM peak hour by 2028 and can be considered to be deficient.

The drop in the LOS is produced from the increase trips on both the local and arterial roadway. With 156th Avenue NE, this is likely the effect of higher volumes of pass-by trips and left-turn movements. It is likely that the LOS can be improved by the addition of turn lanes on both the arterial and local roadways and/or by the installation of a traffic control device such as a 4-way stop.

---

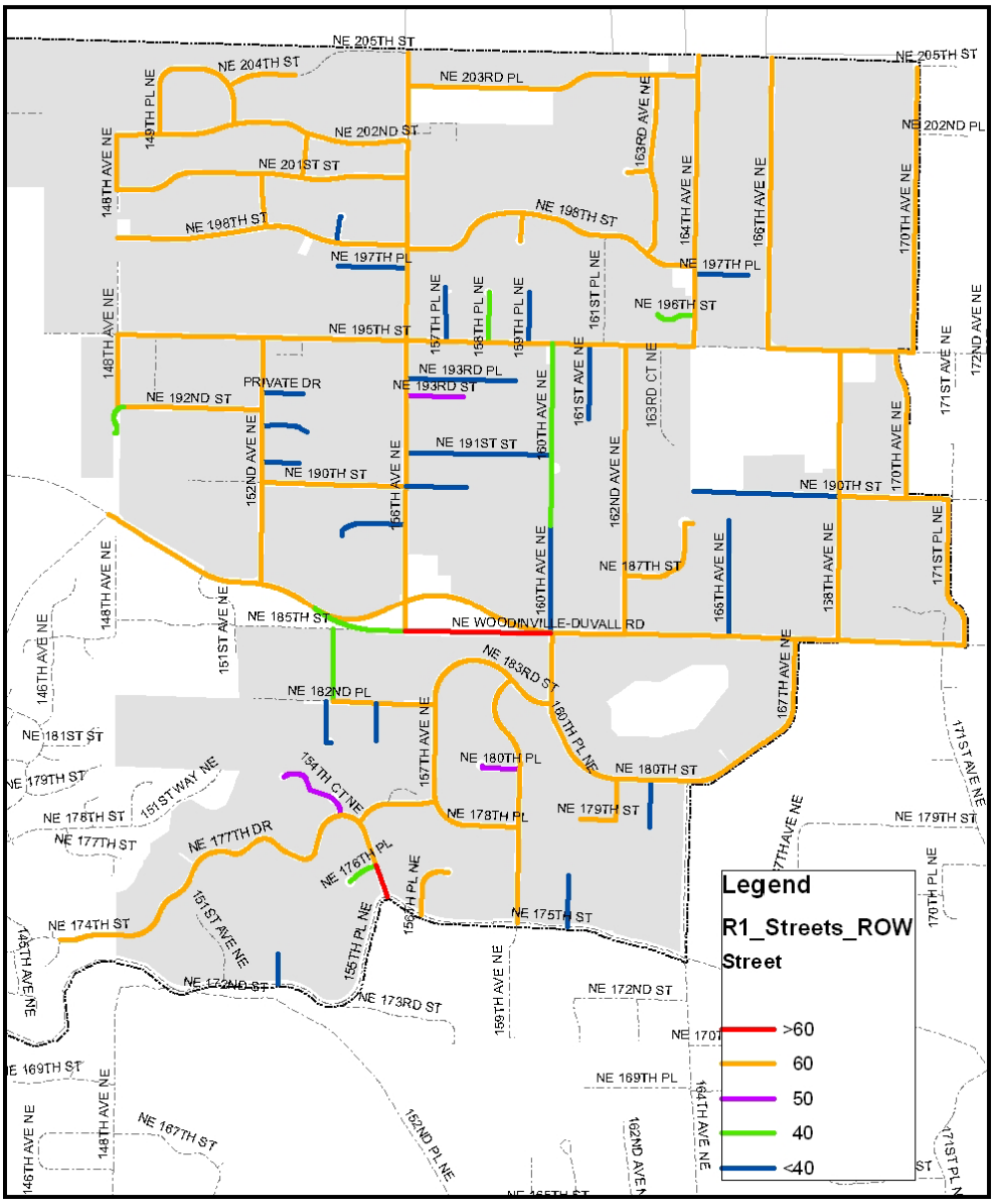
[5] Support information on the modeling is provided in Appendix A.

[6] Two new roads were assumed to be constructed within the 20-year period, under all scenarios, and were included in the modeling. These are NE 203rd Street and NE 204th Street.

Road improvements, necessary for the additional lanes, would involve widening of approximately 12 additional feet (the width of a single travel lane). Physically, this is possible in all of the existing intersections. The only constraint is whether sufficient right-of-way exists or whether additional land would be needed.

To explore this possible constraint, the King County Assessor's map was reviewed for existing right-of-way widths. The results are shown in Figure 12. Based on this information, both NE 195th and NE 198th have sufficient right-of-way to allow for the lane widening.

Figure 12. Existing Street Rights-of-Way



4.3. Relationship of R-1 Transportation Study to Citywide Studies

The scope of the R-1 Sustainable Development Study transportation analysis was specific to the City's current R-1 zone area only and did not include any transportation systems outside of this zone. However, the entire City's road network system was modeled under the City's 2003, 2004, and 2006 Traffic Study which included the R-1 being developed at a R-4 zoning to determine impacts. The current Capital Improvement Plan (CIP) does include projects that would be impacted by development in this area under R-4 and the current Traffic Impact Fee includes new development mitigation payment into these projects. For example, the City's CIP has Woodinville-Duvall Road improvements that will include a dedicated center left turn lane to address back ups during peak and non-peak hours that are typically the result of left turn movement blocking the through traffic.

5. Conclusion

The majority of the roadways within the R-1 zone were developed under King County prior to the City's incorporation. With the exception of newer roads constructed under the City's design requirements, the local streets in the R-1 zone do not meet the City's road cross-section standards. Under the Fire Department Access standard, requiring a minimum paved width of 20 feet, only a few short sections of roadways do not meet this standard.

Future road improvements, for the arterial and collector classified roads, have been identified in the City's long-range CIP and will be systematically reviewed and considered for improvements. It is likely improvements will be performed in several phases along each of these classifications of roadways and as need dictates and development warrants. On local streets, these are likely to occur under special projects (such as a special district for sidewalks) or under development mitigation.

The 156th Avenue NE corridor neighborhood was used to review operational projections for LOS at public road intersections. Using a very conservative traffic circulation model (with 50% of the existing R-1 zone redeveloping at a higher density, an annual growth of 2.5%, and assuming no road improvements) the analysis identified two intersections that would exceed the City's adopted LOS E by 2028. At both locations, the LOS can be brought back into compliance with widening improvements within the existing public right-of-way.

In regard to vehicle capacity, both the City's "Low-Density" and "High-Density" standards provide the same vehicle trip capacity. If additional capacity were needed,

due to physical restrictions within the roadway (such as the need to address a narrow road section), adequate right-of-way currently exists to allow for any needed improvement to address deficiencies.

Several local streets, and one minor arterial, have been identified with vertical sight distance conditions. These instances are currently being taken under review by the City for possible mitigation measures.

Road grades within the entire R-1 zone are all within the City's acceptable standards (under 15%).

Pedestrian and bike facilities are very limited within the entire R-1 zone area. Only Woodinville-Duvall Road has designated shared pedestrian and bike facilities along both sides of the roadway. Most of the developments following incorporation of the City (in 1993) do provide pedestrian facilities. However, these make up a very small portion of the R-1 zone. Of the remaining streets, it is estimated that less than 20% have any type of pedestrian facility and travel by non-motorized means must utilize the edge of the pavement or shoulder area.

6. References Cited

Highway Capacity Manual. 2000.

Appendix A

156th Avenue NE Intersection Analysis (Perteet Inc.)

MEMORANDUM

Perteet Inc.

TO: **Bob Wuotila, Sarah Ruether, and Mick Monken**

FROM: **Joel E. Birchman, PE**

DATE: **January 3, 2007**

RE: **156th Avenue NE 2028 Intersection Analysis**

On December 21, 2006 the staff at the City of Woodinville requested that Perteet perform an analysis of the intersections along 156th Avenue NE within the Wellington neighborhood. The initial results of our analysis were delivered to Bob Wuotila on December 27th and will be further presented in the following text.

Our analysis indicates that if the Wellington neighborhood were to fully develop to an R-4 zone sometime between 2008 and 2028, the intersections of 156th Avenue NE and NE 195th Street, and 156th Avenue NE and NE 198th Street would begin to operate at a Level of Service (LOS) F. In this same time period the other intersections along 156th Avenue NE, north of the Woodinville – Duvall Road, would begin to operate at a LOS "C" or "D". The City's adopted standard is LOS "E".

Due to our efforts to meet your time constraints our analysis is conservative, meaning that we may have over estimated the number of vehicle trips due to the land use changes from its existing condition to full build-out in 2028 with R-1, R-2, and R-4 zoning . Our estimates are reasonable considering that we are trying to project the impacts that may occur in the year 2028. However, many of the parameters that affect our findings may change substantially over the next twenty years (i.e. changes in driving patterns and characteristics due to increases in the price of fuel). This potential over estimate will be explained in the description below.

The following steps were used to develop the potential impacts to the intersections along NE 156th Avenue north of the Woodinville – Duvall Road and south of the King – Snohomish County line. These impacts are resulting from full build-out (assumed to occur by 2028) of the Wellington neighborhood with R-1, R-2, and R-4 zoning:

1. We estimated the maximum gross number of potentially buildable lots in the Wellington neighborhood by performing a lot by lot inventory. This inventory accounted for non-buildable areas due to environmental conditions and lots because of their configuration or existing improvements may not subdivide into

additional lots. This number was developed during the Steward and Associates R-1 Zone Sustainable Development Study. For the Wellington neighborhood that accesses onto 156th Avenue NE there are an estimated 816 potentially buildable lots at 4 dwelling units per acre. This is assuming that Wood Trails and Montevallo are developed as proposed as single family R-4 lots.

2. To determine the number of dwellings developed in the future that may use 156th Avenue NE, vacant and redevelopable properties were reviewed and the gross acres discounted for roads, public facilities and market factors (e.g. property owners not interested in selling property). These discounts reduced buildable lots by fifty percent. The estimated number of living units in 2028, or full build-out, and using 156th Avenue NE, is 408 with an R-4 zoning.
3. Using the latest edition of the Institute of Transportation Engineers *Trip Generation Manual* (ITE Manual) the estimated number of units (Single Family Residential) would generate 1.01 PM peak hour trips per unit.
4. After determining the number of PM peak hour trips, they were then assigned to tripsheds for each intersection along 156th Avenue NE. A tripshed is used to define an area of homes whose travel routes are likely to access NE 156th Avenue at a particular intersection, or directly from a lot onto NE 156th Avenue.
5. It is assumed that residents from the new homes will have relatively the same vehicular travel patterns as the current residents within the Wellington region. Once these trips were assigned to a particular tripshed the movements of the trips within the tripshed were assigned for each intersection, using the following criteria:
    a. These trips were assigned using information from the ITE Manual for vehicles entering and exiting each tripshed.
    b. They were further broken down by the percentage of pass-through vehicles during the PM peak hour currently coming from or to the north on NE 156th Avenue, and the percentages of pass-through vehicles coming from or to the south on NE 156th Avenue. (i.e. at the NE 156th Avenue and 195th Street NE intersection the percentage of existing PM peak hour pass-through vehicles approaching the 195th intersection from the north is forty percent [230/(230+340)], see the Wood Trails – Montevallo FEIS Analysis Figure 3.5-2(A) which is attached).
6. It was further assumed that an R-2 zoning at full build-out would generate half the number of turning movements of a R-4 zoning, and a R-1 zoning would generate, again, half as many as a R-2 zoning. This assumption probably produced a higher than likely numbers for both the R-1 and R-2 zoning scenarios. The number of new trips for the R-2 and R-1 zone is believed to be on the high side because it includes an estimated, larger than likely, number of small existing lots subdivided into two or more new lots. The number of new lots created from small lots with the R-4 zoning is more than two or more times the number of new lots created under the R-2 scenario. The same is also true for the R-2 scenario versus the R-1 scenario.
7. The current traffic volumes plus volumes from pipeline projects (permitted Snohomish County projects identified within the Wood Trails – Montevallo FEIS) were used for the base year (current plus pipeline) to determine the pass-through

2028 traffic volumes. The Puget Sound Regional Council developed a growth rate of 2.5 percent per year, to get to the 2028 pass-through volumes.

8. The 2028 pass-through plus Snohomish County pipeline volumes were then added to the full build-out volumes generated within the Wellington neighborhood to get a total 2028 turning movement volume for each intersection along NE 156th Avenue. A LOS analyses was then performed for the seven intersections (five existing and two proposed) for full build-out of a R-1, R-2, and R-4 condition. The result of our LOS analysis is presented on the following page.

2028 Full Build-Out Conditions LOS Summary

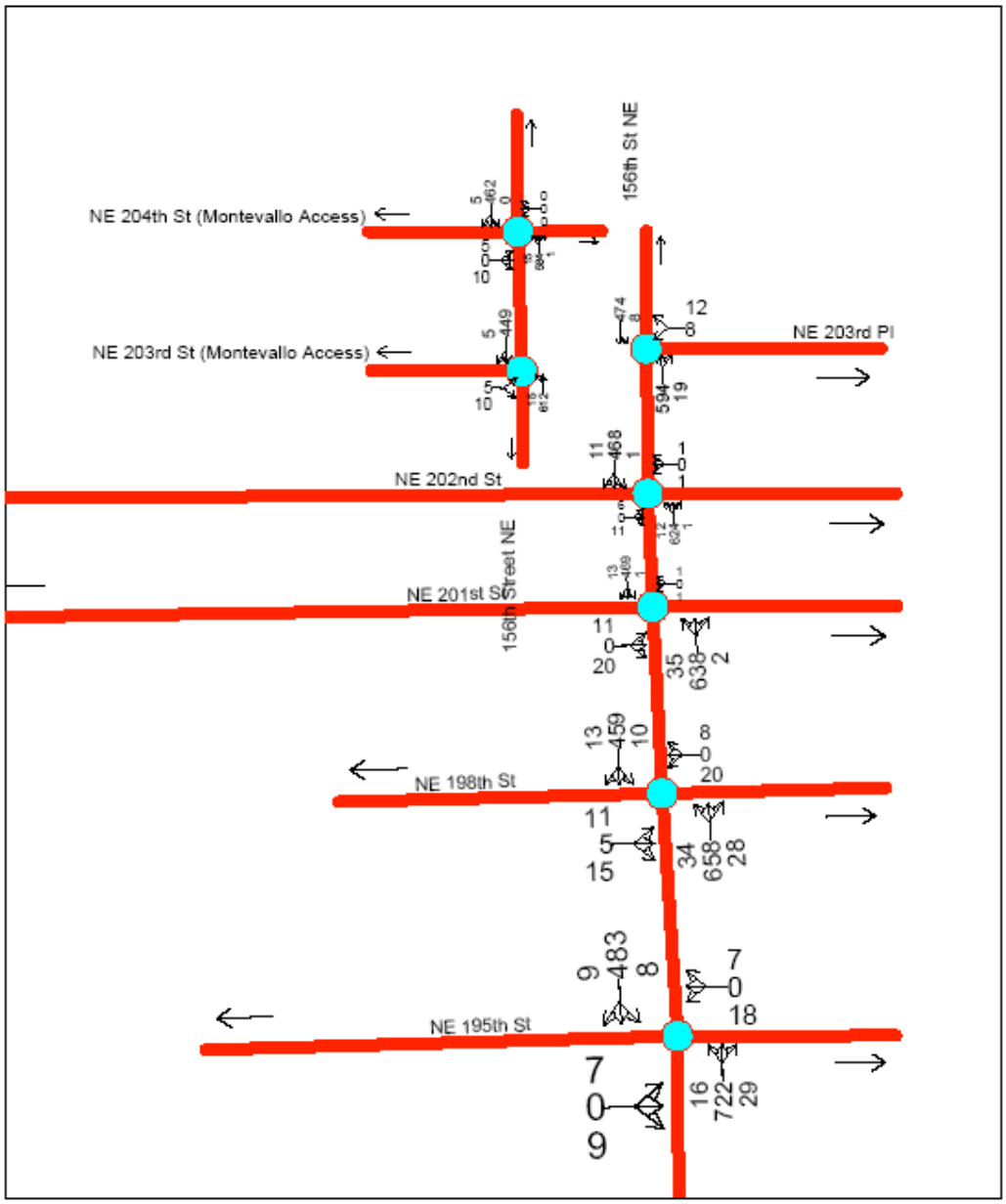
Weekday PM Peak Hour	2008 Baseline Conditions			2028 R-1 Zoning			2028 R-2 Zoning			2028 R-4 Zoning		
	LOS	Delay	Leg	LOS	Delay	Leg	LOS	Delay	Leg	LOS	Delay	Leg
156th Avenue NE/NE 204th Street	N/A	N/A	N/A	C	16.9	EB App.	C	17.6	EB App.	C	19.0	EB App.
156th Avenue NE/NE 203rd Place	B	10.1	WB App.	C	17.0	WB App.	C	18.1	WB App	C	21.0	WB App.
156th Avenue NE/NE 203rd Street	N/A	N/A	N/A	C	15.4	EB App.	C	15.6	EB App.	C	17.5	EB App.
156th Avenue NE/NE 202nd Street	B	10.2	EB App.	C	21.2	WB App.	D	25.8	WB App	D	28.2	WB App
156th Avenue NE/NE 201st Street	B	10.6	EB App.	C	24.7	WB App.	D	26.8	WB App	D	33.7	WB App.
156th Avenue NE/NE 198th Street	B	11.8	WB App.	E	40.2	WB App.	E	47.6	WB App	F	79.1	WB App.
156th Avenue NE/NE 195th Street	B	12.8	WB App.	E	37.2	WB App.	E	42.9	WB App.	F	63.8	WB App.

Providing proposed solutions or mitigation where intersections along NE 156th Avenue will be operating below the City's adopted minimum LOS E in 2028, are beyond our scope of services at this time.

Attached, as appendices, you will find tables that we developed to determine the trips and turning movements for each intersection as well as the Synchro output files for each intersection and land use zoning scenario.

We would be happy to meet with you, the CAP, Planning Commission, and Council to present our findings.

Map - Woodinville-Sutainabilty Study
Volumes 12/26/2006



2028 PM Peak Hour - R1 Zoning
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Woodinville-Sutainabilty Study
25: NE 204th St (Montevallo Access) & 156th Street NE — 2028 PM Peak Hour - R1 Zoning

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	5	0	10	0	0	0	15	584	1	0	462	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	11	0	0	0	16	635	1	0	502	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1173	1173	505	1184	1176	635	508			636		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1173	1173	505	1184	1176	635	508			636		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	98	100	100	100	98			100		
cM capacity (veh/h)	169	189	571	161	188	478	1062			948		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	16	0	652	508
Volume Left	5	0	16	0
Volume Right	11	0	1	5
cSH	318	1700	1062	948
Volume to Capacity	0.05	0.00	0.02	0.00
Queue Length 95th (ft)	3	0	1	0
Control Delay (s)	16.9	0.0	0.4	0.0
Lane LOS	C	A	A	
Approach Delay (s)	16.9	0.0	0.4	0.0
Approach LOS	C	A		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		

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Woodinville-Sutainabilty Study
2: NE 202nd St & 156th St NE

2028 PM Peak Hour - R1 Zoning

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	6	0	11	1	0	1	12	624	1	1	468	11
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	7	0	12	1	0	1	13	678	1	1	509	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1223	1222	515	1234	1228	679	521			679		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1223	1222	515	1234	1228	679	521			679		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	100	98	99	100	100	99			100		
cM capacity (veh/h)	156	177	564	149	176	452	1051			913		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	18	2	692	522
Volume Left	7	1	13	1
Volume Right	12	1	1	12
cSH	293	224	1051	913
Volume to Capacity	0.06	0.01	0.01	0.00
Queue Length 95th (ft)	4	1	1	0
Control Delay (s)	18.1	21.2	0.3	0.0
Lane LOS	C	C	A	A
Approach Delay (s)	18.1	21.2	0.3	0.0
Approach LOS	C	C		

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	52.0%	ICU Level of Service	A
Analysis Period (min)	15		

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Woodinville-Sutainabilty Study
5: NE 195th St & 156th St NE

2028 PM Peak Hour - R1 Zoning

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	7	0	9	18	0	7	16	722	29	8	483	9
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	0	10	20	0	8	17	785	32	9	525	10
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1390	1398	530	1392	1388	801	535			816		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1390	1398	530	1392	1388	801	535			816		
tC, single (s)	7.1	6.5	6.2	7.2	6.6	6.3	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.6	4.1	3.4	2.2			2.2		
p0 queue free %	93	100	98	82	100	98	98			99		
cM capacity (veh/h)	116	138	553	111	135	376	1028			807		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	17	27	834	543
Volume Left	8	20	17	9
Volume Right	10	8	32	10
cSH	209	139	1028	807
Volume to Capacity	0.08	0.20	0.02	0.01
Queue Length 95th (ft)	5	14	1	1
Control Delay (s)	23.8	37.2	0.5	0.3
Lane LOS	C	E	A	A
Approach Delay (s)	23.8	37.2	0.5	0.3
Approach LOS	C	E		

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	58.5%	ICU Level of Service	B
Analysis Period (min)	15		

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Woodinville-Sutainabilty Study
29: NE 203rd St (Montevallo Access) & 156th Street NE

2028 PM Peak Hour - R1 Zoning

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Volume (veh/h)	5	10	15	612	449	5
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	11	16	665	488	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None					
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1189	491	493			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1189	491	493			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	97	98	98			
cM capacity (veh/h)	207	582	1075			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	16	682	493
Volume Left	5	16	0
Volume Right	11	0	5
cSH	362	1075	1700
Volume to Capacity	0.05	0.02	0.29
Queue Length 95th (ft)	3	1	0
Control Delay (s)	15.4	0.4	0.0
Lane LOS	C	A	
Approach Delay (s)	15.4	0.4	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		

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Woodinville-Sutainabilty Study
3: NE 201st St & 156th St NE

2028 PM Peak Hour - R1 Zoning

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Volume (veh/h)	11	0	20	1	0	1	35	638	2	1	469	13
Peak Hour Factor	0.89	0.92	0.89	0.92	0.92	0.92	0.89	0.89	0.92	0.92	0.89	0.89
Hourly flow rate (vph)	12	0	22	1	0	1	39	717	2	1	527	15
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1334	1334	534	1356	1340	718	542			719		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1334	1334	534	1356	1340	718	542			719		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	90	100	96	99	100	100	96			100		
cM capacity (veh/h)	128	148	550	118	146	429	1032			882		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	35	2	758	543
Volume Left	12	1	39	1
Volume Right	22	1	2	15
cSH	253	185	1032	882
Volume to Capacity	0.14	0.01	0.04	0.00
Queue Length 95th (ft)	9	1	2	0
Control Delay (s)	21.5	24.7	1.0	0.0
Lane LOS	C	C	A	A
Approach Delay (s)	21.5	24.7	1.0	0.0
Approach LOS	C	C		

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		

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Peak Hour Turning Volume Movements

Approach Direction	Movement	2008 FEIS No Action PM PH (w/o WT & MV)	2028 w/ 2.5%/Yr Base Growth: No Action PM PH w/o WT & MV Only Thru Traffic Growth	WT & MV Action PM PH (no WT & MV growth)	No Action PM PH + w/ WT & MV Action PM PH	R-1 Project PM PH	R-1 Total PM PH	R-2 Project PM PH	R-2 Total PM PH	R-4 Project PM PH	R-4 Total PM PH
156th Ave. NE / NE 204th St.											
SB	RT	N/A		5	5	0	5	0	5	0	5
	Thru	265	434	5	439	23	462	45	484	90	529
	LT	N/A									
WB	RT	N/A									
	Thru	N/A									
	LT	N/A									
NB	RT	1	1		1	0	1	0	1	0	1
	Thru	345	565	5	570	14	584	28	598	55	625
	LT	N/A		15	15	0	15	0	15	0	15
EB	RT	N/A		10	10	0	10	0	10	0	10
	Thru	N/A									
	LT	N/A		5	5	0	5	0	5	0	5
156th Ave. NE / NE 203rd Pl.											
SB	RT	N/A									
	Thru	260	426	25	451	23	474	45	496	90	541
	LT	5	5		5	3	8	6	11	11	16
WB	RT	10	10		10	2	12	4	14	7	17
	Thru	N/A	0		0	0	0	0	0	0	0
	LT	5	5		5	3	8	5	10	10	15
NB	RT	15	15		15	4	19	9	24	17	32
	Thru	335	549	31	580	14	594	28	608	55	635
	LT	N/A									
EB	RT	N/A									
	Thru	N/A									
	LT	N/A									

Approach Direction	Movement	2008 FEIS No Action PM PH (w/o WT & MV)	2028 w/ 2.5%/Yr Base Growth: No Action PM PH w/o WT & MV Only Thru Traffic Growth	WT & MV Action PM PH (no WT & MV growth)	No Action PM PH + w/ WT & MV Action PM PH	R-1 Project PM PH	R-1 Total PM PH	R-2 Project PM PH	R-2 Total PM PH	R-4 Project PM PH	R-4 Total PM PH
156th Ave. NE / NE 203rd St.											
SB	RT			5	5	0	5	0	5	0	5
	Thru	265	434	15	449	0	449	0	449	92	541
	LT	N/A									
WB	RT	N/A									
	Thru	N/A									
	LT	N/A									
NB	RT	N/A									
	Thru	350	574	15	589	23	612	46	635	67	656
	LT			15	15	0	15	0	15	0	15
EB	RT			10	10	0	10	0	10	0	10
	Thru	N/A									
	LT			5	5	0	5	0	5	0	5
156th Ave. NE / NE 202nd St..											
SB	RT	10	10		10	1	11	3	13	5	15
	Thru	255	418	27	445	23	468	46	491	92	537
	LT	N/A				1	1	2	2	3	3
WB	RT	N/A				1	1	1	1	2	2
	Thru	N/A					0		0	0	0
	LT	N/A				1	1	2	2	3	3
NB	RT	N/A				1	1	3	3	5	5
	Thru	345	565	42	607	17	624	34	641	67	674
	LT	10	10		10	2	12	4	14	8	18
EB	RT	10	10		10	1	11	3	13	5	15
	Thru	N/A					0		0	0	0
	LT	5	5		5	1	6	2	7	3	8

Approach Direction	Movement	2008 FEIS No Action PM PH (w/o WT & MV)	2028 w/ 2.5%/Yr Base Growth: No Action PM PH w/o WT & MV Only Thru Traffic Growth	WT & MV Action PM PH (no WT & MV growth)	No Action PM PH + w/ WT & MV Action PM PH	R-1 Project PM PH	R-1 Total PM PH	R-2 Project PM PH	R-2 Total PM PH	R-4 Project PM PH	R-4 Total PM PH
156th Ave. NE / NE 201st St..											
SB	RT	5	5	7	12	1	13	2	14	3	15
	Thru	260	426	20	446	23	469	46	492	92	538
	LT	N/A				1	1	3	3	5	5
WB	RT	N/A				1	1	2	2	3	3
	Thru	N/A				0	0	0	0	0	0
	LT	N/A				1	1	2	2	4	4
NB	RT	N/A				2	2	4	4	7	7
	Thru	355	582	37	619	19	638	39	658	77	696
	LT	15	15	18	33	2	35	3	36	5	38
EB	RT	10	10	9	19	1	20	2	21	3	22
	Thru	N/A				0	0	0	0	0	0
	LT	5	5	5	10	1	11	1	11	2	12
156th Ave. NE / NE 198th St..											
SB	RT	5	5	6	11	2	13	4	15	7	18
	Thru	255	418	23	441	18	459	36	477	72	513
	LT	5	5		5	5	10	10	15	20	25
WB	RT	5	5		5	3	8	6	11	12	17
	Thru	0	0		0	0	0	0	0	0	0
	LT	15	15		15	5	20	9	24	18	33
NB	RT	20	20		20	8	28	16	36	31	51
	Thru	360	590	50	640	18	658	36	676	72	712
	LT	15	15	16	31	3	34	5	36	10	41
EB	RT	5	5	8	13	2	15	3	16	6	19
	Thru	5	5		5	0	5	0	5	0	5
	LT	5	5	5	10	1	11	2	12	4	14

Approach Direction	Movement	2008 FEIS No Action PM PH (w/o WT & MV)	2028 w/ 2.5%/Yr Base Growth: No Action PM PH w/o WT & MV Only Thru Traffic Growth	WT & MV Action PM PH (no WT & MV growth)	No Action PM PH + w/ WT & MV Action PM PH	R-1 Project PM PH	R-1 Total PM PH	R-2 Project PM PH	R-2 Total PM PH	R-4 Project PM PH	R-4 Total PM PH
156th Ave. NE / NE 195th St..											
SB	RT	5	5		5	4	9	8	13	15	20
	Thru	265	434	31	465	18	483	35	500	70	535
	LT	5	5	0	5	3	8	6	11	12	17
WB	RT	5	5	0	5	2	7	4	9	7	12
	Thru	0	0		0	0	0	0	0	0	0
	LT	15	15		15	3	18	5	20	10	25
NB	RT	25	25		25	4	29	9	34	17	42
	Thru	385	631	66	697	25	722	50	747	99	796
	LT	10	10		10	6	16	12	22	23	33
EB	RT	5	5		5	4	9	7	12	14	19
	Thru	0	0		0	0	0	0	0	0	0
	LT	5	5		5	2	7	5	10	9	14

Splits

Trip Watersheds to 156th Street between intersections and each intersection											
	East/West		R-4 Zoning	1.01	Trips Entering Shed			Trips Exiting Watershed			C
	Watershed	Gross	Number of Lots	Trip/home	63%			37%	40%	60%	
		No. of Lots	that will develop	Net Trips	Split	40%	60%	Split	to North	to South	
			(Gross X 50%)	PM PH	Total	to North	to South	Total			
156th Ave. NE / NE 204th St	N/A		0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 203rd Pl.	East	88	44	44	28	11	17	16	7	10	
156th Ave. NE / NE 203rd St			0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 202nd St.	East	25	13	13	8	3	5	5	2	3	
	West	43	22	22	14	5	8	8	3	5	
156th Ave. NE / NE 201st St.	East	36	18	18	11	5	7	7	3	4	
	West	27	14	14	9	3	5	5	2	3	
156th Ave. NE / NE 198th St.	East	160	80	81	51	20	31	30	12	18	
	West	53	27	27	17	7	10	10	4	6	
156th Ave. NE / NE 195th St.	East	91	46	46	29	12	17	17	7	10	
	West	121	61	61	38	15	23	23	9	14	
between intersections											
WD to 195		145	73	73	46	18	28	27	11	16	
195 to 198		21	11	11	7	3	4	4	2	2	
198 to 201		6	3	3	2	1	1	1	0	1	
		816	408								
			R-2 Zoning								
156th Ave. NE / NE 204th St	N/A		0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 203rd Pl.	East	44	22	22	14	6	8	8	3	5	
156th Ave. NE / NE 203rd St			0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 202nd St.	East	13	7	7	4	2	2	2	1	1	
	West	22	11	11	7	3	4	4	2	2	
156th Ave. NE / NE 201st St.	East	18	9	9	6	2	3	3	1	2	
	West	14	7	7	4	2	3	3	1	2	
156th Ave. NE / NE 198th St.	East	80	40	40	25	10	15	15	6	9	
	West	27	14	14	9	3	5	5	2	3	
156th Ave. NE / NE 195th St.	East	46	23	23	15	6	9	9	3	5	
	West	61	31	31	19	8	12	11	5	7	
between intersections											
WD to 195		73	37	37	23	9	14	14	5	8	
195 to 198		11	6	6	3	1	2	2	1	1	
198 to 201		3	2	2	1	0	1	1	0	0	
		412	206								
			R-1 Zoning								
156th Ave. NE / NE 204th St	N/A		0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 203rd Pl.	East	22	11	11	7	3	4	4	2	2	
156th Ave. NE / NE 203rd St			0	0	0	0	0	0	0	0	C
156th Ave. NE / NE 202nd St.	East	7	4	4	2	1	1	1	1	1	
	West	11	6	6	3	1	2	2	1	1	
156th Ave. NE / NE 201st St.	East	9	5	5	3	1	2	2	1	1	
	West	7	4	4	2	1	1	1	1	1	
156th Ave. NE / NE 198th St.	East	40	20	20	13	5	8	7	3	4	
	West	14	7	7	4	2	3	3	1	2	
156th Ave. NE / NE 195th St.	East	23	12	12	7	3	4	4	2	3	
	West	31	16	16	10	4	6	6	2	3	
between intersections											
WD to 195		37	19	19	12	5	7	7	3	4	
195 to 198		6	3	3	2	1	1	1	0	1	
198 to 201		2	1	1	1	0	0	0	0	0	
		209	105								

Trip Watersheds to 156th Street between intersections and each intersection

	East/West Watershed	Gross No. of Lots	**R-4 Zoning** Number of Lots that will develop (Gross X 50%)	1.01 Trip/home Net Trips PM PH	Trips Entering Shed 63% Split Total	40% fr North	60% fr South	Trips Exiting Watershed 37% Split Total	40% to North	60% to South	Comment
156th Ave. NE / NE 204th St.	N/A		0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 203rd Pl.	East	88	44	44	28	11	17	16	7	10	
156th Ave. NE / NE 203rd St.			0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 202nd St..	East	25	13	13	8	3	5	5	2	3	
	West	43	22	22	14	5	8	8	3	5	
156th Ave. NE / NE 201st St..	East	36	18	18	11	5	7	7	3	4	
	West	27	14	14	9	3	5	5	2	3	
156th Ave. NE / NE 198th St..	East	160	80	81	51	20	31	30	12	18	
	West	53	27	27	17	7	10	10	4	6	
156th Ave. NE / NE 195th St..	East	91	46	46	29	12	17	17	7	10	
	West	121	61	61	38	15	23	23	9	14	
between intersections											
WD to 195		145	73	73	46	18	28	27	11	16	
195 to 198		21	11	11	7	3	4	4	2	2	
198 to 201		6	3	3	2	1	1	1	0	1	
		816	408								
			R-2 Zoning								
156th Ave. NE / NE 204th St.	N/A		0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 203rd Pl.	East	44	22	22	14	6	8	8	3	5	
156th Ave. NE / NE 203rd St.			0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 202nd St..	East	13	7	7	4	2	2	2	1	1	
	West	22	11	11	7	3	4	4	2	2	
156th Ave. NE / NE 201st St..	East	18	9	9	6	2	3	3	1	2	
	West	14	7	7	4	2	3	3	1	2	
156th Ave. NE / NE 198th St..	East	80	40	40	25	10	15	15	6	9	
	West	27	14	14	9	3	5	5	2	3	
156th Ave. NE / NE 195th St..	East	46	23	23	15	6	9	9	3	5	
	West	61	31	31	19	8	12	11	5	7	
between intersections											
WD to 195		73	37	37	23	9	14	14	5	8	
195 to 198		11	6	6	3	1	2	2	1	1	
198 to 201		3	2	2	1	0	1	1	0	0	
		412	206								
			R-1 Zoning								
156th Ave. NE / NE 204th St.	N/A		0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 203rd Pl.	East	22	11	11	7	3	4	4	2	2	
156th Ave. NE / NE 203rd St.			0	0	0	0	0	0	0	0	Counted in WT & MV turning movements
156th Ave. NE / NE 202nd St..	East	7	4	4	2	1	1	1	1	1	
	West	11	6	6	3	1	2	2	1	1	
156th Ave. NE / NE 201st St..	East	9	5	5	3	1	2	2	1	1	
	West	7	4	4	2	1	1	1	1	1	
156th Ave. NE / NE 198th St..	East	40	20	20	13	5	8	7	3	4	
	West	14	7	7	4	2	3	3	1	2	
156th Ave. NE / NE 195th St..	East	23	12	12	7	3	4	4	2	3	
	West	31	16	16	10	4	6	6	2	3	
between intersections											
WD to 195		37	19	19	12	5	7	7	3	4	
195 to 198		6	3	3	2	1	1	1	0	1	
198 to 201		2	1	1	1	0	0	0	0	0	
		209	105								

Appendix B

Transportation Frequently Asked Questions

Appendix B: Transportation Frequently Asked Questions

Staff response is shown in *Italics.*

#1 Do traffic results account for proposed plats in the R-1 zone?

The 2008/2028 Perteet model for traffic flow along the 156th Avenue NE corridor did take into consideration proposed preliminary plat developments to date. The results indicated that no roadway improvements were needed except at the 195th and 198th intersection. In regard to proposed plat developments, there was a traffic model prepared that is covered in a 2006 Final EIS (FEIS) issued by the City. Please see the City's website for more information: www.ci.woodinville.wa.us.

#2 Would a change from R1 to R4 impact traffic in downtown Woodinville (e.g. NW 175th St.)?

The scope of the study was specific to the City's current R-1 zone area only and did not include any transportation system outside of this zone. However, the entire City's road network system, which included NE 175th Street, was modeled under the City's 2003, 2004, and 2006 Traffic Study, which include the R-1 being developed at a R-4 zoning to determine impacts. The current Capital Improvement Plan (CIP) does include projects that would be impacted by development in this area under R-4 and the current Traffic Impact Fee includes new development mitigation payment into these projects.

#3 How will increased development change road character? How will adding more traffic impact Woodinville Duvall Road?

Zoning from R-1 to R-4 would result in more trips generated within Woodinville. Residential streets and the collectors have the capacity to handle the additional trip volume but could result in a change in the "feel" of the local streets, especially during peak hours. The arterials and collector road would see an increase from the additional trips from an R-1 to a R-4 zoning. From modeling, the collector (156th, 168th, and 171st/173rd/175th) roads have shown to have the capacity for R-4. Wood-Duvall does not currently have the capacity during peak hours but has been included in the City's current CIP to address future capacity needs under projected R-4 generated new trips.

#4 How will traffic affect Woodinville-Duvall Road lengthy backups and potential for accidents?

The road is traveled several time during all days by the Police and Public Works staff and back ups has not been observed to be a problem except during peak hours. During peak hours, in the morning and evening, Wood-Duvall has long queue lengths of several hundred feet (300 to 500 feet). It has not been

observed to have back ups of miles during the peak and non-peak hours except during a blockage occurrence.

Back ups along Wood-Duvall during peak and non-peak have been observed to typically be the result of left turn movement blocking the through traffic. This has also been the cause of most accidents, when vehicles fail to stop for a left turning vehicle, resulting in a rear end accident. The City's CIP has Wood-Duvall improvements that will include a dedicated center left turn lane to address this condition.

#6 How can 156th Ave, a steep road, take additional traffic?

156th Avenue NE grade does not present a capacity problem future traffic under R-4 zoning. From modeling, there are two intersections, where one of the four legs is projected to exceed the City's current adopted of level of service (LOS). These can be mitigated with minor improvements to address these deficiencies within the existing right of way. When the road is designed for future improvement, this is expected to occur to address any bottleneck conditions and would be designed to current standards that would be expected to address road conditions of concern.

#7 How will increased density on NE 195th St. affect safety for cars and pedestrians on 195th?

NE 195th Street was designed under King County and did not include pedestrian facilities. This is a common condition throughout King County including areas within the City outside of the R-1 zone. It is common throughout the region to have pedestrian using the edge of the pavement for travel and most northwest motorist drive appropriate for this condition. Also, no injuries between vehicles and pedestrians along NE 195th are known to be on record with the City.

#8 Should there be a subarea plan in place defining a roadway network for the R-1 area so that development/traffic has an improvement plan?

City CIP plans address arterial and collector improvements. City road standards do address local street spacing and design cross sections. Circulation is often addressed over time as development applications are received. A circulation plan in advance of development proposals is a good suggestion for future consideration no matter the density. A circulation plan would not be necessary for this R-1 zone study, but the City could consider it in future work programs.

#9 How will levels of service change at 198th and 195th on 156th at higher densities?

The LOS as defined in the study shows that one leg of both of these intersections would exceed the City's current LOS and would require improvements. The needed improvements to bring them back to an acceptable City standard LOS would be minor and could be provided within the existing right of way limits.

#11 How will the City access the R-1 area during emergencies or weather events?

The difference between an R-1 to and R-4 is not expected to significantly increase the number of road miles and the demand for road services, such as a weather event. See Capital Facilities Report appendices for information from the Fire District about emergency responses.

#12 Access to Wood-Duvall Rd from 156th seems to increase each month as well as traffic volumes since Costco opened. How will the City address this?

The 156th/Wood-Duvall intersection is largely impacted from by pass through trips which results in peak-hour back ups for southbound 156th Avenue AM trips. This intersection is included in the City's CIP for future improvements and may be included under concurrency that would require future City development to contribute into improving its LOS.

#13 How can 198th St. accommodate traffic from any new neighborhood built?

Under current City LOS standards, NE 198th has the capacity for the increased volume from an R-1 to and R-4. Modeling shows that future development may increase one of the approach legs to a LOS F by 2028 if no improvement are performed for any of the approach legs at 156th. It is possible to bring the LOS back into compliance with minor turn lane improvement along NE 156th Avenue. These improvements can be performed within the existing right of way.

#14 Can the City remove the bollard that blocks 195th St and improve road access from 201st through that street to both schools?

The bollards were placed by the City in 2005 to stop "cut through" driving around the gates and onto the pedestrian walkway. This are a safety feature and it is unlikely that these would be removed unless an alternative safety feature could be provided.

The two gates, which are intended to block off through vehicle travel, were placed prior to the City under King County. The gate along NE 195th, (most westerly), was installed to stop traffic from using NE 195th, east of 156th NE, from using this as a route to drop off and pick up students. The east gate was installed to prevent trespassing onto private land and using as a "cut through". Only the westerly gate is under the jurisdiction of the City. Under City governance, the opening of this gate has been approached several times but due to pressure by the neighborhoods in the area, it has remained closed.

#15 How can the City retain the character and environment while trying to build adequate roads to accommodate growth?

The City has a standard that is close to the existing character of the roads in many of the neighborhoods with the exception of providing a pedestrian walkway. This standard is identified for R-1 zoning but has been allowed for higher density development within the R-1 zone under a deviation.

#17 Where is the detailed model data? What is the proposed mitigation for 156th as traffic increases?

The data used to model 156th Avenue NE is included in the appendix of the Transportation Report (prepared by Perteet Engineering). 156th Avenue NE is identified within the City Standard for future

improvements to handle the anticipated growth and would be considered as the proposed mitigation. The modeling did assess the future growth through 2028 and showed that two of the neighborhood intersection at 156th NE will have one approach leg each exceed the City's adopted LOS. In both cases, the LOS can be brought back into compliance with the adopted LOS with minor intersection improvements. These improvements can be performed within the limits of the existing right of way. See http://www.ci.woodinville.wa.us/events/moratoriuminfo.asp*, Attachment C, Transportation Report for more information.*

Attachment D. Capital Facilities

Capital Facilities and Utilities Report

Capital Facilities and Utilities in the R-1 Area
City of Woodinville

Prepared January 2007
Revised February 2007

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List of Acronyms

DU	dwelling units
FAR	Floor Area Ratio
FTE	full-time equivalent
GMA	Washington State Growth Management Act
gpd	gallons per day
I/I	Infiltration/Inflow
MBR	membrane bioreactor
PRO	Parks, Recreation, and Open Space
UGA	Urban Growth Area
WF&LSD	Woodinville Fire and Life Safety District
WWD	Woodinville Water District

Appendices

Appendix A. Capital Facilities Frequently Asked Questions

Appendix B. Woodinville Fire & Life Safety District

Appendix C. R-1 Surface Water Map

1. Overview

This report describes the existing inventory of service providers in the R-1 Zoning District of the City of Woodinville for sewer, water, stormwater, schools, police, and fire and life safety. These are major services most likely to be affected by future density increases in the area. Parks and recreation is not addressed in this report, because the Woodinville Parks, Recreation, and Open Space (PRO) plan outlines a neighborhood park level of service and an implementation method (Park Impact Fee Ordinance) that is designed to keep pace with increases in housing density.

Woodinville is currently conducting a Sustainable Development Project for an area of approximately 1,100 acres on an upland plateau east of the central city. It is a predominantly residential area developed at an average density of less than one dwelling per acre. The City's Comprehensive Plan designates the area as Low Density Residential, suitable for one dwelling per acre, while allowing it to be rezoned to permit four units per acre if adequate public services can be provided. Chief among these services is public sewer.

The Washington State Growth Management Act (GMA) requires cities to provide adequate urban services along with growth. Cities are also required to account for capacity for growth. The geographic area of study for this report contains 170 net acres of land suitable for growth as determined by the City's Buildable Lands Reports that are required by the GMA. Future development in this area at an average density of one unit per acre would result in an increase of 170 new housing units; future development at densities of four units per acre would add 680 new units. There currently are 864 housing units in the area.

The objective of this report is to determine if the facilities and utilities in the study area are adequate to accommodate growth at an R-4 density. Other requirements of the GMA mandate forecasts of future needs for capital facilities, and the use of minimum standards for levels of service of facility capacity. As a result, all of the providers of facilities and services must have plans based on quantifiable, objective measures of capacity. These are discussed in detail in the various provider agency plans and to a lesser extent in the Woodinville Comprehensive Plan, and are included herein by reference.

2. Service Providers

All of the service providers included in this report, except for police and stormwater service providers, have extraterritorial jurisdiction beyond the boundaries of the City.

Police services are contracted with the King County Sheriff's Office.

The Woodinville Fire and Life Safety District (WF&LSD) (King County) serves Woodinville and unincorporated areas of King County (King County Fire Districts #36/42). A plan is underway by the Fire District that will replace the Fire Services Study of 1992 by Hughes, Heiss and Associates (Backer pers. comm.).

Students in the R-1 study area are served by the Northshore School District, which also serves unincorporated King County, Snohomish County, and the City of Bothell. The source for background information for this report is the *2006 Northshore School District Plan for Capital Facilities*.

The Woodinville Water District (WWD), a municipal corporation, serves all of the City of Woodinville, which is only a portion of their 29-square-mile service area that includes parts of unincorporated King County. A water facility comprehensive plan (1993) is under revision with completion due in the summer of 2007 (Jamison pers. comm.).

In addition to water service, the Woodinville Water District also provides sanitary sewer service within the corporate boundaries of the City of Woodinville and to more than 30 square miles of unincorporated King County.

The City of Woodinville has a stormwater utility, and regulates the provision of stormwater facilities in new development.

3. Capital Facilities Plans

All of the capital facilities plans of service providers are required to be consistent with land use; transportation; utilities; and parks, recreation, and open space elements of the Comprehensive Plan and with the plans of other governments and agencies.

For purposes of the Sustainable Development Project, existing service and facility plans were evaluated for impacts that might result from increases of densities to four units per acre on lands suitable for development in the R-1 study area.

4. Levels of Service

Each service provider uses standards of service that are typically quantitative, but that can vary according to issues such as financial feasibility or quality. Most standards measure the size, amount, or capacity of the capital facility. Police and fire services are measured in time of response. School services are measured in the number of students per teacher (student/teacher ratio), as well as student/classroom ratio. Water and sewer service is measured in terms of gallons of waste or water usage per household or per person. These are discussed in detail in the various agency capital facility plans.

5. Service Provision Capacity Analysis

Each service provider is analyzed in this report for capacity to absorb additional growth based on increases in population and housing due to potential R-4 development in areas that can realistically accommodate density increases as determined by buildable lands numbers discussed earlier. From this analysis a map has been developed showing suitable areas for growth in the R-1 area based on service provider's abilities to accommodate that growth. Each of the agency providers' capacities are reviewed below. In addition, some frequently asked questions are addressed in Attachment A.

5.1. Police and Fire and Life Safety

Correspondence with John McSwain, Police Chief for the City of Woodinville, indicates that projected increases in housing units due to zoning changes from R-1 to R-4 would not affect response time for the department. Population and housing increases may require additional personnel and facilities (vehicles), but response time is not usually affected by increases in density unless access is restricted (McSwain pers. comm.).

Fire and life safety service uses the same standards as police response time. Correspondence with Bud Backer of WF&LS indicates that level of service also would not be affected by increases to R-4 densities in the R-1 area, unless access was made more difficult (Backer pers. comm.) See also Appendix B for a letter from the District.

This report must conclude that for these two service providers, R-4 density in the report area presents no decreases in service. Therefore, R-4 is a suitable designation for the R-1 study area outlined on Figure 1 at the end of this report.

5.2. Northshore School District

Any changes in R-1 area densities will be obscured in an analysis of the area due to the extent of school district boundaries. However, taken in context, some measures of predictability can be gleaned from the District Plan.

Enrollment in the Northshore district has fluctuated over the past 6 years. Over the last 2 years, enrollment has gradually increased at the elementary and high school levels, and these increases have offset the decline in enrollment at the junior high level. Projections for enrollment have been made with consideration of the following factors: the School District's enrollment trends, population and housing growth, any market share losses or gains due to private school, as well as the effects of the District's recent adoption of new school service boundary lines. Projected full-time equivalent (FTE) enrollments are predicted to be 19,510 students for 2012; 20,305 for 2020; and 21,317 for 2025 (see Table 1).

Table 1. District Projected FTE Enrollment

Level	2012	2020	2025
Elementary	9, 725	10, 390	10, 951
Junior High	4, 952	4, 982	5, 258
High School	4, 834	4, 932	5, 108
Total	19, 510	20, 305	21, 317

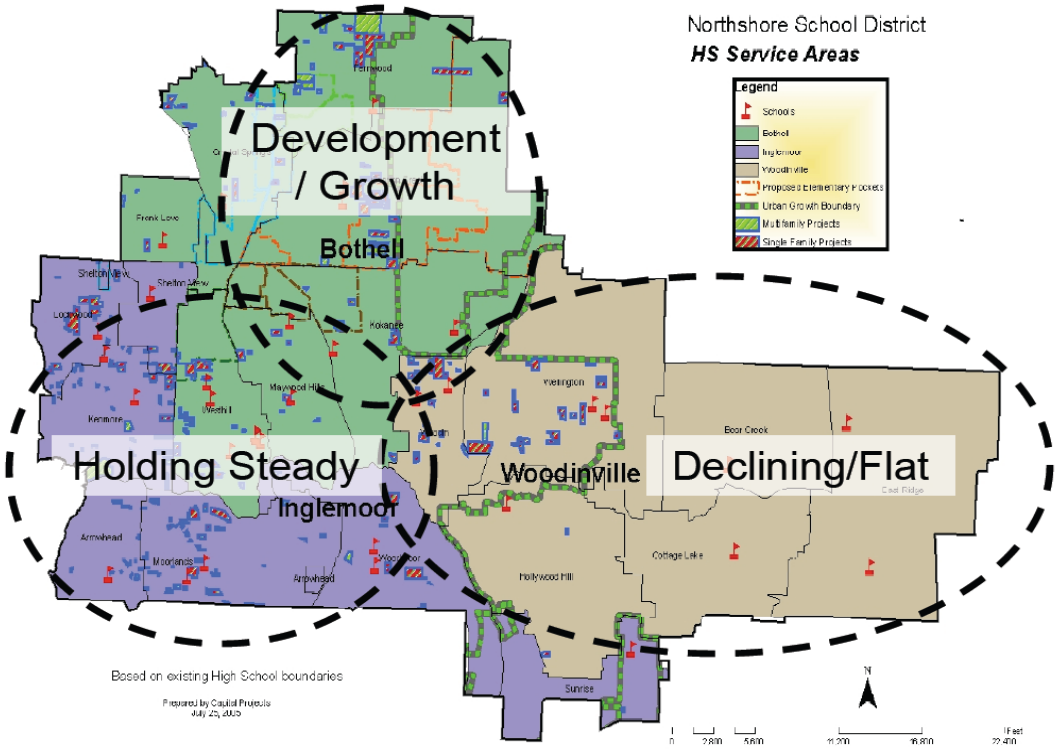
Table 1 illustrates an overall increase in enrollment at all levels. However, a recent study by the School Board of the Northshore School District has revealed that the projected increase in enrollment is unbalanced among the schools. A trend for increased enrollment can be seen in the northern part of the district, while a decline is projected for the eastern part of the district (see Graph A). The School Board felt this imbalance would affect students' access to high-quality education. Thus, it moved to change the district's boundary service lines in order to balance enrollment. The results of this study enabled the Board to approve boundary changes to be phased in over the next 3 years. These changes would affect eight elementary schools and all of the junior high and high schools in the District. The Board approved this change with the assumption that further development of the eastern portion of the district was unlikely.

The eastern part of the district partly includes an area zoned currently at 1 house per acre (R-1). This is the area of projected declining enrollment. Leota Junior High is located in this area. The boundary changes will increase, instead of decrease, projected enrollment for Leota Junior High by 147 students over the next 3 years (see Graph B). Wellington Elementary is also in this R-1 area, but is not affected by the

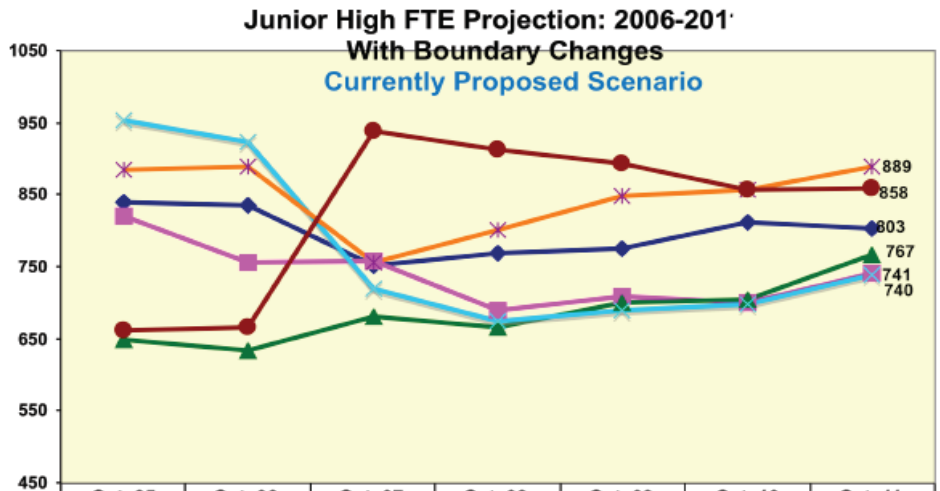
boundary service line changes. However, both schools would be impacted by any development to the R-1 area.

Capacities of Wellington Elementary and Leota Junior High (R-1 schools) become important when considering the possibility of increased development densities in the R-1 area of the district. Graph A and Graph B below illustrate the trends in enrollment. Due to the inconsistency in population projection base data and boundaries, it is only possible to generalize about geographic impact from the R-1 area on enrollment at the area's two schools, Wellington Elementary and Leota Junior High.

Graph A. Enrollment Trends



Graph B. Enrollment Trends



	Oct_05	Oct_06	Oct_07	Oct_08	Oct_09	Oct_10	Oct_11
Canyon Park	840	836	753	769	775	813	803
Kenmore	821	756	758	689	710	700	741
Leota	648	635	681	667	700	705	767
Northshore	954	923	720	675	690	698	740
Skyview	886	890	756	801	849	857	889
Timbercrest	662	666	938	913	893	858	858

School facilities and student capacity needs are dictated by the types and amounts of space required to accommodate the District's adopted educational program. The educational program standards, which typically drive facility space needs, include grade configuration, optimum facility size, class size, educational program offerings, classroom utilization and scheduling requirements, and use of relocatable (portable) classroom facilities. Current enrollment for the R-1 area schools can be seen in Table 2.

Table 2. Enrollment Capacities for Wellington Elementary and Leota Junior High

	Classrooms	Student Capacity	Portables Contributing to Capacity	Student Portable Capacity	Total Capacity
Wellington Elementary	22	526	4	68	594
Leota Junior High	37	912	8	54	966

Based on these capacities, growth at R-4 densities in the R-1 area of Woodinville would limit these schools' ability to support a dramatic influx of new students. However, the ratio of R-1 area student contribution in relation to the contribution of the remainder of the district would be small. Projections required to ascertain that kind of detail are not possible using current geographic data limitations.

In conclusion, it must be noted, that the Northshore School District maintains ordinance authority to exact impact fees from new development to pay for new facilities caused by increases in enrollment due to those developments. As such, for school services within the R-1 Study Area (see area in Figure 1) suitability is indicated as R-4, due, in part, to minor projections in student population that may result from R-4 density increases in the R-1 area, and due to the District's ability to charge impact fees.

5.3. Public and Private Water Facilities

The Woodinville Water District (WWD) covers about 18,660 acres and serves about 13,000 connections. It is supplied by the City of Seattle Public Utilities through the Tolt Pipeline and the Tolt Eastside Supply Line, which run through the Water District service area. The Water District has eight connections to the Tolt Pipeline and one to the Tolt Eastside Supply Pipeline. Each connection is separately metered. The Water District owns and maintains one well near the Water District office as an emergency standby water source. The Water District has seven emergency inter-ties. The Water District does not have formal inter-tie agreements with any adjacent water purveyors, though emergency connections exist with the City of Bothell, the Northshore Utility District, and the City of Redmond.

Average Day Demand in 2004 was about 5 million gallons per day. Demand in recent years has averaged between 86 and 96 gallons per capita per day on an annual basis. Historically, about 73% of water demand has been from single family residences, with multi-family customers taking another 10%. Commercial customers take another 10% and industrial demand is about 3% with the remainder going to

municipal and irrigation uses. The Water District operates an aggressive conservation program. The ratio of maximum day demand to average day demand within the Water District has been about 3.0, while about 2.1 is the average for the Seattle system as a whole. The higher Water District value reflects the larger lot sizes present within the Water District and significant irrigation use.

Increases in R-1 area zoning to R-4 over buildable parcels, under the above ratios result in an increase in demand for 4,312 gallons per day in the entire study area, considered by Water District officials to have no major impact to the current capacity of supply or facilities.

5.3.1. Wells

There are a number of wells that are on record with the Washington State Department of Ecology within the Water District boundary and only five on record in the R-1 area. Wells within the service area serve individual water supply, are resource protection wells, or have been decommissioned. These wells are typically privately owned, shallow (less than 100 feet deep) wells, with low capacities of 20 gallons per minute (gpm) or less. Due to the small number of wells in the R-1 area, and because most supply comes from surface water sources, there appears to be no capacity implications for future development.

5.4. On-site Sewage Disposal Systems

There are many privately owned and operated on-site sewage disposal systems within the Water District sewer service area. The Water District is not involved with the operation and maintenance of these systems. Failure of on-site sewage facilities within the Urban Growth Area (UGA), or development of the properties, may necessitate an extension of sewerage facilities, which will be constructed by the affected property owners. It is estimated that approximately 80% of the Water District's residential water customers use on-site sewage disposal systems, most of these customers being outside the UGA. Approximately 25% of these customers are inside the UGA. On-site sewage disposal consists of a facility located typically on a single lot or tax parcel that incorporates a septic tank discharging to a drainfield. Operated properly, on-site sewage disposal systems are an acceptable means of treating and disposing of sewage on a small scale at low development densities. However, if on-site sewage disposal systems are improperly maintained, or are constructed in soils with poor percolation rates, or the lots are too small, operating problems may develop. Repair scenarios in accordance with WAC 246 272-16501 then may be required by Seattle-King County Public Health authorities to resolve the problem. These repairs may include the addition of treatment devices such as a sand

filter, a different disposal technique such as a mound, disinfection, or an alternate technology such as a membrane bioreactor (MBR). In severe cases, individual properties may be required to use holding tanks and haul sewage to an approved receptacle.

Septic failures in the R-1 area do not indicate a need for sewerage on an area-wide basis and therefore have no impact on suitability for R-4 zoning in the study area of this report.

5.5. Sanitary Sewage

Sewerage facilities and service is managed by the WWD and structured within the 2006 General Sewer Plan. The Plan is based on an ultimate R-4 density in the current R-1 study area because the City of Woodinville Comprehensive Plan land use designation (Low Density Residential) for the R-1 area allows rezones up to a maximum R-4 density when adequate facilities are present. The Plan for the R-1 area also indicates that it is currently feasible physically and economically to extend facilities up to and including the western third of the R-1 area (Figure 1). The eastern two-thirds of the area is more difficult due to severe grade change that would involve pump stations and major expense. For these reasons, this report is classifying the R-1 area into two categories. The western portion, consisting of the western one-third of the R-1 zone, is suitable, in terms of ease of extension, for R-4 density while the eastern portion should remain at R-1 until such time as sewer facility economics becomes feasible.

The characteristics of the system and capacity calculations are included in the following part of this report.

Sewage flow includes residential, commercial, and industrial contributions. Most mini-basins include a mix of these land uses. Typical residential sewage generation can be calculated from the flow data developed by the King County Regional Infiltration/Inflow (I/I) Control Program and checked against the water consumption actually billed to selected neighborhoods. No flow monitoring data is available to quantify sewage generated by other land uses, which is likely highly variable according to the specific activity of each individual parcel.

Accordingly, for calibration of the hydraulic flow model, a specific number will be developed for each mini-basin defining infiltration, rain-induced inflow, and single-family residential sewage. Other unit flow rates from land uses will then be adjusted to balance the actual flows recorded on selected dates by the King County I/I Program.

5.5.1. Residential Sewage

Residential land uses occupy most of the land area within the Water District sewer service area and also in the R-1 study area of this report. The average quantity of sewage generated by residences within the Water District can be computed from the flows monitored in Mini-basin WDN 001, described in the WWD 2006 General Sewer Plan, because it is entirely residential except for the elementary school. Winter water consumption data was provided by the Woodinville Water District for 445 customer accounts in the English Hill area, identified as Mini-basins WDN 001 and 002. These two mini-basins had an average water use of 98,915 gallons per day (gpd). The average water use per customer water was 222 gpd.

Sewage flow for Mini-Basin WDN 001 derives from 502 parcels, and averaged 97,000 gpd. This is an average of 194 gpd per parcel, and at 2.6 persons per household is equivalent to 75 gpd per capita. Dividing the sewage flow per parcel by the winter water usage per parcel indicates that on average about 87% of the total winter water billed per customer becomes sewage, which is approximately the ratio observed in most residential communities and indicates the value is realistic of actual conditions. Homes in English Hill may not be typical in all respects for all homes receiving sewer service from the Water District. More water may be used for summer landscape irrigation, for example. However, household size is believed typical, and water appliances that generate sewage are believed typical. Therefore, existing residential sewage flow for the entire Woodinville Water District is assumed to average 194 gpd per parcel.

At these ratios, the R-1 area may be assumed to use an additional 131,920 gallons of sewage flow for future developed buildable parcels at R-4 densities, and 132,696 for existing developed parcels. These increases do not have major capacity or facility implications viewed as a percent of the whole Water District. All capital improvements and additions to the sewer system are, as a matter of Water District policy, the responsibility of the developer, and are feasible if engineered according to the 2006 General Sewer Plan.

5.5.2. Future Service Area Conditions

For sewer capacity planning purposes the entire City of Woodinville will be served by sewers in the future, including the eastern portion of the City, which is not currently served. The entire City of Woodinville lies within the King County UGA; therefore, sewer service is allowed throughout the City limits. As previously stated, these sewers are expected to be built by developers and/or those requiring service in their area, not by the Water District.

Due to the topography of the eastern R-1 portion of the City of Woodinville, lift stations will be needed to convey the sewage generated in that area to existing Water District and King County pipes for treatment. Approximately four lift stations will be required in the eastern portion of the City. The Lake Leota area of the City will require special consideration to define how sewers will serve the surrounding homes due to the lake topography. Service may be viable through grinder pumps or a vacuum sewer system. The Water District will determine the type of service to be used prior to extending sewers in that area. It is important to note that the piping and pump stations are approximations of what is necessary to serve the currently unserved areas of the City. The elevations and design have been derived from existing topographic maps. Actual development may differ from what is shown in the WWD Sewer Plan and will depend on plans prepared by the developers.

5.5.3. Build-out Conditions

The 2006 WWD General Sewer Plan makes the assumption that the entire City of Woodinville will be served by sewers in the future, as stated above. This is defined as the "build-out condition." These build-out conditions are assumed to occur by the year 2025. Included in the sewer service area is the eastern portion of the City not currently served. This area will need approximately two new mini-basins, along with several lift stations.

5.6. Stormwater

At any future density, developments would be required to meet the requirements of the City's Stormwater Manual (WMC 14.09) and provide for detention and discharge to safe locations. Appendix C contains a R-1 Surface Water Map prepared by the City for background information.

5.7. Conclusions

An analysis of suitability of capital facilities for police protection, fire protection, school facilities and water supply revealed that no future impacts to level of service standards would occur due to increases from R-1 to R-4 densities in the study area. The major determinant or catalyst for density increase will be sewer availability and the 2006 WWD General Sewer Plan.

The preceding explanations of conditions, and the assumptions, opportunities, and liabilities found in the WWD 2006 General Sewer Plan suggest that the R-1 area be considered as two separate potential zoning areas. The western portion (see

Figure 1), which has gravity access to the existing facilities, may be physically suitable for R-4 zoning while the eastern section, due to its topographic liability, is currently most suitable for R-1 zoning.

5.8. References Cited

2006 Northshore School District Plan for Capital Facilities

Backer, Bud. Personal Communication.

Jamison, Dee. Personal communication.

McSwain. Personal communication.

Woodinville, City of. 2002. Comprehensive Plan.

City of Woodinville

Sustainable Development Project

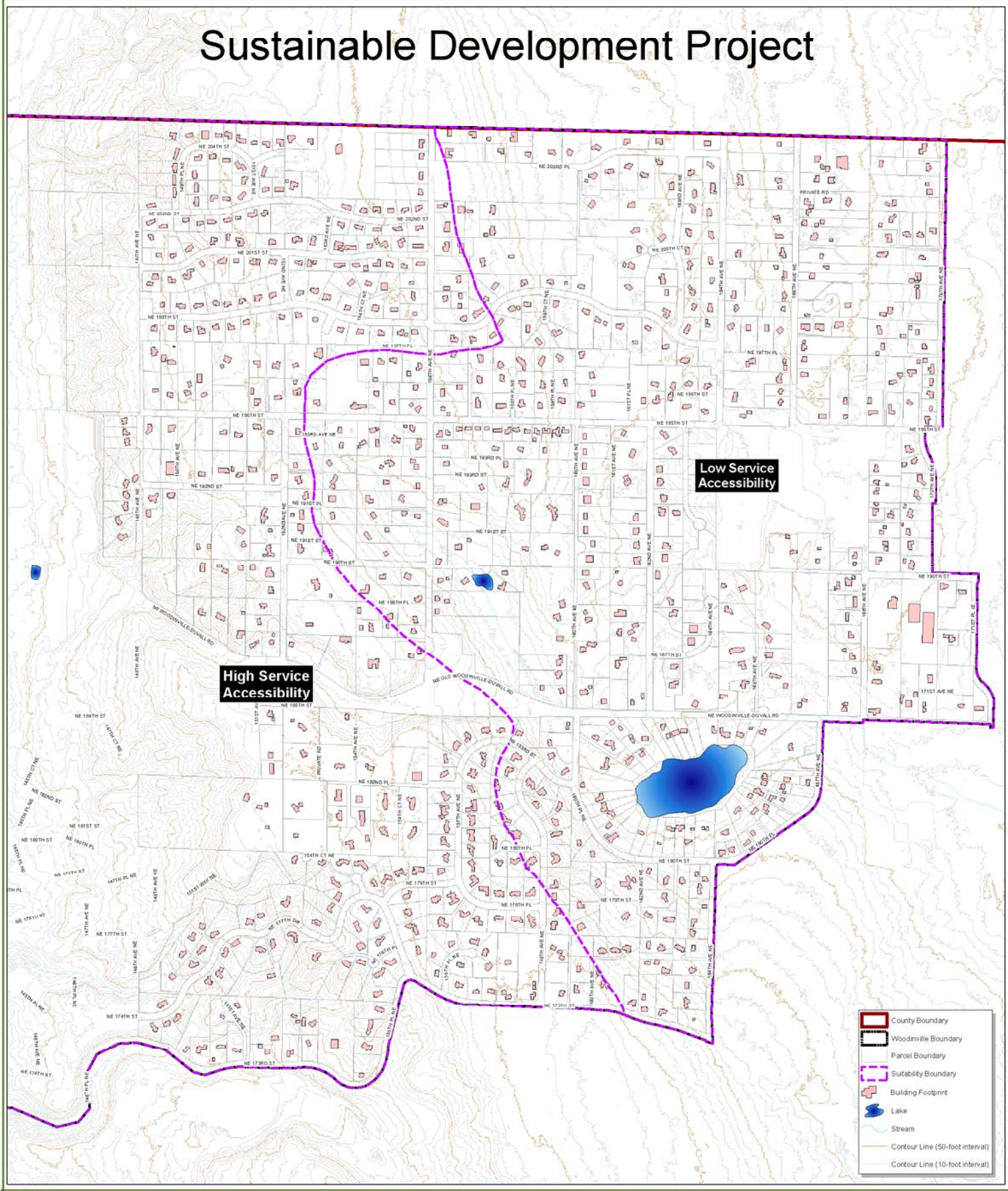


Figure 1
Composite Capital Facility and Utility Suitability

0 500 1,000
Feet

Appendix A

Capital Facilities Frequently Asked Questions

Appendix A. Capital Facilities Frequently Asked Questions

Staff response is shown in *Italics.*

#1. Is higher service accessibility going to equal to higher residential density if it negatively impacts the environment and neighborhood character?

Environmental and neighborhood character are under consideration as part of the sustainable study along with transportation and capital facilities.

#2. Why do sewers require higher density?

This is a policy of the sewer service provider and not of the City. The reasoning behind a certain level of density, to support a sewer system, is that the revenues generated by the customers serviced by a system needs to be sufficient to cover the maintenance, operation and long range replacement of that system.

Appendix B

Woodinville Fire and Life Safety District

Woodinville Fire and Life Safety District
P.O. Box 2200 • 17718 Woodinville - Snohomish Rd NE
Woodinville, WA 98072
Phone 425-483-2131 • Fax 425-486-0361

EXHIBIT 2/8
PAGE __ OF __

RECEIVED
FEB 13 2007
CITY OF WOODINVILLE
DEVELOPMENT SERVICES

February 12, 2007

Cindy Baker
City of Woodinville
Community Development

Re: Fire Department Emergency Response times and criteria for the urban area as defined by the Woodinville Fire and Life Safety District (WFLSD) Standards of Coverage.

Responding to the question of how a zoning change in the R-1 area, located on the east side of the city of Woodinville, may affect the emergency response times of the fire district requires the need to understand the tools by which WFLSD measures its responding vehicles speed in reaching an emergency scene. The WFLSD "Standards of Coverage" is the basic tool for measuring times and establishing distribution of stations.

Standards of Coverage

The purpose of the Standards of Coverage is as follows:

Standards of response coverage are defined as those written policies and procedures that establish the distribution and concentration of fixed and mobile resources of an organization. This document serves as the Woodinville Fire and Life Safety District's (WFLSD's) operational business plan maintaining and improving upon the high quality, effective fire protection and emergency medical services to the community.

Long range planning is crucial to meet the needs of the community. Among the elements examined in this standard are Risk Assessment (a makeup of the occupancies in the district and the probability/consequence of an incident), and the historical performance of the WFLSD's responses to emergency incidents.

The examination of risk assessment and historical response performance will assist the district in developing distribution and concentration plans for fixed and mobile resources that best meet the community's needs.

Maintenance of the Standard
Annual review of the standard will be conducted to assure that it continues to meets the needs of the community, the fire service and the philosophy of the WFLSD and its Board of Fire Commissioners. The Deputy Chief of Administration shall be responsible for annual review of this standard.

Note: The above are important statements as they assure our citizens that WFLSD has taken in account the need to project and look forward as our district undergoes changes associated with development or growth.

Distribution of resources is critical to providing the citizens of our district the most effective emergency services possible within the financial framework established by the Board of Commissioners.

The term distribution is defined as the geographical location of first due resources for initial intervention in all classifications of risk. Proper location of stations and resources ensures the rapid response and deployment of first due units to minimize and handle routine emergencies. Distribution is measured by the percentage of the jurisdiction covered by first due units within the specifically adopted response time goals.
The WFLSD has divided its coverage area into three population density types, urban, suburban and rural. Response time goals have been established specifically for each zone. Rural response zones were defined using available water supply and accessibility as key components. The urban and suburban response zones were established using the King County urban growth boundaries set forth in the Washington State Growth Management Act (GMA) of 1990.

The R-1 area in question is defined in the Standards of Coverage as urban.

The urban area of the fire district covers approximately 12 square miles and includes the City of Woodinville.

The Standards of Coverage has response time goals for first unit response times in the Urban Zone as follows:

Urban Response Times Goals

First in units on fire responses in:	< 08 minutes	70% of the time
First in units on BLS responses in:	< 07 minutes	80% of the time
First in units on ALS responses in:	< 07 minutes	80% of the time

Urban Response Times (actual)		**2003**	**2004**
First in units on fire responses in:	< 08 minutes	72%	73%
	< 07 minutes	59%	60%
	< 06 minutes	41%	43%
First in units on BLS responses in:	< 08 minutes	89%	87%
	< 07 minutes	82%	80%
	< 06 minutes	68%	67%

First in units on ALS responses in:	< 08 minutes	90%	91%
	< 07 minutes	81%	84%
	< 06 minutes	69%	68%

As can be seen from the above numbers WFLSD is meeting and exceeding the current objectives in the urban zone. Given that WFLSD has established the urban objectives with an eye to the future it is apparent that increased traffic due to growth, although it may have a minimal effect, should not place the fire district in a position of not meeting the current response time goals. It also must be restated that the Standards of Coverage must be maintained on an annual basis with complete review by the Deputy Chief of Administration for the purposes of determining if a rethinking of distribution of resources is needed.

As part of the equation of emergency response times it is noted that the State of Washington allows that emergency vehicles may, with lights and sirens operating and with due caution exceed the speed limit, travel in the opposing lane of traffic and otherwise provide necessary actions to access an emergency scene. All WFLSD emergency vehicle drivers are held to the highest standards for the purpose of acting in the appropriate manner to the hazards of emergency response. Each driver is continually trained and required to be nationally certified every 3 years.

With any zoning change, street standards have the greatest affect on response times. Providing streets adequate (wide enough) for response vehicles is a primary concern of the fire service.

As stated in the Standards of Coverage "A commitment by the WFLSD to continue to pursue excellence through constant evaluation of services has been made by the board of fire commissioners." The District is currently evaluating the need for additional fire stations as part of the Strategic Planning Process.

The affect on call volume

Assuming a complete build out of an additional 800 homes, and assuming three (3) persons per home, we can project 2,400 residents. This number is most likely high, as the national average pre home is less than three, and there are already a number of homes in this area that would substantially reduce "new" residents well below the 2,400 Using a conservative estimate of one (1) incident per every 100 persons, this zoning change would result in an additional 24 alarms per year (barring any senior housing). The affect on call volume would be insignificant.

If you have any questions, please do not hesitate to contact me.

Sincerely,

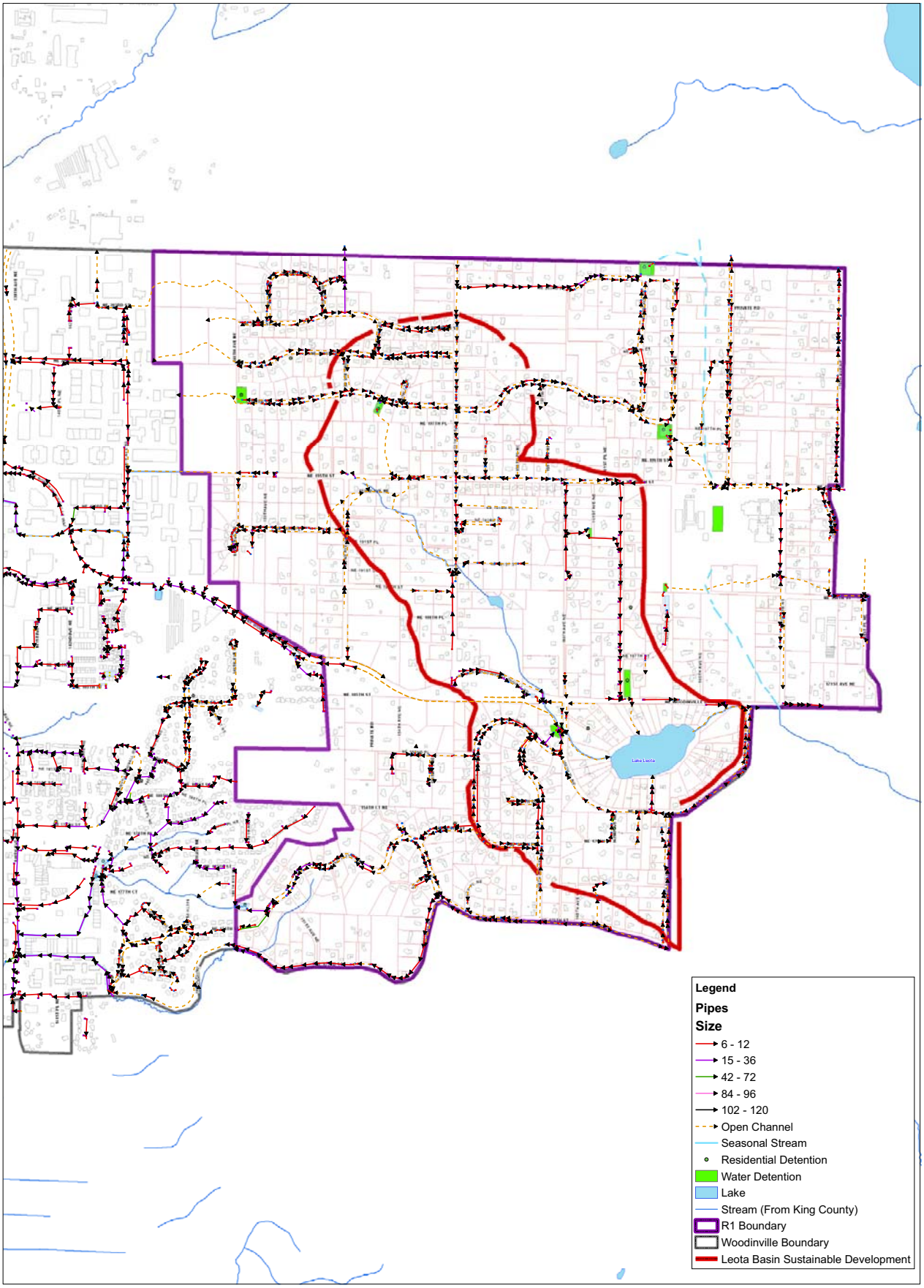
Bud Backer

Bud Backer, Deputy Chief

Appendix C

R-1 Surface Water

City of Woodinville



R1 Surface Water

0 250 500 1,000 Feet

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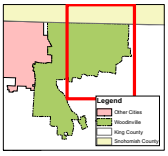

NO	DESIGN/REVISION	DATE	BY
1	Draft	10/30/06	AU
2	Revision	02/05/07	AU
3			
4			
5			

City of Woodinville
17301 - 133rd Ave NE
Woodinville, WA 98072
www.woodinville.wa.us
425-489-2700

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Attachment E Moratorium Ordinances

ORDINANCE NO. 419

AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, ADOPTED PURSUANT TO RCW 35A.63.220 AND RCW 36.70A.390; IMPOSING A TEMPORARY MORATORIUM UPON THE RECEIPT AND PROCESSING OF BUILDING PERMIT AND OTHER LAND USE DEVELOPMENT APPLICATIONS WITHIN THE CITY'S R-1 ZONING DISTRICT; SETTING FORTH FINDINGS OF FACT IN SUPPORT OF SAID MORATORIUM; ENUMERATING LIMITED EXCEPTIONS; SCHEDULING A PUBLIC HEARING DATE; AUTHORIZING OFFICIAL INTERPRETATIONS BY THE CITY OF WOODINVILLE PLANNING DIRECTOR; PROVIDING FOR SEVERABILITY; DECLARING AN EMERGENCY; AND ESTABLISHING AN IMMEDIATE EFFECTIVE DATE.

WHEREAS, the City of Woodinville is currently undertaking a comprehensive "Sustainable Development" program that will yield significant policy recommendations regarding the protection of critical areas while simultaneously accommodating appropriate future growth within the City's R-1 Zoning District; and

WHEREAS, the Woodinville City Council desires to preserve the current *status quo* by imposing a temporary moratorium upon the acceptance and processing of building and other land use permit applications until the Sustainable Development program has concluded and the resulting policy recommendations are implemented; NOW, THEREFORE,

THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, DO ORDAIN AS FOLLOWS:

Section 1. Findings. The Woodinville City Council hereby makes the following findings in support of the moratorium imposed by this ordinance:

A. The City of Woodinville is primarily zoned for residential land use.

B. The City has recently received numerous permit applications for development activity within the City's residential neighborhoods. Continued development of the City's residentially zoned neighborhoods — particularly the R-1 (one residential dwelling unit per acre) Zoning District — at current rates will irreversibly alter the character and physical environment of these areas in a manner potentially inconsistent with various goals and polices adopted by the City and mandated by the GMA.

C. The R-1 Zoning District comprises approximately 1,291 acres, and is the largest single zone within the City of Woodinville's territorial jurisdiction.

D. The R-1 Zoning District contains coarse, permeable geologic materials that allow infiltration to mapped critical aquifer recharge areas (CARAs), many of which have been characterized as possessing a "high" or "medium" potential for ground water contamination.

E. The R-1 Zoning District contains Lake Leota, a natural water body with known water quality impacts. The shallow ground water surrounding Lake Leota is believed to be hydrologically connected to local CARAs.

F. Regions within the R-1 Zoning District hydrologically drain toward areas characterized by "high" or "medium" potential for ground water contamination. Said areas are known or suspected of being hydrologically connected to Bear Creek, a significant and biologically productive salmonid-bearing stream. Other areas within the R-1 zone drain variously toward Lake Leota, Little Bear Creek, and Woodin Creek, the latter two of which are known to contain salmonids.

G. The Bear Creek Basin drainage area encompasses a significant portion of the eastern Woodinville City limits within the R-1 Zoning District. The basin drains southeasterly into the Cold Creek Natural Area wetland system, a complex network of wetlands and groundwater springs feeding the headwaters of Cold Creek and an important cold water source for the Bear Creek system. The Bear/Cottage Lake/Cold Creek system is formally rated as a Tier I sub area under the draft WRIA 8 Chinook Salmon Conservation Plan, and the action start list for the North Lake Washington Chinook population is to identify and protect headwater areas, wetlands, groundwater sources, natural hydrologic processes and temperatures that support Chinook salmon within this area.

H. The R-1 Zoning District contains numerous steep slopes and areas characterized by high "geologic hazard" potential under the City's critical area mapping resources.

I. The eastern portion of the R-1 Zoning District contains the lowest existing development intensity, the highest total level of existing pervious surface area, and the most extensive tree canopy cover within the City — the removal or reduction of which would likely create adverse impacts to local hydrological cycles, increased sedimentation, and greater pollutant migration to local streams and wetlands. As such, the R-1 Zoning District contains

both the highest potential for environmental protection and enhancement, and the highest potential for environmental impact, loss or degradation of critical habitat for endangered species.

J. The R-1 Zoning District currently lacks the level of public infrastructure necessary to adequately support urban levels of service, including but not limited to sewer utility mains and transportation facilities. The City does not serve as the purveyor of sewer utility service within the R-1 Zoning District or elsewhere within the Woodinville community.

K. The City is required by the Growth Management Act (GMA) codified at Chapter 36.70A RCW to balance numerous competing policy interests with respect to local land use planning. Such policy interests include, *inter alia*, accommodation of appropriate urban growth, protection of critical areas, recognition of private property rights, retention of open space areas, conservation of fish and wildlife habitat, and ensuring the concurrent adequacy of public facilities and services necessary to support new development.

L. Protection of the local environment generally — and critical areas specifically — expressly underlies several goals, policies, programs and efforts adopted, funded and/or otherwise undertaken by the City. A partial, nonexclusive list of such goals, policies, programs and efforts is attached hereto as Exhibit A and incorporated herein by this reference as if set forth in full.

M. The City has recently initiated a comprehensive "Sustainable Development" program in an attempt to ensure the compliance of future development within the City — specifically and particularly including the current R-1 Zoning District — with applicable GMA policies, goals and directives. The Sustainable Development program involves a thorough, detailed inventory of local environmental resources, projection of future development demand, and analysis of public infrastructure availability. The Sustainable Development program will ultimately yield recommendations for a multi-faceted regulatory approach to balance the competing policies of the GMA within the R-1 Zoning District — including but not limited to the protection of critical areas, the preservation and enhancement of anadromous fisheries, and the accommodation of appropriate residential growth.

N. The City is presently participating in a joint ground water study with King County and the City of Redmond. Results of the study are expected to provide more detailed information regarding local environmental resources, especially as they relate to local CARAs and hydrological connections to productive salmonid-bearing streams.

O. A significant probability exists that the City will amend several components of its Comprehensive Plan and development regulations upon completion of the Sustainable Development program — specifically and particularly including development regulations governing the current R-1 Zoning District.

P. The City Council desires to preserve the *status quo* within the R-1 Zoning District during the pendency of the City's consideration, preparation and adoption of such amended development regulations.

Q. The acceptance and processing of building and other land use permit applications within the R-1 Zoning District prior to the City's implementation of such amendments would jeopardize the public interest by vesting development rights inconsistent with the City's amended regulations.

R. The City is authorized pursuant to RCW 35A.63.220 and RCW 36.70A.390 to adopt development moratoria for the purpose of preserving the *status quo* while new development standards are considered, prepared and enacted.

S. Imposing a temporary moratorium upon the receipt and processing of building and other land use permit applications specific to the R-1 Zoning District is consistent with the goals and policies enumerated in Exhibit A, and will serve the public interest.

T. The moratorium imposed herein is necessary for the protection of public health, property, safety and welfare. A public emergency exists requiring that the City's moratorium become effective immediately upon adoption.

U. The probable impact of the exceptions contained in Section 3 of this ordinance is *de minimus,* and will not materially detract from or otherwise subvert the purposes and desired effect of the moratorium imposed hereunder.

Section 2. Moratorium Imposed. The City hereby imposes a moratorium upon the receipt and processing of building permit applications, land use applications, and any other permit application for the development, rezoning or improvement of real property within the R-1 Zoning District as defined by Chapter 21.04 WMC and further delineated by the City's Official Zoning Map.

Section 3. Exceptions. The moratorium imposed under Section 2 of this ordinance shall not apply to (1) permit applications for the remodeling, expansion, restoration or refurbishment of existing single-family and multi-family residential structures, or (2) permit applications for publicly-owned structures and facilities.

Section 4. Effect upon Vested Rights. The moratorium imposed under Section 2 of this ordinance shall apply prospectively only, and shall operate to prevent the acceptance and processing of any permit application submitted after the effective date hereof.

Nothing in this ordinance shall be construed to extinguish, limit or otherwise infringe upon any permit applicant's vested development rights — as defined by state law and City of Woodinville regulations — with respect to any complete permit application submitted before the effective date hereof.

Section 5. Severability. If any section, sentence, clause or phrase of this ordinance should be held to be invalid or unconstitutional by a court, board or tribunal of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this ordinance.

Section 6. Public Hearing. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, a pubic hearing on the moratorium imposed under Section 2 of this ordinance is hereby scheduled for May 1, 2006 at 7:30 p.m. in the City Council Chambers of Woodinville City Hall, 17301 133rd Avenue NE. The City Clerk is authorized and directed to provide public notice of said hearing in accordance with applicable City standards. The City Council may in its discretion adopt additional findings of fact at the conclusion of said hearing.

Section 7. Interpretative Authority. The City of Woodinville Planning Director is hereby authorized to issue official interpretations arising under or otherwise necessitated by this ordinance.

Section 8. Declaration of Emergency; Effective Date; Duration. Based upon the findings enumerated in Section 1 of this ordinance, the City Council declares a public emergency necessitating an immediate effective date of the moratorium imposed hereunder. Said moratorium shall take effect immediately, and shall remain effective for six months unless terminated earlier by the City Council. PROVIDED, that the City Council may, in its sole discretion, renew said moratorium for one or more six month periods in accordance with

state law. This ordinance or a summary thereof consisting of the title shall be published in the official newspaper of the City.

PASSED by the City Council of the City of Woodinville this 20th day of March ,2006.

APPROVED:

MAYOR CATHY VONWALD

ATTEST/AUTHENTICATED:

CITY CLERK, SANDRA PARKER, MMC

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY:

BY _____

FILED WITH THE CITY CLERK: 3-10-2006
PASSED BY THE CITY COUNCIL: 3-20-2006
PUBLISHED: 3-27-2006
EFFECTIVE DATE: 3-20-2006
ORDINANCE NO. 419

Exhibit A

A(1). The Woodinville City Council's adopted Environment Goal provides as follows:

> Create a community that reduces the waste stream, promotes energy conservation, preserves and enhances aquatic and wildlife habitat, protects and improves water quality, and protects the public from natural hazards.
>
> A. Remain an active partner in the WRIA Region 8 effort to develop, fund and implement early action strategies.
>
> B. Work collaboratively through WRIA 8 with NMFS, State, tri-county and other public and private partners to develop a recovery plan for Puget Sound Chinook salmon.

A(2). The City has been actively involved in the WRIA recovery activities since the late 1990's.

A(3). In 1999, the Woodinville City Council approved Resolution No. 167, adopting key preliminary actions for the development of a species recovery plan in response to the listing of Puget Sound Chinook Salmon as threatened under the federal Endangered Species Act.

A(4). In 2001, the Woodinville City Council approved Resolution No. 194, adopting an "Early Action Program and Other On-going Investments for Species Protection" to establish the City's policy goals and strategies for conservation of salmonid stocks.

A(5). In 2002, the Woodinville City Council approved Resolution No. 222, adopting the "Regional Road Maintenance ESA Program Guidelines".

A(6). In 2002, the Woodinville City Council updated its Comprehensive Plan to expressly include an Environmental Element.

A(7). In 2004, the City updated its Critical Areas Ordinance to include "Best Available Science" in an effort to further protect critical areas during land use development.

A(8). In 2005, the Woodinville City Council approved Resolution No. 301, ratifying the Water Resource Inventory Area 8 Chinook Salmon Conservation Plan" dated February 25, 2005.

A(9). In 2006, the City initiated the update of its Shoreline Master Program pursuant to new guidelines promulgated by the Department of Ecology.

A(10). The City has acquired various parcels of real property in an effort to protect critical areas, and has expended significant resources to preserve, restore and enhance habitat located thereupon.

A(11). The City has commissioned habitat assessment studies of Little Bear and Woodin Creeks.

A(12). The City has initiated various fish habitat enhancement projects on Little Bear and Woodin Creeks.

A(13). The City currently sponsors or participates in numerous public programs that support environmental objectives, including but not limited to Salmon Watchers, Sammamish Re-Leaf, Arbor Day, chipping and recycling events, and sales of rain-barrels.

A(14). The City has initiated a storm water utility and implemented the Department of Ecology NPDES program to more effectively manage the impacts of storm water.

A(15). City staff routinely monitor environmental restoration projects in order to assure their success.

A(16). The City has implemented an Urban Forestry program to encourage retention and replacement of landscaping, especially trees.

A(17). The City's "Parks, Recreation and Open Space Plan" expressly identifies the need to protect open spaces and habitat pursuant to a comprehensive approach to natural resource management.

A(18). The Environmental Element of the City's Comprehensive Plan expressly includes the following policies:

GOAL ENV-3: To preserve and enhance aquatic and wildlife habitat.

Policies

ENV-3.1 Encourage preservation of the urban forest.

ENV-3.2 Identify and ensure the protection of sensitive habitat areas, including wetlands, streams and shorelines.

ENV-3.3 Maintain a standard of no net loss in the functions and values of sensitive habitat features, including wetlands, streams, lakes and shoreline areas.

ENV-3.4 Maintain connectivity between sensitive areas, including the Sammamish River and related streams, to provide safe travel routes for wildlife and fish and improve the biological integrity of sensitive habitat areas.

ENV -3.5 Support watershed-based salmon recovery efforts and compliance with the requirements of the Endangered Species Act (ESA).

ENV-3.6 Periodically review and update the Shoreline Master Program and sensitive areas regulations to ensure consistency with the policies of this Comprehensive Plan, the Shoreline Management Act and the Department of Ecology shoreline regulations.

ENV-3.7 Encourage the use of native plants in residential and commercial landscapes.

ENV-3.8 Consider and incorporate the best available science, consistent with the GMA and applicable rules, in developing regulations for fish and wildlife habitat areas, wetlands, and other critical areas.

ENV-3.9 Employ adaptive management for natural habitat. Adaptive management allows the City to monitor and make adjustments to its regulations as appropriate in response to changing conditions or new information.

ENV-3.10 Encourage acquisition of sites that protect habitat, stream corridors and provide aquatic habitat.

ENV-3.11 Encourage the restoration of ecological functions and the natural environment in environmentally damaged areas.

ENV-3.12 Participate in efforts to minimize drawdowns and warming of the Sammamish River.

GOAL ENV-4: To protect the public from floods, landslides, erosion and other natural hazards resulting from disturbance of the environment.

Policies

ENV-4.1 Protect public safety in potential seismic, flood hazard and slide hazard areas.

ENV-4.2 Minimize the adverse effects of development on topographic, geologic and hydrologic features, and native vegetation.

ENV-4.3 Control the quantity and velocity of surface water runoff.

GOAL ENV-5: To protect and improve water quality.

Policies

ENV-5.1 Preserve aquifer-recharge areas.

ENV-5.2 Include enhancement of shorelines and waterways with adjacent development activities.

ENV-5.3 Minimize impervious surfaces.

ENV-5.4 ***Minimize impacts of recreational uses on water quality.***

ENV-5.5 Protect the quality and quantity of water in waterways, wetlands, floodplains and watersheds from degradation.

ORDINANCE NO. 424

AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; INCORPORATING SUPPLEMENTAL FINDINGS OF FACT IN SUPPORT OF THE CITY'S TEMPORARY LAND USE MORATORIUM WITHIN THE R-1 ZONING DISTRICT; REVISING AND CLARIFYING THE EXEMPTIONS FOR SPECIFIED PERMIT APPROVALS UNDER THE MORATORIUM; REQUIRING CITY COUNCIL NOTIFICATION PRIOR TO ISSUANCE OF FORMAL INTERPRETATIONS UNDER THE MORATORIUM; PROVIDING FOR SEVERABILITY; AND ESTABLISHING AN EFFECTIVE DATE.

WHEREAS, the Woodinville City Council adopted Ordinance No. 419 on March 20, 2006 for the purpose of imposing a temporary moratorium upon the receipt and processing of new building, land use and other development permits within the City's R-1 Zoning District; and

WHEREAS, pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council conducted a public hearing on May 1, 2006, for the purpose of receiving and considering public testimony regarding Ordinance No. 419; and

WHEREAS, at the conclusion of the May 1, 2006, public hearing, the City Council formally adopted numerous supplemental findings in support of Ordinance No. 419; and

WHEREAS, based upon public comments received during the public hearing and subsequent Council deliberations, the City Council desires to amend Ordinance No. 419 for the purpose of formally incorporating the Council's supplemental findings, revising and clarifying the moratorium exemptions specified in the ordinance,

and requiring City Council notification before issuance of any official interpretations of the ordinance by the City's Planning Director;

NOW, THEREFORE,

THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, DO ORDAIN AS FOLLOWS:

Section 1. Amendment of Section 1 of Ordinance No. 419. Section 1 of Ordinance No. 419 is hereby amended by the addition of a new subsection 1(V) to provide in its entirety as follows:

> Findings. The Woodinville City Council hereby makes the following findings in support of the moratorium imposed by this ordinance:
>
> V. The City has formally considered the GMA planning goals enumerated at RCW 36.70A.020 as evidenced by, *inter alia*, the Supplemental Findings attached hereto as Exhibit B and incorporated herein by this reference as if set forth in full.

Section 2. Addition of Exhibit B to Ordinance No. 419. Ordinance No. 419 is hereby amended by the addition of Exhibit B hereto, which shall be attached to Ordinance No. 419 and incorporated therein as if set forth in full.

Section 3. Amendment of Section 3 of Ordinance No. 419. Section 3 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Exceptions. The moratorium imposed under Section 2 of this ordinance shall not apply to the following:
>
> A. Permit applications for the remodeling, repair, expansion, restoration, refurbishment, enhancement or replacement of an existing structure;

B. Permit applications for the construction of structures and facilities directly related to, located on the same building site as, and incidental to an existing structure;

C. Permit applications related to a publicly owned structure or facility;

D. Permit applications to construct an accessory living quarters;

E. Building and other permits necessary to complete the construction of vested development projects, complete applications for which were received by the City prior to the effective date of this ordinance; and

Section 4. Amendment of Section 7 of Ordinance No. 419. Section 7 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Interpretive Authority. The City of Woodinville Planning Director is hereby authorized to issue official interpretations arising under or otherwise necessitated by this ordinance. Prior to issuance of any such official interpretation, the Planning Director shall formally notify the City Council of both the interpretation and any relevant background information.

Section 5. Severability. If any section, sentence, clause or phrase of this ordinance should be held to be invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this ordinance.

Section 6. Effective Date. This ordinance or a summary thereof consisting of the title shall be published in the official newspaper of the City and shall take effect and be in full force five (5) days after publication.

PASSED by the City Council of the City of Woodinville this tenth day of July 2006.

APPROVED:

Cathy Von Wald

MAYOR CATHY VON WALD

ATTEST/AUTHENTICATED:

Sandra Parker, MMC

CITY CLERK, SANDRA PARKER, MMC

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY:

BY _____

PASSED BY THE CITY COUNCIL: 7-10-2006
PUBLISHED: 7-17-2006
EFFECTIVE DATE: 7-22-2006
ORDINANCE NO. 424

Exhibit B

SUPPLEMENTAL FINDINGS IN SUPPORT OF DEVELOPMENT MORATORIUM

The Woodinville City Council reaffirms the findings contained in Ordinance No. 419. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council additionally enters the supplemental findings below in support of the temporary development moratorium imposed under that ordinance. The City has duly considered the Growth Management Act (GMA) planning goals enumerated in RCW 36.70A.020. The moratorium imposed under Ordinance No. 419 will assist the City in reviewing and amending its Comprehensive Plan and development regulations in a manner that appropriately balances these policy interests for the Woodinville community and physical environment. Specifically, the City has considered the following GMA goals:

1. Urban Growth - *Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.* (RCW 36.70A.020(1)).

The City is committed to accommodating and encouraging appropriate levels of urban development in accordance with applicable GMA directives. The comprehensive Sustainable Development study that will be conducted during the moratorium period will help the City to identify which public facilities and services are needed in order to accommodate such future growth within the R-1 zoning district, an area that is — and historically has been — under-served with respect to utility service and other public facilities.

Moreover, the Sustainable Development study will help determine the appropriate phasing and installation timeframe regarding public facilities within the R-1 zone. This in turn will assist the City's capital planning and budgeting efforts. Other plans and studies, including but not limited to the Downtown/Little Bear Creek Corridor Master Plan (DT/LBC) and the Economic Development Study, are currently being reviewed by the City Council and will likewise assist the City in influencing the location and timing of urban development where adequate public facilities and services are provided.

2. Reduce Sprawl - *Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.* (RCW 36.70A.020(2)).

The Sustainable Development study conducted during the moratorium period will help determine the measures necessary to encourage the conversion of undeveloped land at appropriate levels of urban density. The study is intended in part to help the City balance the need to accommodate growth while simultaneously ensuring appropriate protection of the local environment and natural resources. Innovative land use management techniques aimed at reducing sprawl and protecting the environment will

be evaluated as part of this process. It is anticipated that the City's development regulations may be amended at the conclusion of the Sustainable Development study process to specifically encourage and provide incentives for the use of such innovative techniques.

3. Transportation – *Encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.* (RCW 36.70A.020(3)).

During the Sustainable Development study period, the City will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services consistent with local and regional transportation plans.

4. Housing - *Encourage the availability of affordable housing to all economic segments of the population of this State, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.* (RCW 36.70A.020(4)).

As the largest contiguous residential area in the City, the R-1 zone contains a substantial percentage of the City's existing housing stock. Although single family homes are predominant in the R-1 zone, the development pattern in this zoning district has traditionally provided for a variety in age, style and size of houses. The Sustainable Development study conducted during the moratorium will help to determine appropriate development techniques — potentially including, but not limited to, low impact development standards — to protect the environment and natural resources while simultaneously accommodating growth and preserving existing housing stock.

5. Economic Development - *Encourage economic development throughout the State that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and disadvantaged persons, promote the retention and expansion of existing business and recruitment of new business, experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.* (RCW 36.70A.020(5)).

A critical goal of the City's long-range planning efforts is to enhance the economic vitality of the Woodinville community. However, this policy must be carefully balanced and viewed holistically with the City's other planning goals to ensure an appropriate balance of economic development, housing, and environmental protection. The results and recommendations of the City's Sustainable Development study will be considered

together with the City's economic development efforts to foster a complementary and coherent pattern of housing and business growth.

Furthermore, the State's fisheries are recognized as a significant element of the Pacific Northwest economy. Different portions of the City's R-1 zone drain into the headwaters of Bear Creek, and towards Little Bear Creek and Woodin Creek, all known to contain salmonids — including Chinook salmon. The Sustainable Development study will likely recommend methods of protecting this valuable economic resource through the adoption and implementation of careful and well-balanced land use planning and zoning measures. The City's Economic Study also identifies the livability of the City's residential neighborhoods and the protection of the natural environment as keys to the local economy's vitality. The Sustainable Development and Concurrency studies will serve to identify the need for public facilities and services which support economic development.

6. Property Rights - *Private property shall not be taken for public use without just compensation having been made. The property rights of landowners shall be protected from arbitrary and discriminatory actions.* (RCW 36.70A.020(6)).

The moratorium process is a legally-sanctioned development control mechanism, and the City has enacted its R-1 moratorium ordinance in conformance with applicable state law. By its terms, the moratorium is of a limited, temporary duration, and will not be construed to violate any previous permit applicant's vested development rights as defined by state and local regulations. Moreover, the limited exceptions contained in Section 3 of Ordinance No. 419 authorize modification, remodeling and expansion of existing structures notwithstanding the moratorium, ensuring that landowners may continue to alter their existing residences during the pendency of the City's Sustainable Development study.

7. Permits - *Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability.* (RCW 36.70A.020(7)).

The receipt and processing of new land use permits under the moratorium will be suspended only for the limited time necessary to conduct the Sustainable Development study. Upon the expiration of the moratorium, the City will process development applications involving the R-1 zoning district in a fair and timely manner consistent with applicable state and local regulations.

The separate Development Services study initiated earlier this year is intended to make the City's permit process more efficient. The recommendations resulting from this study are expected to be implemented over the next few months. The Sustainable Development study will address current uncertainties regarding the R-1 zone. Having these questions answered, particularly with regard to appropriate environmental protections, will enhance the certainty of the City's permit application and approval

process. Individual property owners will know in advance what mitigation, construction techniques, and infrastructure is required for the proposed development of their property. This in turn will provide for more timely permit processing and the need for fewer individual environmental studies by permit applicants. The Development Services study will thus serve as a valuable resource for both the City and development applicants, and will increase the predictability of the development process within the R-1 zone.

8. Natural Resources - *Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forest lands and productive agricultural lands, and discourage incompatible uses.* (RCW 36.70A.020(8)).

The Bear Creek Basin drainage area encompasses a significant portion of the eastern Woodinville City limits within the R-1 Zoning District. The basin drains southeasterly into the Cold Creek Natural Area wetland system, a complex network of wetlands and groundwater springs feeding the headwaters of Cold Creek and an important cold water source for the Bear Creek system. The Bear/Cottage Lake/Cold Creek system is formally rated as a Tier I subarea under the draft WRIA 8 Chinook Salmon Conservation Plan, and the action start list for the North Lake Washington Chinook population is to identify and protect headwater areas, wetlands, groundwater sources, natural hydrologic processes and temperatures that support Chinook salmon within this area. The Sustainable Development study conducted during the moratorium period will provide policy recommendations concerning the protection of these valuable resources.

9. Open Space and Recreation - *Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities.* (RCW 36.70A.020(9)).

The Sustainable Development studies will assist in identifying potential park and recreation (i.e., trail) opportunities in concert with habitat conservation areas.

10. Environment - *Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.* (RCW 36.70A.020(10)).

A primary purpose of the Sustainable Development study is to address the protection of the environment, quality of life, air and water quality, and the availability of water resources. The City's R-1 zoning district contains coarse, permeable geologic materials that allow infiltration to mapped critical aquifer recharge areas (CARAs), many of which have been characterized as possessing a "high" or "medium" potential for ground water contamination. The R-1 Zoning District also contains Lake Leota, a natural water body, with known water quality impacts. The shallow ground water surrounding Lake Leota is believed to be hydrologically connected to local CARAs.

Regions within the R-1 Zoning District hydrologically drain toward areas characterized by "high" or "medium" potential for ground water contamination. Said areas are known or suspected of being hydrologically connected to Bear Creek, a significant and biologically productive salmonid-bearing stream. Other areas within the R-1 zone drain variously toward Lake Leota, Little Bear Creek, and Woodin Creek, the latter two of which are known to contain salmonids.

11. Citizen Participation and Coordination - *Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.* (RCW 36.70A.020(11)).

The City is committed to providing opportunities for citizen involvement in the public process. The City Council's adoption of Ordinance No. 419 occurred at a public meeting on March 20, 2006, and substantial public comment was received at that meeting. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council also held a public hearing on May 1, 2006 to receive and consider public testimony regarding the R-1 moratorium.

The City Council has also proposed the formation of a Citizen Advisory Panel to assist the Sustainable Development study consultants and the Planning Commission in reviewing information and the promulgation of land use management policies and tools to address environmental protection and development issues within the R-1 zone. Any amendments to the City's Comprehensive Plan and/or development regulations recommended by the Sustainable Development study will undergo significant public scrutiny and commentary before both the Planning Commission and the City Council. It is contemplated and encouraged that residents, property owners, businesses and all other interested parties will participate in this process. Because the R-1 zone area is adjacent to unincorporated areas of both King County and Snohomish County, these counties will also be asked to participate in the review of the studies and potential outcomes.

12. Public Facilities and Services - *Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.* (RCW 36.70A.020(12)).

As explained with respect to subsection 3 above, the Sustainable Development study will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary

transportation facilities and services and consistent with local and regional transportation plans.

13. Historic Preservation - *Identify and encourage the preservation of lands, sites, and structures, that have historical or archaeological significance.* (RCW 36.70A.020(13)).

At this time, there are no lands, sites, or structures within the R-1 zone area known to have historical or archaeological significance.

ORDINANCE NO. 427

AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; RENEWING FOR AN ADDITIONAL SIX MONTH PERIOD THE TEMPORARY R-1 ZONING DISTRICT LAND USE PERMITTING MORATORIUM CURRENTLY SCHEDULED TO EXPIRE ON SEPTEMBER 20, 2006; ADOPTING FINDINGS IN SUPPORT OF SAID RENEWAL; PROVIDING FOR SEVERABILITY; DECLARING AN EMERGENCY; AND ESTABLISHING AN IMMEDIATE EFFECTIVE DATE.

WHEREAS, through the adoption of Ordinance No. 419 on March 20, 2006, the Woodinville City Council imposed a six-month moratorium upon the receipt and processing of new land use permit applications within the City's R-1 Zoning District; and

WHEREAS, Ordinance No. 419 was amended by Ordinance No. 424 on July 10, 2006, which adopted additional supportive findings and clarified the scope of specified exemptions to the moratorium; and

WHEREAS, the chief purpose of the moratorium is to preserve the *status quo* while the City's Sustainable Development study is completed and new development standards are considered and duly enacted; and

WHEREAS, the Sustainable Development study is proceeding steadily, but will not be fully completed prior to the September 20, 2006 expiration date of the moratorium; and

WHEREAS, it is necessary to renew the moratorium imposed under Ordinance No. 419 in order to prevent land use permit applicants from obtaining vested development rights inconsistent with the anticipated code amendments that will likely result from the Sustainable Development study;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. Findings. The recitals above are hereby adopted as findings in support of the moratorium renewal effected by this ordinance. Pursuant to RCW 36.70A.390 and RCW 35A.63.220, the City Council further makes and enters the additional findings contained in Exhibit A, attached hereto and incorporated herein by this reference as if set forth in full.

Section 2. Renewal of Moratorium. The moratorium imposed under Ordinance No. 419, as amended by Ordinance No. 424, is hereby renewed for an

additional six month period commencing upon September 20, 2006. Section 8 of Ordinance No. 419 is accordingly amended to provide in its entirety as follows:

> Based upon the findings enumerated in Section 1 of this ordinance and any subsequent enactment relevant hereto, the City Council declares a public emergency necessitating an immediate effective date of the moratorium imposed hereunder. Said moratorium shall take effect immediately, and shall remain effective for one year unless terminated earlier by the City Council. PROVIDED, that the City Council may, in its sole discretion, renew said moratorium for one or more six month periods in accordance with state law. This ordinance or a summary thereof consisting of the title shall be published in the official newspaper of the City.

Section 3. Declaration of Emergency; Statement of Urgency; Effective Date. Based upon the findings set forth in Section 1 hereof and Exhibit A hereto, the City Council declares a public emergency necessitating an immediate effective date in order to protect public health, safety, property, peace, welfare and the local environment. This ordinance shall accordingly take effect immediately upon adoption.

Section 4. Severability. If any section, sentence, clause or phrase of this ordinance should be held to be invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this ordinance.

ADOPTED BY THE CITY COUNCIL AND SIGNED IN AUTHENTICATION OF ITS PASSAGE THIS 11TH DAY OF SEPTEMBER 2006.

Cathy VonWald, Mayor

ATTEST/AUTHENTICATED:

Jennifer Kuhn
City Clerk

APPROVED AS TO FORM:

OFFICE OF THE CITY ATTORNEY

J. Zachary Lell
City Attorney

PASSED BY THE CITY COUNCIL: 9-11-2006
PUBLISHED: 9-18-2006
EFFECTIVE DATE: 9-20-2006
ORDINANCE NO. 427

EXHIBIT A

FINDINGS IN SUPPORT OF MORATORIUM RENEWAL

The Woodinville City Council hereby reaffirms and incorporates by reference the findings contained in Ordinance Nos. 419 and 424. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council additionally enters the findings below in support of the moratorium renewal effected by this ordinance. Specifically, the City Council has considered the planning goals set forth at Chapter 36.70A RCW, and acknowledges the following circumstances concerning the Sustainable Development study currently underway to resolve outstanding planning and development issues within the R-1 Zoning District:

1. RCW 36.70A.390 and RCW 35A.63.220 expressly authorize renewal of moratoria for one or more six month periods if a subsequent public hearing is held and findings of fact are made prior to each renewal.

2. The current moratorium was imposed on March 20, 2006. The City subsequently approved a contract with Steward & Associates to perform a comprehensive Sustainable Development study during the moratorium period. The study's purpose is to assist the City in determining the appropriate levels of urban density and development within the City's R-1 Zoning District, protecting the local environment, and ensuring compliance with applicable GMA planning goals. It is anticipated that the City's Comprehensive Plan, Critical Areas Ordinance and development regulations may be amended at the conclusion of the Sustainable Development study process, which is currently expected to be completed in late September or early October, 2006.

3. In July 2006, the City approved a contract with EKW Law to provide legal counsel regarding issues associated with GMA compliance and other legal matters relevant to the Sustainable Development program.

4. On June 7, 2006 the City Planning Commission appointed an 11 member Citizen Advisory Panel (CAP) to provide public input to and oversee study activities associated with the Sustainable Development program and make appropriate recommendations to the Planning Commission and City Council. The CAP has had three meetings to date with the City consultants and staff involved in the Sustainable Development program.

5. Various factors, including but not limited to the unforeseen complexity of necessary environmental studies and delays in compiling relevant data, have postponed the originally anticipated completion date for the Sustainable Development study.

6. Additional time is necessary in order to complete the Sustainable Development study, appropriately process and respond to any recommendations arising out of the study, and enact necessary amendments to the City's Comprehensive Plan and development regulations.

7. The City Council received a status report from its Sustainable Development consultants at the August 7, 2006 Council meeting indicating that the study would not be completed until after the current expiration date of the moratorium.

8. The earliest available City Council meeting for which to publicly notice, schedule and conduct the public hearing necessary to renew the current moratorium is September 11, 2006.

9. Pursuant to RCW 35A.13.190, an ordinance generally does not take effect until five days after the date of its publication. The earliest available publication date following the September 11, 2006 City Council meeting is September 18, 2006.

10. Delaying the effective date of the moratorium renewal until five days after the anticipated September 18, 2006 publication date would allow the current moratorium to expire for a period of at least three days, which in turn could allow land use permit applicants to obtain vested development rights inconsistent with the Comprehensive Plan and development code amendments that will result from the Sustainable Development program.

11. Allowing land use development within the City's R-1 Zoning District inconsistent with the above-referenced amendments would jeopardize and pose an imminent threat to public health, peace, welfare, property and the local environment.

12. In order to prevent the accrual of vested development rights prior to the completion of the Sustainable Development study and adoption of appropriate Comprehensive Plan and development code amendments, it is necessary and urgent for the moratorium renewal enacted by this ordinance to take effect immediately upon the expiration of the current moratorium, and for this ordinance to take effect immediately upon adoption. The immediate necessity of this action prevents the City's compliance with otherwise-applicable adoption procedures and processes.

13. Pursuant to RCW 36.70A.390 and RCW 35A.63.220, the City Council held a public hearing on September 11, 2006 regarding the moratorium renewal effected by this ordinance.

14. The City is working diligently and in good faith to complete the Sustainable Development study and will take appropriate action, pursuant to applicable procedures and standards, to expeditiously process the Comprehensive Plan and development regulation amendments recommended by the study.

Attachment F Other Information/Errata

Other Information/Errata

All clarifications and errata included in the Draft Appendix F between January 22, 2007 and February 14, 2007 have been incorporated into the “Sustainable Development Study – R-1 Zone.”

This section is reserved in order to allow for additional information, clarifications, or corrections to be transmitted as appropriate after February 20, 2007, the date of preparation of the final “Sustainable Development Study – R-1 Zone” transmitted to the City Council following Planning Commission recommendations.

Table 1. Housing Allocation and Permits Issued

Housing Allocations and Permits	Housing Units
2001 – 2022 Housing Allocation	1,869
2001 – 2006 Housing Permits Issued	-538*
Housing Allocation Balance	1,331

*Includes both Residential Zone Projects and known Commercial Zone Projects

Using as a base line the 2001 Residential Carrying Capacity analysis, the following table indicates there remains sufficient capacity to accommodate the remaining Housing Allocation under current zoning.

Table 2. Residential Capacity Analysis

Residential Carrying Capacity*	R-1	R-4	R-6	R-8	Multi-Family (R-12 thru R-48/O)	Commercial Zones	Totals
A. 2001 Dwelling Unit Capacity**	158	497	598	170	524	y***	1,947 + y
B. 2001 – 2006 Permitted Units (capacity consumed)	50	77	191	120	1	99	538
Current Capacity (A minus B)	108	420	407	50	523	z (y minus 99)	1,409 + ~~y~~z

*Capacity = land available for development or redevelopment current zoning
**2001 Carrying Capacity Analysis conducted for the 2002 Comprehensive Plan Update
***y = Undetermined capacity in Commercial Zones (CBD & TB)

As Table 3 below indicates, with a current ~~capacity of~~ capacity of 1409 housing units (Table 1) in all residential zones and an allocation balance of 1331 (Table 2) this leaves a surplus capacity of 78 housing units not including any residential capacity in any commercial zone.

Table 3. ~~Housing Allocation~~Carrying Capacity Surplus

Current Carrying Capacity	1409
Housing Allocation Balance	-1331
~~Housing Allocation~~Carrying Capacity Surplus	78

Neither the 2001 analysis nor the table above identify the capacity in the Central Business District (CBD) and Tourist Business (TB) zones to accommodate housing units. Both of these zones allow residential development. Since 2002, 99 units have been permitted for three relatively small projects located in the CBD zone. There are

STAFF REPORT

TO: CITY COUNCIL

THRU: RAY STURTZ, COMMUNITY DEVELOPMENT DIRECTOR

FROM: PETE ROSE, CITY MANAGER

SUBJECT: FIRST READING OF ORDINANCE NO. 424: AMENDING ORDINANCE NO. 419: BUILDING AND LAND USE MORATORIUM IN THE R-1 ZONE

MEETING DATE: JUNE 5, 2006

ISSUE:

Shall the City Council consider Ordinance No. 424 (Attachment A), an ordinance to amend Ordinance No. 419 which enacted an emergency building and land use moratorium in the R-1 zone?

STAFF RECOMMENDATION:

That the City Council consider Ordinance No. 424 (Attachment A), an ordinance to amend Ordinance No. 419, an emergency building and land use moratorium in the R-1 zone.

POLICY DECISION:

The proposal is to amend Ordinance No. 419 (R-1 zone area moratorium) for the purpose of formally incorporating the City Council's supplemental findings, revising and clarifying the moratorium exemptions and requiring City Council notification before issuance of an interpretation of the ordinance by the Planning Director. The proposed amendments are based on public comments received during the May 1, 2006 moratorium public hearing and subsequent City Council deliberations.

BACKGROUND:

At the City Council meeting of March 13, 2006, the City Council received a presentation on a program called Sustainable Development. This program is intended to implement the Action Plan that the City Council discussed at its Fall, 2005 retreat. A key provision of the Sustainable Development program is a comprehensive environmental study or series of studies. These studies will take some time to complete and analyze. The need for these studies, along with the need to prepare an overall set of policies, plans

and regulations were major reasons the City Council decided to consider a moratorium on the R-1 zone.

On March 20, 2006, the City Council adopted emergency Ordinance No. 419. The ordinance put into effect immediately a temporary (6-month) moratorium upon the receipt and processing of new building land use and other development permit applications within the City's R-1 Zoning District. This action was followed by a public hearing on May 1, 2006 to receive public testimony regarding the ordinance. Following the conclusion of the hearing, the City Council approved supplemental findings in support of the moratorium and directed staff to draft an amending ordinance incorporating these findings along with revisions of the ordinance exemptions section and adding a reporting requirement regarding administrative interpretations of the ordinance.

FACTS & FINDINGS

1. At the Fall 2005 retreat, the City Council discussed strategies for managing growth and development in Woodinville and indicated interest in a program to implement such strategies.

2. At the December 5, 2005 City Council meeting, as part of the "Annual Goals Update", the City Council received a proposed "Action Plan."

3. At the March 13, 2006 City Council meeting, the City Council received a report on a detailed program to implement the Action Plan. This program is referred to as Sustainable Development. As an outcome of the presentation, the City Council directed staff to prepare an emergency building and land use moratorium for the R-1 zone.

4. On March 20, 2006, the City Council adopted Ordinance No. 419 for the purpose of imposing a temporary moratorium upon the receipt and processing of new building land use and other development permits within the City's R-1 Zoning District.

5. The City Council conducted a public hearing on May 1, 2006, for the purpose of receiving and considering public testimony regarding Ordinance No. 419.

6. Based upon public comments received on the May 1, 2006, public hearing and subsequent City Council deliberation, the City Council desires to amend Ordinance No. 419 to:

    a. Formally incorporate supplemental findings,
    b. Revise and clarify moratorium exemptions, and
    c. Require City Council notification prior to the issuance of formal interpretations of said ordinance.

ANALYSIS

The supplemental findings (Attachment B) provide an analysis of how the moratorium supports the goals of the Washington State Growth Management Act. Decisions on appeals of moratoria in other cities indicate this type of analysis is important. These findings clearly state the City Council's intent to uphold and comply with the Growth Management Act by conducting studies during the moratorium that will help the City balance growth with protecting the environment.

The current exceptions to the moratorium include: remodeling, expansion, restoration or refurbishment of existing single-family and multi-family residential structures and publicly owned structures and facilities. The proposed amending ordinance would expand this to include all existing structures and incidental structures and facilities to the existing structure. There are more than just residential and publicly owned structures and facilities in the R-1 zone. There are also agricultural buildings, daycares, church buildings and commercial structures at Mack's Corner (168th Ave NE & Woodinville-Duvall Road).

In addition, Ordinance No. 424 clarifies that development projects for which complete applications were received by the City prior to the enactment of the moratorium are considered "vested" and therefore, exempt from the moratorium.

One last item that the ordinance adds is a provision that official interpretations of the moratorium ordinance will be provided to the City Council prior to each one being issued by the Planning Director. This keeps the City Council informed in advance and can identify issues which the City Council may wish to address through further amendments to the moratorium ordinances (No. 419 and No. 424).

ALTERNATIVES:

1. Have First Reading on Ordinance No. 424 as contained in Attachment A.

2. Direct staff as to specific amendments to Ordinance No. 424 and have First Reading at a later date.

3. Receive and discuss this information at another time.

RECOMMENDED MOTION:

I MOVE THAT THE CITY COUNCIL HAVE FIRST READING OF ORDINANCE NO. 424, AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; INCORPORATING SUPPLEMENTAL FINDINGS OF FACT IN SUPPORT OF THE CITY'S TEMPORARY LAND USE MORATORIUM WITHIN THE R-1 ZONING DISTRICT; REVISING AND CLARIFYING THE EXEMPTIONS FOR SPECIFIED PERMIT APPROVALS UNDER THE MORATORIUM; REQUIRING CITY COUNCIL NOTIFICATION PRIOR TO ISSUANCE OF FORMAL INTERPRETATIONS UNDER THE MORATORIUM; PROVIDING FOR SEVERABILITY; AND ESTABLISHING AN EFFECTIVE DATE.

ATTACHMENTS:
A – Ordinance 424
B – Supplemental Findings

ORDINANCE NO. 424

AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; INCORPORATING SUPPLEMENTAL FINDINGS OF FACT IN SUPPORT OF THE CITY'S TEMPORARY LAND USE MORATORIUM WITHIN THE R-1 ZONING DISTRICT; REVISING AND CLARIFYING THE EXEMPTIONS FOR SPECIFIED PERMIT APPROVALS UNDER THE MORATORIUM; REQUIRING CITY COUNCIL NOTIFICATION PRIOR TO ISSUANCE OF FORMAL INTERPRETATIONS UNDER THE MORATORIUM; PROVIDING FOR SEVERABILITY; AND ESTABLISHING AN EFFECTIVE DATE.

WHEREAS, the Woodinville City Council adopted Ordinance No. 419 on March 20, 2006 for the purpose of imposing a temporary moratorium upon the receipt and processing of new building, land use and other development permits within the City's R-1 Zoning District; and

WHEREAS, pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council conducted a public hearing on May 1, 2006, for the purpose of receiving and considering public testimony regarding Ordinance No. 419; and

WHEREAS, at the conclusion of the May 1, 2006, public hearing, the City Council formally adopted numerous supplemental findings in support of Ordinance No. 419; and

WHEREAS, based upon public comments received during the public hearing and subsequent Council deliberations, the City Council desires to amend Ordinance No. 419 for the purpose of formally incorporating the Council's supplemental findings, revising and clarifying the moratorium exemptions specified in the ordinance, and requiring City Council notification before issuance of any official interpretations of the ordinance by the City's Planning Director;

NOW, THEREFORE,

THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, DO ORDAIN AS FOLLOWS:

Section 1. Amendment of Section 1 of Ordinance No. 419. Section 1 of Ordinance No. 419 is hereby amended by the addition of a new subsection 1(V) to provide in its entirety as follows:

> Findings. The Woodinville City Council hereby makes the following findings in support of the moratorium imposed by this ordinance:
>
> V. The City has formally considered the GMA planning goals enumerated at RCW 36.70A.020 as evidenced by, *inter alia*, the Supplemental Findings attached hereto as Exhibit B and incorporated herein by this reference as if set forth in full.

Section 2. Addition of Exhibit B to Ordinance No. 419. Ordinance No. 419 is hereby amended by the addition of Exhibit B hereto, which shall be attached to Ordinance No. 419 and incorporated therein as if set forth in full.

Section 3. Amendment of Section 3 of Ordinance No. 419. Section 3 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Exceptions. The moratorium imposed under Section 2 of this ordinance shall not apply to the following:
>
> A. Permit applications for the remodeling, repair, expansion, restoration, refurbishment, enhancement or replacement of an existing structure;
>
> B. Permit applications for the construction of structures and facilities directly related to, located on the same building site as, and incidental to an existing structure;
>
> C. Permit applications related to a publicly owned structure or facility;

D. Permit applications to construct an accessory living quarters;

E. Building and other permits necessary to complete the construction of vested development projects, complete applications for which were received by the City prior to the effective date of this ordinance; and

Section 4. Amendment of Section 7 of Ordinance No. 419. Section 7 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Interpretive Authority. The City of Woodinville Planning Director is hereby authorized to issue official interpretations arising under or otherwise necessitated by this ordinance. Prior to issuance of any such official interpretation, the Planning Director shall formally notify the City Council of both the interpretation and any relevant background information.

Section 5. Severability. If any section, sentence, clause or phrase of this ordinance should be held to be invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this ordinance.

Section 6. Effective Date. This ordinance or a summary thereof consisting of the title shall be published in the official newspaper of the City and shall take effect and be in full force five (5) days after publication.

PASSED by the City Council of the City of Woodinville this _____ day of _____,2006.

APPROVED:

_____

MAYOR CATHY VON WALD

ATTEST/AUTHENTICATED:

_____
CITY CLERK, SANDRA PARKER, CMC

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY:

BY _____

FILED WITH THE CITY CLERK:
PASSED BY THE CITY COUNCIL:
PUBLISHED:
EFFECTIVE DATE:
ORDINANCE NO. _____

Exhibit B

SUPPLEMENTAL FINDINGS IN SUPPORT OF DEVELOPMENT MORATORIUM

The Woodinville City Council reaffirms the findings contained in Ordinance No. 419. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council additionally enters the supplemental findings below in support of the temporary development moratorium imposed under that ordinance. The City has duly considered the Growth Management Act (GMA) planning goals enumerated in RCW 36.70A.020. The moratorium imposed under Ordinance No. 419 will assist the City in reviewing and amending its Comprehensive Plan and development regulations in a manner that appropriately balances these policy interests for the Woodinville community and physical environment. Specifically, the City has considered the following GMA goals:

1. Urban Growth - *Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.* (RCW 36.70A.020(1)).

The City is committed to accommodating and encouraging appropriate levels of urban development in accordance with applicable GMA directives. The comprehensive Sustainable Development study that will be conducted during the moratorium period will help the City to identify which public facilities and services are needed in order to accommodate such future growth within the R-1 zoning district, an area that is — and historically has been — under-served with respect to utility service and other public facilities.

Moreover, the Sustainable Development study will help determine the appropriate phasing and installation timeframe regarding public facilities within the R-1 zone. This in turn will assist the City's capital planning and budgeting efforts. Other plans and studies, including but not limited to the Downtown/Little Bear Creek Corridor Master Plan (DT/LBC) and the Economic Development Study, are currently being reviewed by the City Council and will likewise assist the City in influencing the location and timing of urban development where adequate public facilities and services are provided.

2. Reduce Sprawl - *Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.* (RCW 36.70A.020(2)).

The Sustainable Development study conducted during the moratorium period will help determine the measures necessary to encourage the conversion of undeveloped land at appropriate levels of urban density. The study is intended in part to help the City balance the need to accommodate growth while simultaneously ensuring appropriate protection of the local environment and natural resources. Innovative land use management techniques aimed at reducing sprawl and protecting the environment will be evaluated as part of this process. It is anticipated that the City's development regulations may be amended at the conclusion of the Sustainable Development study

process to specifically encourage and provide incentives for the use of such innovative techniques.

3. Transportation – *Encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.* (RCW 36.70A.020(3)).

During the Sustainable Development study period, the City will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services consistent with local and regional transportation plans.

4. Housing - *Encourage the availability of affordable housing to all economic segments of the population of this State, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.* (RCW 36.70A.020(4)).

As the largest contiguous residential area in the City, the R-1 zone contains a substantial percentage of the City's existing housing stock. Although single family homes are predominant in the R-1 zone, the development pattern in this zoning district has traditionally provided for a variety in age, style and size of houses. The Sustainable Development study conducted during the moratorium will help to determine appropriate development techniques — potentially including, but not limited to, low impact development standards — to protect the environment and natural resources while simultaneously accommodating growth and preserving existing housing stock.

5. Economic Development - *Encourage economic development throughout the State that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and disadvantaged persons, promote the retention and expansion of existing business and recruitment of new business, experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.* (RCW 36.70A.020(5)).

A critical goal of the City's long-range planning efforts is to enhance the economic vitality of the Woodinville community. However, this policy must be carefully balanced and viewed holistically with the City's other planning goals to ensure an appropriate balance of economic development, housing, and environmental protection. The results and recommendations of the City's Sustainable Development study will be considered together with the City's economic development efforts to foster a complementary and coherent pattern of housing and business growth.

Furthermore, the State's fisheries are recognized as a significant element of the Pacific Northwest economy. Different portions of the City's R-1 zone drain into the headwaters of Bear Creek, and towards Little Bear Creek and Woodin Creek, all known to contain salmonids — including Chinook salmon. The Sustainable Development study will likely recommend methods of protecting this valuable economic resource through the adoption and implementation of careful and well-balanced land use planning and zoning measures. The City's Economic Study also identifies the livability of the City's residential neighborhoods and the protection of the natural environment as keys to the local economy's vitality. The Sustainable Development and Concurrency studies will serve to identify the need for public facilities and services which support economic development.

6. Property Rights - *Private property shall not be taken for public use without just compensation having been made. The property rights of landowners shall be protected from arbitrary and discriminatory actions.* (RCW 36.70A.020(6)).

The moratorium process is a legally-sanctioned development control mechanism, and the City has enacted its R-1 moratorium ordinance in conformance with applicable state law. By its terms, the moratorium is of a limited, temporary duration, and will not be construed to violate any previous permit applicant's vested development rights as defined by state and local regulations. Moreover, the limited exceptions contained in Section 3 of Ordinance No. 419 authorize modification, remodeling and expansion of existing structures notwithstanding the moratorium, ensuring that landowners may continue to alter their existing residences during the pendency of the City's Sustainable Development study.

7. Permits - *Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability.* (RCW 36.70A.020(7)).

The receipt and processing of new land use permits under the moratorium will be suspended only for the limited time necessary to conduct the Sustainable Development study. Upon the expiration of the moratorium, the City will process development applications involving the R-1 zoning district in a fair and timely manner consistent with applicable state and local regulations.

The separate Development Services study initiated earlier this year is intended to make the City's permit process more efficient. The recommendations resulting from this study are expected to be implemented over the next few months. The Sustainable Development study will address current uncertainties regarding the R-1 zone. Having these questions answered, particularly with regard to appropriate environmental protections, will enhance the certainty of the City's permit application and approval process. Individual property owners will know in advance what mitigation, construction techniques, and infrastructure is required for the proposed development of their property. This in turn will provide for more timely permit processing and the need for fewer individual environmental studies by permit applicants. The Development Services study will thus serve as a valuable resource for both the City and development

applicants, and will increase the predictability of the development process within the R-1 zone.

8. Natural Resources - *Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forest lands and productive agricultural lands, and discourage incompatible uses.* (RCW 36.70A.020(8)).

The Bear Creek Basin drainage area encompasses a significant portion of the eastern Woodinville City limits within the R-1 Zoning District. The basin drains southeasterly into the Cold Creek Natural Area wetland system, a complex network of wetlands and groundwater springs feeding the headwaters of Cold Creek and an important cold water source for the Bear Creek system. The Bear/Cottage Lake/Cold Creek system is formally rated as a Tier I subarea under the draft WRIA 8 Chinook Salmon Conservation Plan, and the action start list for the North Lake Washington Chinook population is to identify and protect headwater areas, wetlands, groundwater sources, natural hydrologic processes and temperatures that support Chinook salmon within this area. The Sustainable Development study conducted during the moratorium period will provide policy recommendations concerning the protection of these valuable resources.

9. Open Space and Recreation - *Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities.* (RCW 36.70A.020(9)).

The Sustainable Development studies will assist in identifying potential park and recreation (i.e., trail) opportunities in concert with habitat conservation areas.

10. Environment - *Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.* (RCW 36.70A.020(10)).

A primary purpose of the Sustainable Development study is to address the protection of the environment, quality of life, air and water quality, and the availability of water resources. The City's R-1 zoning district contains coarse, permeable geologic materials that allow infiltration to mapped critical aquifer recharge areas (CARAs), many of which have been characterized as possessing a "high" or "medium" potential for ground water contamination. The R-1 Zoning District also contains Lake Leota, a natural water body, with known water quality impacts. The shallow ground water surrounding Lake Leota is believed to be hydrologically connected to local CARAs.

Regions within the R-1 Zoning District hydrologically drain toward areas characterized by "high" or "medium" potential for ground water contamination. Said areas are known or suspected of being hydrologically connected to Bear Creek, a significant and biologically productive salmonid-bearing stream. Other areas within the R-1 zone drain variously toward Lake Leota, Little Bear Creek, and Woodin Creek, the latter two of which are known to contain salmonids.

11. Citizen Participation and Coordination - *Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.* (RCW 36.70A.020(11)).

The City is committed to providing opportunities for citizen involvement in the public process. The City Council's adoption of Ordinance No. 419 occurred at a public meeting on March 20, 2006, and substantial public comment was received at that meeting. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council also held a public hearing on May 1, 2006 to receive and consider public testimony regarding the R-1 moratorium.

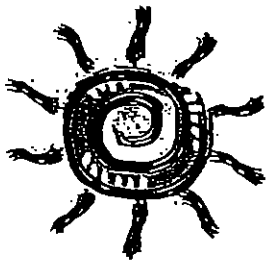
The City Council has also proposed the formation of a Citizen Advisory Panel to assist the Sustainable Development study consultants and the Planning Commission in reviewing information and the promulgation of land use management policies and tools to address environmental protection and development issues within the R-1 zone. Any amendments to the City's Comprehensive Plan and/or development regulations recommended by the Sustainable Development study will undergo significant public scrutiny and commentary before both the Planning Commission and the City Council. It is contemplated and encouraged that residents, property owners, businesses and all other interested parties will participate in this process. Because the R-1 zone area is adjacent to unincorporated areas of both King County and Snohomish County, these counties will also be asked to participate in the review of the studies and potential outcomes.

12. Public Facilities and Services - *Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.* (RCW 36.70A.020(12)).

As explained with respect to subsection 3 above, the Sustainable Development study will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services and consistent with local and regional transportation plans.

13. Historic Preservation - *Identify and encourage the preservation of lands, sites, and structures, that have historical or archaeological significance.* (RCW 36.70A.020(13)).

At this time, there are no lands, sites, or structures within the R-1 zone area known to have historical or archaeological significance.



STAFF REPORT

TO: CITY COUNCIL

THRU: RAY STURTZ, COMMUNITY DEVELOPMENT DIRECTOR

FROM: PETE ROSE, CITY MANAGER

SUBJECT: FIRST READING OF ORDINANCE NO. 424: AMENDING ORDINANCE NO. 419: BUILDING AND LAND USE MORATORIUM IN THE R-1 ZONE

MEETING DATE: JUNE 5, 2006

ISSUE:

Shall the City Council consider Ordinance No. 424 (Attachment A), an ordinance to amend Ordinance No. 419 which enacted an emergency building and land use moratorium in the R-1 zone?

STAFF RECOMMENDATION:

That the City Council consider Ordinance No. 424 (Attachment A), an ordinance to amend Ordinance No. 419, an emergency building and land use moratorium in the R-1 zone.

POLICY DECISION:

The proposal is to amend Ordinance No. 419 (R-1 zone area moratorium) for the purpose of formally incorporating the City Council's supplemental findings, revising and clarifying the moratorium exemptions and requiring City Council notification before issuance of an interpretation of the ordinance by the Planning Director. The proposed amendments are based on public comments received during the May 1, 2006 moratorium public hearing and subsequent City Council deliberations.

BACKGROUND:

At the City Council meeting of March 13, 2006, the City Council received a presentation on a program called Sustainable Development. This program is intended to implement the Action Plan that the City Council discussed at its Fall, 2005 retreat. A key provision of the Sustainable Development program is a comprehensive environmental study or series of studies. These studies will take some time to complete and analyze. The need for these studies, along with the need to prepare an overall set of policies, plans

and regulations were major reasons the City Council decided to consider a moratorium on the R-1 zone.

On March 20, 2006, the City Council adopted emergency Ordinance No. 419. The ordinance put into effect immediately a temporary (6-month) moratorium upon the receipt and processing of new building land use and other development permit applications within the City's R-1 Zoning District. This action was followed by a public hearing on May 1, 2006 to receive public testimony regarding the ordinance. Following the conclusion of the hearing, the City Council approved supplemental findings in support of the moratorium and directed staff to draft an amending ordinance incorporating these findings along with revisions of the ordinance exemptions section and adding a reporting requirement regarding administrative interpretations of the ordinance.

FACTS & FINDINGS

1. At the Fall 2005 retreat, the City Council discussed strategies for managing growth and development in Woodinville and indicated interest in a program to implement such strategies.

2. At the December 5, 2005 City Council meeting, as part of the "Annual Goals Update", the City Council received a proposed "Action Plan."

3. At the March 13, 2006 City Council meeting, the City Council received a report on a detailed program to implement the Action Plan. This program is referred to as Sustainable Development. As an outcome of the presentation, the City Council directed staff to prepare an emergency building and land use moratorium for the R-1 zone.

4. On March 20, 2006, the City Council adopted Ordinance No. 419 for the purpose of imposing a temporary moratorium upon the receipt and processing of new building land use and other development permits within the City's R-1 Zoning District.

5. The City Council conducted a public hearing on May 1, 2006, for the purpose of receiving and considering public testimony regarding Ordinance No. 419.

6. Based upon public comments received on the May 1, 2006, public hearing and subsequent City Council deliberation, the City Council desires to amend Ordinance No. 419 to:

    a. Formally incorporate supplemental findings,
    b. Revise and clarify moratorium exemptions, and
    c. Require City Council notification prior to the issuance of formal interpretations of said ordinance.

ANALYSIS

The supplemental findings (Attachment B) provide an analysis of how the moratorium supports the goals of the Washington State Growth Management Act. Decisions on appeals of moratoria in other cities indicate this type of analysis is important. These findings clearly state the City Council's intent to uphold and comply with the Growth Management Act by conducting studies during the moratorium that will help the City balance growth with protecting the environment.

The current exceptions to the moratorium include: remodeling, expansion, restoration or refurbishment of existing single-family and multi-family residential structures and publicly owned structures and facilities. The proposed amending ordinance would expand this to include all existing structures and incidental structures and facilities to the existing structure. There are more than just residential and publicly owned structures and facilities in the R-1 zone. There are also agricultural buildings, daycares, church buildings and commercial structures at Mack's Corner (168th Ave NE & Woodinville-Duvall Road).

In addition, Ordinance No. 424 clarifies that development projects for which complete applications were received by the City prior to the enactment of the moratorium are considered "vested" and therefore, exempt from the moratorium.

One last item that the ordinance adds is a provision that official interpretations of the moratorium ordinance will be provided to the City Council prior to each one being issued by the Planning Director. This keeps the City Council informed in advance and can identify issues which the City Council may wish to address through further amendments to the moratorium ordinances (No. 419 and No. 424).

ALTERNATIVES:

1. Have First Reading on Ordinance No. 424 as contained in Attachment A.

2. Direct staff as to specific amendments to Ordinance No. 424 and have First Reading at a later date.

3. Receive and discuss this information at another time.

RECOMMENDED MOTION:

I MOVE THAT THE CITY COUNCIL HAVE FIRST READING OF ORDINANCE NO. 424, AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; INCORPORATING SUPPLEMENTAL FINDINGS OF FACT IN SUPPORT OF THE CITY'S TEMPORARY LAND USE MORATORIUM WITHIN THE R-1 ZONING DISTRICT; REVISING AND CLARIFYING THE EXEMPTIONS FOR SPECIFIED PERMIT APPROVALS UNDER THE MORATORIUM; REQUIRING CITY COUNCIL NOTIFICATION PRIOR TO ISSUANCE OF FORMAL INTERPRETATIONS UNDER THE MORATORIUM; PROVIDING FOR SEVERABILITY; AND ESTABLISHING AN EFFECTIVE DATE.

ATTACHMENTS:
A – Ordinance 424
B – Supplemental Findings

ORDINANCE NO. 424

AN ORDINANCE OF THE CITY OF WOODINVILLE, WASHINGTON, AMENDING ORDINANCE NO. 419; INCORPORATING SUPPLEMENTAL FINDINGS OF FACT IN SUPPORT OF THE CITY'S TEMPORARY LAND USE MORATORIUM WITHIN THE R-1 ZONING DISTRICT; REVISING AND CLARIFYING THE EXEMPTIONS FOR SPECIFIED PERMIT APPROVALS UNDER THE MORATORIUM; REQUIRING CITY COUNCIL NOTIFICATION PRIOR TO ISSUANCE OF FORMAL INTERPRETATIONS UNDER THE MORATORIUM; PROVIDING FOR SEVERABILITY; AND ESTABLISHING AN EFFECTIVE DATE.

WHEREAS, the Woodinville City Council adopted Ordinance No. 419 on March 20, 2006 for the purpose of imposing a temporary moratorium upon the receipt and processing of new building, land use and other development permits within the City's R-1 Zoning District; and

WHEREAS, pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council conducted a public hearing on May 1, 2006, for the purpose of receiving and considering public testimony regarding Ordinance No. 419; and

WHEREAS, at the conclusion of the May 1, 2006, public hearing, the City Council formally adopted numerous supplemental findings in support of Ordinance No. 419; and

WHEREAS, based upon public comments received during the public hearing and subsequent Council deliberations, the City Council desires to amend Ordinance No. 419 for the purpose of formally incorporating the Council's supplemental findings, revising and clarifying the moratorium exemptions specified in the ordinance, and requiring City Council notification before issuance of any official interpretations of the ordinance by the City's Planning Director;

NOW, THEREFORE,

THE CITY COUNCIL OF THE CITY OF WOODINVILLE, WASHINGTON, DO ORDAIN AS FOLLOWS:

Section 1. Amendment of Section 1 of Ordinance No. 419. Section 1 of Ordinance No. 419 is hereby amended by the addition of a new subsection 1(V) to provide in its entirety as follows:

> Findings. The Woodinville City Council hereby makes the following findings in support of the moratorium imposed by this ordinance:
>
> V. The City has formally considered the GMA planning goals enumerated at RCW 36.70A.020 as evidenced by, *inter alia*, the Supplemental Findings attached hereto as Exhibit B and incorporated herein by this reference as if set forth in full.

Section 2. Addition of Exhibit B to Ordinance No. 419. Ordinance No. 419 is hereby amended by the addition of Exhibit B hereto, which shall be attached to Ordinance No. 419 and incorporated therein as if set forth in full.

Section 3. Amendment of Section 3 of Ordinance No. 419. Section 3 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Exceptions. The moratorium imposed under Section 2 of this ordinance shall not apply to the following:
>
> A. Permit applications for the remodeling, repair, expansion, restoration, refurbishment, enhancement or replacement of an existing structure;
>
> B. Permit applications for the construction of structures and facilities directly related to, located on the same building site as, and incidental to an existing structure;
>
> C. Permit applications related to a publicly owned structure or facility;

D. Permit applications to construct an accessory living quarters;

E. Building and other permits necessary to complete the construction of vested development projects, complete applications for which were received by the City prior to the effective date of this ordinance; and

Section 4. Amendment of Section 7 of Ordinance No. 419. Section 7 of Ordinance No. 419 is hereby amended to provide in its entirety as follows:

> Interpretive Authority. The City of Woodinville Planning Director is hereby authorized to issue official interpretations arising under or otherwise necessitated by this ordinance. Prior to issuance of any such official interpretation, the Planning Director shall formally notify the City Council of both the interpretation and any relevant background information.

Section 5. Severability. If any section, sentence, clause or phrase of this ordinance should be held to be invalid or unconstitutional by a court of competent jurisdiction, such invalidity or unconstitutionality shall not affect the validity or constitutionality of any other section, sentence, clause or phrase of this ordinance.

Section 6. Effective Date. This ordinance or a summary thereof consisting of the title shall be published in the official newspaper of the City and shall take effect and be in full force five (5) days after publication.

PASSED by the City Council of the City of Woodinville this _____ day of _____,2006.

APPROVED:

_____

MAYOR CATHY VON WALD

ATTEST/AUTHENTICATED:

_____
CITY CLERK, SANDRA PARKER, CMC

APPROVED AS TO FORM:
OFFICE OF THE CITY ATTORNEY:

BY _____

FILED WITH THE CITY CLERK:
PASSED BY THE CITY COUNCIL:
PUBLISHED:
EFFECTIVE DATE:
ORDINANCE NO. _____

Exhibit B

SUPPLEMENTAL FINDINGS IN SUPPORT OF DEVELOPMENT MORATORIUM

The Woodinville City Council reaffirms the findings contained in Ordinance No. 419. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council additionally enters the supplemental findings below in support of the temporary development moratorium imposed under that ordinance. The City has duly considered the Growth Management Act (GMA) planning goals enumerated in RCW 36.70A.020. The moratorium imposed under Ordinance No. 419 will assist the City in reviewing and amending its Comprehensive Plan and development regulations in a manner that appropriately balances these policy interests for the Woodinville community and physical environment. Specifically, the City has considered the following GMA goals:

1. Urban Growth - *Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.* (RCW 36.70A.020(1)).

The City is committed to accommodating and encouraging appropriate levels of urban development in accordance with applicable GMA directives. The comprehensive Sustainable Development study that will be conducted during the moratorium period will help the City to identify which public facilities and services are needed in order to accommodate such future growth within the R-1 zoning district, an area that is — and historically has been — under-served with respect to utility service and other public facilities.

Moreover, the Sustainable Development study will help determine the appropriate phasing and installation timeframe regarding public facilities within the R-1 zone. This in turn will assist the City's capital planning and budgeting efforts. Other plans and studies, including but not limited to the Downtown/Little Bear Creek Corridor Master Plan (DT/LBC) and the Economic Development Study, are currently being reviewed by the City Council and will likewise assist the City in influencing the location and timing of urban development where adequate public facilities and services are provided.

2. Reduce Sprawl - *Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development.* (RCW 36.70A.020(2)).

The Sustainable Development study conducted during the moratorium period will help determine the measures necessary to encourage the conversion of undeveloped land at appropriate levels of urban density. The study is intended in part to help the City balance the need to accommodate growth while simultaneously ensuring appropriate protection of the local environment and natural resources. Innovative land use management techniques aimed at reducing sprawl and protecting the environment will be evaluated as part of this process. It is anticipated that the City's development regulations may be amended at the conclusion of the Sustainable Development study

process to specifically encourage and provide incentives for the use of such innovative techniques.

3. Transportation – *Encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.* (RCW 36.70A.020(3)).

During the Sustainable Development study period, the City will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services consistent with local and regional transportation plans.

4. Housing - *Encourage the availability of affordable housing to all economic segments of the population of this State, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.* (RCW 36.70A.020(4)).

As the largest contiguous residential area in the City, the R-1 zone contains a substantial percentage of the City's existing housing stock. Although single family homes are predominant in the R-1 zone, the development pattern in this zoning district has traditionally provided for a variety in age, style and size of houses. The Sustainable Development study conducted during the moratorium will help to determine appropriate development techniques — potentially including, but not limited to, low impact development standards — to protect the environment and natural resources while simultaneously accommodating growth and preserving existing housing stock.

5. Economic Development - *Encourage economic development throughout the State that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and disadvantaged persons, promote the retention and expansion of existing business and recruitment of new business, experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.* (RCW 36.70A.020(5)).

A critical goal of the City's long-range planning efforts is to enhance the economic vitality of the Woodinville community. However, this policy must be carefully balanced and viewed holistically with the City's other planning goals to ensure an appropriate balance of economic development, housing, and environmental protection. The results and recommendations of the City's Sustainable Development study will be considered together with the City's economic development efforts to foster a complementary and coherent pattern of housing and business growth.

Furthermore, the State's fisheries are recognized as a significant element of the Pacific Northwest economy. Different portions of the City's R-1 zone drain into the headwaters of Bear Creek, and towards Little Bear Creek and Woodin Creek, all known to contain salmonids — including Chinook salmon. The Sustainable Development study will likely recommend methods of protecting this valuable economic resource through the adoption and implementation of careful and well-balanced land use planning and zoning measures. The City's Economic Study also identifies the livability of the City's residential neighborhoods and the protection of the natural environment as keys to the local economy's vitality. The Sustainable Development and Concurrency studies will serve to identify the need for public facilities and services which support economic development.

6. Property Rights - *Private property shall not be taken for public use without just compensation having been made. The property rights of landowners shall be protected from arbitrary and discriminatory actions.* (RCW 36.70A.020(6)).

The moratorium process is a legally-sanctioned development control mechanism, and the City has enacted its R-1 moratorium ordinance in conformance with applicable state law. By its terms, the moratorium is of a limited, temporary duration, and will not be construed to violate any previous permit applicant's vested development rights as defined by state and local regulations. Moreover, the limited exceptions contained in Section 3 of Ordinance No. 419 authorize modification, remodeling and expansion of existing structures notwithstanding the moratorium, ensuring that landowners may continue to alter their existing residences during the pendency of the City's Sustainable Development study.

7. Permits - *Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability.* (RCW 36.70A.020(7)).

The receipt and processing of new land use permits under the moratorium will be suspended only for the limited time necessary to conduct the Sustainable Development study. Upon the expiration of the moratorium, the City will process development applications involving the R-1 zoning district in a fair and timely manner consistent with applicable state and local regulations.

The separate Development Services study initiated earlier this year is intended to make the City's permit process more efficient. The recommendations resulting from this study are expected to be implemented over the next few months. The Sustainable Development study will address current uncertainties regarding the R-1 zone. Having these questions answered, particularly with regard to appropriate environmental protections, will enhance the certainty of the City's permit application and approval process. Individual property owners will know in advance what mitigation, construction techniques, and infrastructure is required for the proposed development of their property. This in turn will provide for more timely permit processing and the need for fewer individual environmental studies by permit applicants. The Development Services study will thus serve as a valuable resource for both the City and development

applicants, and will increase the predictability of the development process within the R-1 zone.

8. Natural Resources - *Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forest lands and productive agricultural lands, and discourage incompatible uses.* (RCW 36.70A.020(8)).

The Bear Creek Basin drainage area encompasses a significant portion of the eastern Woodinville City limits within the R-1 Zoning District. The basin drains southeasterly into the Cold Creek Natural Area wetland system, a complex network of wetlands and groundwater springs feeding the headwaters of Cold Creek and an important cold water source for the Bear Creek system. The Bear/Cottage Lake/Cold Creek system is formally rated as a Tier I subarea under the draft WRIA 8 Chinook Salmon Conservation Plan, and the action start list for the North Lake Washington Chinook population is to identify and protect headwater areas, wetlands, groundwater sources, natural hydrologic processes and temperatures that support Chinook salmon within this area. The Sustainable Development study conducted during the moratorium period will provide policy recommendations concerning the protection of these valuable resources.

9. Open Space and Recreation - *Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities.* (RCW 36.70A.020(9)).

The Sustainable Development studies will assist in identifying potential park and recreation (i.e., trail) opportunities in concert with habitat conservation areas.

10. Environment - *Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.* (RCW 36.70A.020(10)).

A primary purpose of the Sustainable Development study is to address the protection of the environment, quality of life, air and water quality, and the availability of water resources. The City's R-1 zoning district contains coarse, permeable geologic materials that allow infiltration to mapped critical aquifer recharge areas (CARAs), many of which have been characterized as possessing a "high" or "medium" potential for ground water contamination. The R-1 Zoning District also contains Lake Leota, a natural water body, with known water quality impacts. The shallow ground water surrounding Lake Leota is believed to be hydrologically connected to local CARAs.

Regions within the R-1 Zoning District hydrologically drain toward areas characterized by "high" or "medium" potential for ground water contamination. Said areas are known or suspected of being hydrologically connected to Bear Creek, a significant and biologically productive salmonid-bearing stream. Other areas within the R-1 zone drain variously toward Lake Leota, Little Bear Creek, and Woodin Creek, the latter two of which are known to contain salmonids.

11. Citizen Participation and Coordination - *Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.* (RCW 36.70A.020(11)).

The City is committed to providing opportunities for citizen involvement in the public process. The City Council's adoption of Ordinance No. 419 occurred at a public meeting on March 20, 2006, and substantial public comment was received at that meeting. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council also held a public hearing on May 1, 2006 to receive and consider public testimony regarding the R-1 moratorium.

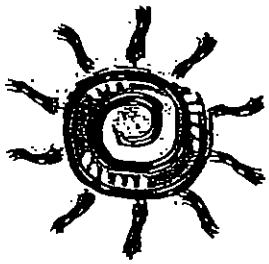
The City Council has also proposed the formation of a Citizen Advisory Panel to assist the Sustainable Development study consultants and the Planning Commission in reviewing information and the promulgation of land use management policies and tools to address environmental protection and development issues within the R-1 zone. Any amendments to the City's Comprehensive Plan and/or development regulations recommended by the Sustainable Development study will undergo significant public scrutiny and commentary before both the Planning Commission and the City Council. It is contemplated and encouraged that residents, property owners, businesses and all other interested parties will participate in this process. Because the R-1 zone area is adjacent to unincorporated areas of both King County and Snohomish County, these counties will also be asked to participate in the review of the studies and potential outcomes.

12. Public Facilities and Services - *Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.* (RCW 36.70A.020(12)).

As explained with respect to subsection 3 above, the Sustainable Development study will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services and consistent with local and regional transportation plans.

13. Historic Preservation - *Identify and encourage the preservation of lands, sites, and structures, that have historical or archaeological significance.* (RCW 36.70A.020(13)).

At this time, there are no lands, sites, or structures within the R-1 zone area known to have historical or archaeological significance.



CITY OF WOODINVILLE
REQUEST FOR QUALIFICATIONS
ENVIRONMENTAL CONSULTING SERVICES FOR
SUSTAINABLE DEVELOPMENT PROGRAM
April 2006

I. Request

The City of Woodinville solicits requests for qualifications from consulting firms for:

- Review and analysis of environmentally critical areas in the City,
- Identification of potential impacts of development on such areas, and
- Recommendations for protection measures

pursuant to the Growth Management Act.

II. Project Description

Work to be performed by the consultant consists of professional services to review and analyze certain areas of the City for the presence of critical areas, rank these critical areas and make recommendations on the appropriate intensity of development to protect these areas, consistent with the requirements of the Growth Management Act (GMA) to: "protect the functions and values of critical areas" and "give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries" (RCW 36.70A.172).

It is anticipated that qualified consultants will have the expertise necessary to assess the status of, and implications of development on the City's critical areas as identified in the Woodinville Critical Areas Ordinance (WMC 21.24), including the following: wetlands, streams, critical aquifer recharge areas, flood hazard areas, geologic hazard areas and fish and wildlife conservation areas. <u>It is further anticipated that qualified consultants will have the following subject area expertise: hydrogeology, civil engineer, transportation engineer, land use planning, fisheries biology, wildlife biology, wetland biology, tree ecology and Geographic Information System technician.</u> Additionally, qualified consultants will have the expertise to assess the impact of development on the conservation and protection of anadromous fisheries.

III. Background and Objectives

Protection of the natural environment has been identified by the City Council as an important component to the vitality and overall well being of the community. On March 20, 2006, the City Council imposed a building and land use moratorium in the R-1 zone area of the City to allow time for the subject environmental studies and protection measures to be adopted. The City Council has specific goals to work with other entities toward the recovery of the Puget Sound Chinook Salmon; a threatened specie under the Federal Endangered Species Act. On the other hand, the City has obligations and adopted policies to promote quality economic development and accommodate growth in housing, jobs and population. Balancing these goals and obligations is an increasingly important challenge for the City. This balance is seen as consistent with the City's Comprehensive Plan vision for maintaining a high quality environment in the community, supporting a diverse and vital mix of businesses and is also a welcoming place for

families. The City has been pro-active in establishing policies and programs to carry-out GMA objectives to support growth, economic development and environmental protection.

In 2002 the City updated its major five-year update to its Comprehensive Plan to include an Environmental Element. In 2004 the City updated its Critical Areas Ordinance for enhancing protection of critical areas during land use development. In 2005, the City prepared a draft Economic Development Plan to encourage a vibrant and diverse mix of businesses. In 2006, the City has initiated an update of its Shoreline Master Program, under the new guidelines of the Department of Ecology.

The City is experiencing a steady rate of residential growth. The City Council wants to further study how the City can maintain its quality of life, improve its economic development and accommodate growth and development where adequate public facilities exist; while also protecting natural resources, especially anadromous fisheries, in a manner consistent with its adopted goals and policies and the requirements of the GMA. As part of this project, a Citizen's Advisory Panel (CAP) will be formed by the City to provide input to the process of creating the overall strategies for this plan. The CAP and staff will review findings of consultant work and make policy recommendations for the City's Planning Commission and City Council.

IV. Preliminary Scope of Services

The City and the selected consultant will develop a final scope of services. The following is a list of preliminary areas of interest to the City for this study. Consultant submittals should address these and any other areas they view as important qualifications.

- Assess certain specified areas of the City where there are known or potential critical areas as defined in the City's critical areas regulations (WMC 21.24). The City's defined critical areas include: streams, wetlands, steep slopes, geologic hazards, critical aquifer recharge areas, flood hazard areas, tree canopy preservation and fish and wildlife conservation areas. The assessments should evaluate environmental resources and potential impacts to environmental resources from development in a manner consistent with cases with relevant issues that have been ruled on by the Central Puget Sound Growth Management Hearings Board.

- Areas to be tested include known or potential critical areas in certain locations of the City that may have an effect on preserving or enhancing anadromous fish habitat or other identified critical areas <u>The area in which most testing is contemplated will be certain areas of the City's R-1 zone, which totals approximately 1,100 acres</u>. It is anticipated that other areas of the City should have some level of review and analysis. The City and consultant will determine which particular areas will be analyzed and the level of detail necessary.

- Assessment of other factors or other areas that are not presently defined as critical areas, but that may also have a significant effect on preserving and enhancing anadromous fish habitat. These factors include the relative amount of pervious versus impervious surfaces, amount of tree canopy cover, slope, soils and surface water run-off conditions and present land use patterns.

- Prepare a report of findings and recommendations for development intensities, potential revision to the City's land use policies, regulations and development practices to improve the City's ability to meet GMA requirements to preserve and

enhance anadromous fish resources while also allowing reasonable use of the affected lands and accommodating overall growth targets.

- Attend meetings and present information to aid public understanding and assist decision makers with policy choices.

V. Available Information

The City will provide to the selected consultant, existing and available studies, plans, and other information that the City has and that it determines would be useful for this project.

VI. Estimated Timeline

The timeline has been divided into two segments to emphasize the need to complete the environmental studies for the R-1 zone area within the 6 month (March 20 – September 20) moratorium period and allow time for work to be completed in the balance of the City (City-wide).

Publish Request for Qualifications	Apr 21, 2006
Responses (Qualifications) Due	May 5, 2006
Consultant Interviews and Selection	May 12, 2006
Final Scope of Services, Contract Execution and Notice to Proceed	May 26, 2006
Consultant Work and CAP Meetings	June 1-Oct 31, 2006
Draft R-1 Report from Consultant	Aug 1, 2006
City Review of Draft R-1 Area Report (staff, CAP, Planning Commission, legal)	Aug 11-Sept 6, 2006
Final Draft Report Report from Consultant	Aug 31, 2006
Planning Commission R-1 Area report & recommendation	Sept 6, 2006
City Council R-1 Area report and direction	Sept 18, 2006
Draft City-wide report from Consultant (staff, CAP, Planning Commission, legal)	Oct 13, 2006
Final City-wide Report from Consultant	Oct 31, 2006
Planning Commission City-wide report & recommendation	Nov 15, 2006
City Council City-wide report and direction	Dec 18, 2006

VII. Submittal Requirements

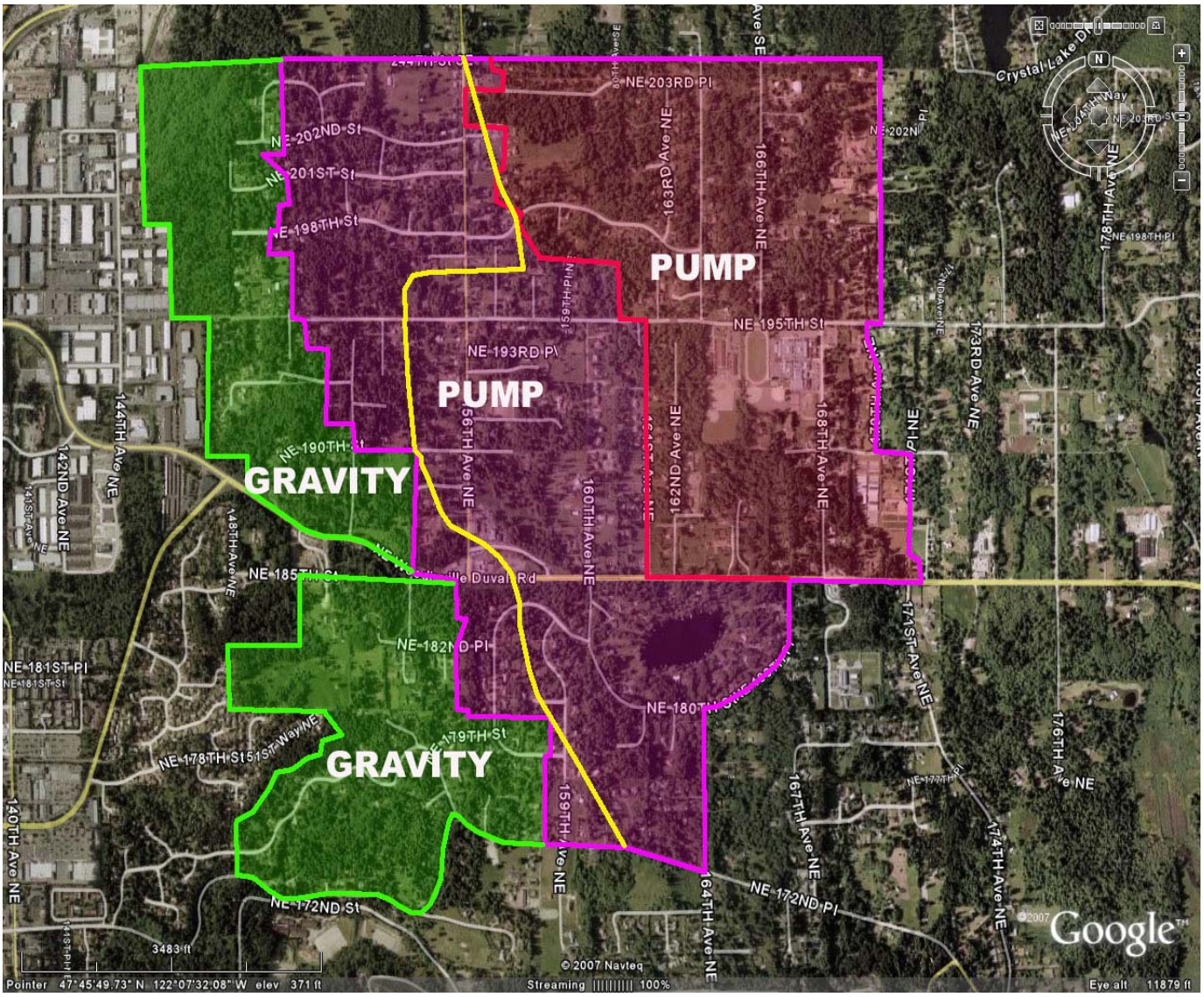
Pleases submit seven copies of your qualifications. Submittals should not exceed 20 pages, and address the following topics:

- A statement of your firm's understanding of this project, and how your firm is qualified to address them, including experience with cities comparable to Woodinville
- Key staff who will be involved with this project and their roles and experience
- A preliminary scope of services
- Previous examples of relevant experience
- Professional references
- Cost breakdown of budget expenditures by position title

VIII. Schedule & Contacts

Submittals will be received in the Department of Community Development until 5:00 pm on Friday, May 5, 2006. The City intends to select a consultant by May 17 and the target completion date for consultant services is September 20, 2006. The project budget is up to $150,000, depending on final scope of services approved by the City. Your submittal may be mailed or hand delivered to: Ray Sturtz, Community Development Director, City of Woodinville 17301 133rd Avenue NE, Woodinville, WA 98072. If you have any questions, you may contact Ray Sturtz at (425) 489-2757, ext. 2281 or Catherine Borghes at ext. 2284.

Errata for Final City of Woodinville Sustainable Development Study – R-1 Zone
New Sewer Map indicating location of gravity flow sewer area and pump (required) sewer area
Distributed at 3-5-07 City Council Public Hearing



STAFF REPORT

TO: CITY COUNCIL

THRU: PETE ROSE, CITY MANAGER

FROM: RAY STURTZ, COMMUNITY DEVELOPMENT DIRECTOR

SUBJECT: CONTRACT APPROVAL WITH STEWARD AND ASSOCIATES FOR THE SUSTAINABLE DEVELOPMENT PROGRAM STUDIES

FOR MEETING OF: JUNE 5, 2006

ISSUE

Shall the City Council authorize the City Manager to execute a contract in an amount not to exceed $150,000 with Steward and Associates (Attachment A) to prepare the environmental studies and alternative development standards as part of the Sustainable Development Program?

STAFF RECOMMENDATION

That Council authorize the City Manager to execute a contract with Steward and Associates in an amount not to exceed $150,000 to prepare the Sustainable Development Program environmental studies and alternative development standards.

POLICY DECISIONS

Council approval is required for all contracts of $20,000 or greater. The subject contract will provide a consultant team to prepare the Sustainable Development studies and related work to provide the analysis necessary to:

- Substantiate the need to maintain the low-density (R-1) designation in the eastern portion of the City for environmental, endangered species, infrastructure adequacy, and other Growth Management reasons, and
- Develop policies and regulations in response to the R-1 zone area moratorium.

The City Council has approved a budget amendment utilizing beginning balance funds to cover the cost of this contract.

BACKGROUND

On April 10, 2006, the City Council directed staff to solicit consultant teams qualified to conduct the Sustainable Development Program studies. A request for qualifications was issued on April 21st from consulting firms for:

- Review and analysis of environmentally critical areas in the City,
- Identification of potential impacts of development on such areas, and
- Recommendations for protection measures pursuant to the Growth Management Act.

Three teams of consultants responded to the City's RFQ; Steward and Associates (Attachment B), Pentec Environmental (Attachment C), and The Watershed Company (Attachment D).

Work to be performed by the consultant consists of professional services to review and analyze certain areas of the City for the presence of critical areas, rank these critical areas and make recommendations on the appropriate intensity of development to protect these areas, consistent with the requirements of the Growth Management Act (GMA) to: "protect the functions and values of critical areas" and "give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries" (RCW 36.70A.172).

Protection of the natural environment has been identified by the City Council as an important component to the vitality and overall well being of the community. On March 20, 2006, the City Council imposed a building and land use moratorium in the R-1 zone area of the City to allow time for the subject environmental studies and protection measures to be adopted. The City Council has specific goals to work with other entities toward the recovery of the Puget Sound Chinook Salmon; a threatened species under the Federal Endangered Species Act.

On the other hand, the City has obligations and adopted policies to promote quality economic development and accommodate growth in housing, jobs and population. Balancing these goals and obligations is an increasingly important challenge for the City. This balance is seen as consistent with the City's Comprehensive Plan vision for maintaining a high quality environment in the community, supporting a diverse and vital mix of businesses and is also a welcoming place for families. The City has been pro-active in establishing policies and programs to carry out GMA objectives to support growth, economic development and environmental protection.

In 2002, the City approved its major five-year update to its Comprehensive Plan to include an Environmental Element. In 2004, the City updated its Critical Areas Ordinance to enhance protection of critical areas during land use development. In 2005, the City prepared a draft Economic Development Plan

to encourage a vibrant and diverse mix of businesses. In 2006, the City has initiated an update of its Shoreline Master Program, under the new guidelines of the Department of Ecology.

The City is experiencing a steady rate of residential growth. The City Council wants to further study how the City can maintain its quality of life, improve its economic development and accommodate growth and development where adequate public facilities exist; while also protecting natural resources, especially anadromous fisheries, in a manner consistent with its adopted goals and policies and the requirements of the GMA. In order to accommodate this, the City Council has budgeted $150,000 for the Sustainable Development Program studies. The City Council is now at the point of authorizing the City Manager to enter into a contract with a team of qualified consultants to conduct these studies.

FACTS & FINDINGS

1. The City, through its Comprehensive Goals and Policies, is committed to accommodating and encouraging appropriate levels of urban development in accordance with applicable Growth Management Act directives. This includes a balance of economic growth, housing, and environmental protection appropriate for the Woodinville community.

2. At the Fall 2005 retreat, the Council discussed strategies for managing growth and development in Woodinville and indicated interest in a program to implement such strategies.

3. At the December 5, 2005 Council meeting, as part of the "Annual Goals Update", the City Council received a proposed "Action Plan" for addressing the issue of strategies for managing growth and development.

4. At the December 12, 2005 Council meeting, the City Council received a report on proposed concepts for a transportation concurrency program, which is part of an overall strategy for managing growth and development through a sustainable development program.

5. At the March 13, 2006 Council meeting, the City Council received a staff report on Sustainable Development, a program for managing the City's growth and natural environment.

6. At the March 20, 2006 Council meeting, the City Council enacted Ordinance No. 419, establishing an emergency moratorium on building and land use permits in the R-1 zone.

7. On May 22, 2006, the City Council approved a budget amendment utilizing a beginning cash balance for 2006 to put the contract amount of $150,000 into place.

8. Three qualified teams responded to the City's RFQ issued on April 21, 2006, as directed by the City Council.

9. The consultant team, led by Steward and Associates provides, the necessary breadth and depth of experience and expertise to complete the environmental studies in the R-1 zone area of the City prior to the September 20, 2006 R-1 zone area moratorium six-month deadline.

ANALYSIS

As described in prior staff reports referenced under "Facts & Findings", comprehensive studies are needed to ascertain the level of potential environmental risk from future land use actions in the City's lowest-density residential zone.

Ordinance No. 419, approved by the City Council on March 20, 2006, which established the moratorium in the R-1 zone, is intended to prevent further potential impacts while the environmental studies are undertaken. Based on the results of the studies, decisions can be made on appropriate future development that will also provide adequate environmental protections.

The areas of expertise to conduct the studies include:

- hydro-geologist (soils, ground water)
- geologist/geotechnical engineer (geologic hazard areas)
- civil engineer (roads, water, sewer and other utilities)
- transportation engineer (traffic and roadways)
- biologist (wildlife)
- fisheries biologist (fish and habitat)
- tree ecologist (pervious surface, tree canopy)
- land use planner (zoning densities and land use design)
- GIS technician (mapping and data layers)
- wetland biologist (wetlands)

The Steward and Associates team was the only consultant team that provided expertise in all of these areas plus one more: limnologist, the study of fresh water lakes and ponds. The presence of Lake Leota in the R-1 area deemed this an important addition.

Individual team members have experience and knowledge of the City and surrounding areas including the Cold Creek/Bear Creek drainage system. The team also provides expertise and experience with low impact development

standards. According to their response to the RFQ, the Steward and Associates teams' intent is to submit a draft R-1 area report by August 1st and draft report on the balance of the City by mid-October. This schedule may make it possible for the City to have appropriate policies and regulations adopted for the R-1 zone area prior to the 6-month moratorium deadline.

ALTERNATIVES:

1. Authorize the City Manager to execute a contract with Steward and Associates. This would allow the Sustainable Development Program studies to begin immediately.

2. Direct staff to seek out other consultants to prepare the Sustainable Development Program studies. This would delay the initiation of these studies and shorten the time period to complete these studies prior to the R-1 moratorium six-month deadline of September 20, 2006.

RECOMMENDED MOTION:

I MOVE THE CITY COUNCIL AUTHORIZE THE CITY MANAGER TO EXECUTE A CONTRACT WITH STEWARD AND ASSOCIATES FOR AN AMOUNT NOT TO EXCEED $150,000 FOR THE PREPARATION OF THE SUSTAINABLE DEVELOPMENT PROGRAM STUDIES.

Attachments:

A - Steward and Associates Contract and Scope of Services
B - Steward and Associates proposal
C - Pentec Environmental proposal
D - The Watershed Company proposal

AGREEMENT FOR SERVICES BETWEEN THE CITY OF WOODINVILLE AND Steward and Associates

THIS AGREEMENT is made this ___day of _____, 2006, by and between the City of Woodinville (hereinafter referred to as "City"), a Washington Municipal Corporation, and Steward and Associates (hereinafter referred to as "Service Provider"), doing business at 120 Avenue A, Suite D Snohomish, WA 98290.

WHEREAS, Service Provider is in the business of providing certain services specified herein; and

WHEREAS, the City desires to contract with Service Provider for the provision of such services for Sustainability Development Program Studies, and Service Provider agrees to contract with the City for same;

NOW, THEREFORE, in consideration of the mutual promises set forth herein, it is agreed by and between the parties as follows:

TERMS

1. **Description of Work**. Service Provider shall perform work as described in Attachment A, Scope of Work, which is attached hereto and incorporated herein by this reference, according to the existing standard of care for such services. Service Provider shall not perform any additional services without the expressed permission of the City.

2. **Payment**.

   A. The City shall pay Service Provider at the hourly rate set forth in Attachment B, but not more than a total of One hundred fifty thousand dollars ($150,000) for the services described in this Agreement. This is the maximum amount to be paid under this Agreement, and shall not be exceeded without prior written authorization from the City in the form of a negotiated and executed supplemental agreement.

   B. Service Provider shall submit monthly payment invoices to the City after such services have been performed, and the City shall make payment within four (4) weeks after the submittal of each approved invoice. Such invoice shall detail the hours worked, a description of the tasks performed, and shall separate all charges for clerical work and reimbursable expenses.

   C. If the City objects to all or any portion of any invoice, it shall so notify Service Provider of the same within five (5) days from the date of receipt and shall pay that portion of the invoice not in dispute. The parties shall immediately make every effort to settle the disputed portion.

3. **Relationship of Parties**. The parties intend that an independent contractor - client relationship will be created by this Agreement. As Service Provider is customarily engaged in an independently established trade which encompasses the specific service provided to the City hereunder, no agent, employee, representative or subcontractor of Service Provider shall be or shall be deemed to be the employee, agent, representative or subcontractor of the City. None of the benefits provided by the City to its employees, including, but not limited to, compensation, insurance and unemployment insurance, are available from the City to the Service Provider or his employees, agents, representatives or subcontractors. Service Provider will be solely and entirely responsible for his acts and for the acts of Service Provider's agents, employees, representatives and subcontractors during the performance of this Agreement. The City may, during the term of this Agreement, engage other independent contractors to perform the same or similar work that Service Provider performs hereunder.

4. **Project Name**. Sustainability Development Program Studies

5. **Duration of Work**. Service Provider shall complete the work described in Attachment A on or before December 31, 2006.

6. **Termination**.

   A. *Termination Upon the City's Option*. The City shall have the option to terminate this Agreement at any time. Termination shall be effective upon ten (10) days written notice to the Service Provider.

   B. *Termination for Cause*. If Service Provider refuses or fails to complete the tasks described in Attachment A, or to complete such work in a manner unsatisfactory to the City, then the City may, by written notice to Service Provider, give notice of its intention to terminate this Agreement. After such notice, Service Provider shall have ten (10) days to cure, to the satisfaction of the City or its representative. If Service Provider fails to cure to the satisfaction of the City, the City shall send Service Provider a written termination letter which shall be effective upon deposit in the United States mail to Service Provider's address as stated below.

   C. *Rights upon Termination*. In the event of termination, the City shall only be responsible to pay for all services satisfactorily performed by Service Provider to the effective date of termination, as described in the final invoice to the City. The City Manager shall make the final determination about what services have been satisfactorily performed.

7. **Nondiscrimination**. In the hiring of employees for the performance of work under this Agreement or any subcontract hereunder, Service Provider, its subcontractors or any person acting on behalf of Service Provider shall not, by reason of race, religion, color, sex, marital status, national origin or the presence of any sensory, mental, or physical disability, discriminate against any person who is qualified and available to perform the work to which the employment relates.

8. **Indemnification / Hold Harmless**. The Service Provider shall defend, indemnify and hold the City, its officers, officials, employees and volunteers harmless from any and all claims, injuries, damages, losses or suits including attorney fees, arising out of or in connection with the performance of this Agreement, except for injuries and damages caused by the sole negligence of the City.

   Should a court of competent jurisdiction determine that this Agreement is subject to RCW 4.24.115, then, in the event of liability for damages arising out of bodily injury to persons or damages to property caused by or resulting from the concurrent negligence of the Service Provider and the City, its officers, officials, employees, and volunteers, the Service Provider's liability hereunder shall be only to the extent of the Service Provider's negligence. It is further specifically and expressly understood that the indemnification provided herein constitutes the Service Provider's waiver of immunity under Industrial Insurance, Title 51 RCW, solely for the purposes of this indemnification. This waiver has been mutually negotiated by the parties. The provisions of this section shall survive the expiration or termination of this Agreement.

9. **Insurance**. The Service Provider shall procure and maintain for the duration of the Agreement, insurance against claims for injuries to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Service Provider, their agents, representatives, employees or subcontractors.

   A. Minimum Scope of Insurance. Service Provider shall obtain insurance of the types described below:

      1. *Automobile Liability* insurance covering all owned, non-owned, hired and leased vehicles. Coverage shall be written on Insurance Services Office (ISO) form CA 00 01 or a substitute form providing equivalent liability coverage. If necessary, the policy shall be endorsed to provide contractual liability coverage.

      2. *Commercial General Liability* insurance shall be written on ISO occurrence form CG 00 01 and shall cover liability arising from premises, operations, independent contractors, products-completed operations, personal injury and advertising injury, and liability assumed under an insured contract. The City shall be named as an insured under the Service Provider's Commercial General Liability insurance policy with respect to the work performed for the City using ISO additional insured endorsement GC 20 10 10 01 and GC 20 37 10 01 or substitute endorsements providing equivalent coverage.

      3. *Workers' Compensation* coverage as required by the Industrial Insurance laws of the State of Washington.

B. Minimum Amounts of Insurance. Service Provider shall maintain the following insurance limits:

1. *Automobile Liability* insurance with a minimum combined single limit for bodily injury and property damage of $1,000,000 per accident.

2. *Commercial General Liability* insurance shall be written with limits no less than $1,000,000 each occurrence, $2,000,000 general aggregate and $2,000,000 products-completed operations aggregate limit.

C. Other Insurance Provisions. The insurance policies are to contain, or be endorsed to contain, the following provisions for Automobile Liability and Commercial General Liability insurance:

1. The Service Provider's insurance coverage shall be primary insurance as respect to the City. Any insurance, self-insurance, or insurance pool coverage maintained by the City shall be excess of the Service Provider's insurance and shall not contribute with it.

2. The Service Provider's insurance shall be endorsed to state that coverage shall not be cancelled by either party, except after thirty (30) days prior written notice by certified mail, return receipt requested, has been given to the City.

D. Acceptability of Insurers. Insurance is to be placed with insurers with a current A.M. Best rating of not less than A:VII.

E. Verification of Coverage. Service Provider shall furnish the City with original certificates and a copy of the amendatory endorsements, including but not necessarily limited to the additional insured endorsement, evidencing the insurance requirements of the Service Provider before commencement of the work.

F. Subcontractors. Service Provider shall include each subcontractor as insured under its policies or shall furnish separate certifications and endorsements for each subcontractor. All coverage shall be subject to all of the same insurance requirements as stated herein for the Service Provider.

10. Entire Agreement. The written provisions and terms of this Agreement, together with all documents attached hereto, shall supersede all prior verbal statements of any officer or other representative of the City, and such statements shall not be effective or be construed as entering into or forming a part of, or altering in any manner whatsoever, this Agreement.

11. City's Right of Supervision, Limitation of Work Performed by Service Provider. Even though Service Provider works as an independent contractor in the performance of his

duties under this Agreement, the work must meet the approval of the City and be subject to the City's general right of inspection and supervision to secure the satisfactory completion thereof. In the performance of work under this Agreement, Service Provider shall comply with all federal, state and municipal laws, ordinances, rules and regulations that are applicable to Service Provider's business, equipment, and personnel engaged in operations covered by this Agreement or accruing out of the performance of such operations.

12. **Work Performed at Service Provider's Risk**. Service Provider shall be responsible for the safety of its employees, agents and subcontractors in the performance of the work hereunder and shall take all protections reasonably necessary for that purpose. All work shall be done at Service Provider's own risk, and Service Provider shall be responsible for any loss of or damage to materials, tools, or other articles used or held for use in connection with the work.

13. **Ownership of Products and Premises Security**.

    A. All reports, plans, specifications, data maps, and documents produced by the Service Provider in the performance of services under this Agreement, whether in draft or final form and whether written, computerized, or in other form, shall be the property of the City.

    B. While working on the City's premises, the Service Provider agrees to observe and support the City's rules and policies relating to maintaining physical security of the City's premises.

14. **Modification**. No waiver, alteration or modification of any of the provisions of this Agreement shall be binding unless in writing and signed by a duly authorized representative of the City and Service Provider.

15. **Assignment**. Any assignment of this Agreement by Service Provider without the written consent of the City shall be void.

16. **Written Notice**. All communications regarding this Agreement shall be sent to the parties at the addresses listed below, unless notified to the contrary. Any written notice hereunder shall become effective as of the date of mailing by registered or certified mail, and shall be deemed sufficiently given if sent to the addressee at the address stated in this Agreement or such other address as may be hereafter specified in writing.

17. **Non-Waiver of Breach**. The failure of the City to insist upon strict performance of any of the covenants and agreements contained herein, or to exercise any option herein conferred in one or more instances shall not be construed to be a waiver or relinquishment of said covenants, agreements or options, and the same shall be and remain in full force and effect.

18. **Resolution of Disputes, Governing Law**. Should any dispute, misunderstanding or conflict arise as to the terms and conditions contained in this Agreement, the matter shall be referred to the City Manager, whose decision shall be final. In the event of any

litigation arising out of this Agreement, the prevailing party shall be reimbursed for its reasonable attorney fees from the other party. This Agreement shall be governed by and construed in accordance with the laws of the State of Washington.

IN WITNESS WHEREOF, the parties have executed this Agreement on the day and year above written.

CITY OF WOODINVILLE

By: _____

City Manager

SERVICE PROVIDER

By: _____

Title: _____

Taxpayer ID #: _____

CITY CONTACT

Ray Sturtz, Community Development Director

City of Woodinville

17301 133rd Avenue NE

Woodinville, WA 98072

Phone: 425-489-2757, x 2281

Fax: 425-489-2705

SERVICE PROVIDER CONTACT

_____

_____

_____

_____

Phone: _____

Fax: _____

ATTEST/AUTHENTICATED

By: _____

City Clerk

APPROVED AS TO FORM

By: _____

Office of the City Attorney

Scope of Work and Budget

Steward and Associates ("Consultant") would assist Woodinville ("the City") with its Sustainable Development Program, including an analysis of critical areas city-wide, with an emphasis on the R-1 Area; an evaluation of current and potential densities in the R-1 Area and their potential impacts on critical areas; an evaluation of strategies the City could take to improve protections for critical areas elsewhere in the City; written and oral reports on these subjects to a Citizen Advisory Panel (CAP), the Planning Commission and the City Council; and assistance with the adoption process for related City actions. Consultant shall use sub-consultants to assist with this work, but shall be fully responsible for all final deliverables. The budget for this project shall not exceed $150,000.

Consultant reserves the right to transfer funds among tasks as necessary to produce the deliverables listed below, notifying the City promptly if total costs for any task appear likely to depart by more than 20% from the estimates below.

John Lombard shall be Project Manager and the primary contact on this project for Consultant; the City shall assign a Contract Manager and the primary contact for this project for the City.

Task 1: Project Initiation

Consultant shall develop a proposed scope of work for the project, including work that may be performed by subcontractors, and shall work with the City to refine and finalize this scope and related contracts and subcontracts. The Project Manager shall attend one City Council meeting to answer questions about the contract and to assist in its adoption.

Deliverables: Draft and final scope of work. Attendance at City Council meeting.
Target Completion: June 5, 2006.
Estimated Cost: $6,527

Task 2: Field Trip to R-1 Area

Consultant shall work with the City to organize and carry out a field trip to the R-1 Area and adjacent critical areas that may be affected by it. At a minimum, the trip shall include Cold Creek, Lake Leota, Woodin Creek, fish and wildlife habitat conservation areas within the R-1 Area, and geologically hazardous areas within and adjacent to the R-1 Area. The trip shall provide opportunities to assess the overall tree canopy and the potential for low impact development in the R-1 Area, and may have additional goals as the City may direct. Not all members of the consultant team shall attend the entire field trip; members shall focus on areas of their expertise.

Deliverables: Itinerary for field trip, and participation on it.
Target Completion: No later than June 15, 2006.
Estimated Cost: $6,306

Task 3: Document Review

Consultant shall review existing documents relevant to this project as determined jointly by the City and Consultant. Examples include the Draft Environmental Impact Statement for the

proposed Wood Trails/Montevallo Plats development, the City's critical area regulations and supporting documentation, King County analysis of groundwater in the vicinity of the R-1 Area, water quality records for Lake Leota, aerial photographs, relevant City maps, analysis of drainage issues and geologic hazards in and adjacent to the R-1 Area, the City's Comprehensive Plan and relevant subarea plans, and analysis of traffic issues in the R-1 Area. An initial review of documents shall help determine the itinerary for the field trip in Task 2.
Deliverables: E-mail and phone conversations to identify and request documents; brief e-mail assessments of key issues from the documents, as appropriate.
Target Completion: End of June 2006.
Estimated Cost: $12,018

Task 4: Pre-Draft Briefings of CAP, members of Planning Commission and City Council

Prior to submitting the draft R-1 report, Consultant shall provide up to four briefings of the CAP. These briefings are anticipated to include an orientation to the project; a review of existing knowledge regarding critical areas in or affected by the R-1 Area and how they might be impacted by increases in density; and a review of preliminary findings and recommendations from this project. The project budget includes time for responses to e-mail and phone requests from individual members of the CAP, Planning Commission and City Council, following protocols established with City staff.
Deliverables: Handouts and other meeting materials; limited Power Point presentations, as requested; attendance at meetings; records of e-mail and phone conversations. Target Completion: Mid-June through July 2006.
Estimated Cost: $17,822

Task 5: Coordination with City and Team

Throughout the project, the Project Manager shall coordinate closely with City staff and the consultant team to ensure a clear, shared understanding of the status and goals of the project and upcoming activities. The budget for this task includes meetings with the City, meetings between Consultant and sub-consultants, and phone and e-mail conversations between these parties that are not specifically related to other tasks. Consultant has not budgeted to provide meeting minutes to the City, but shall provide e-mail summaries of meeting results, as needed or as requested by the City.
Deliverables: E-mails, phone conversations, attendance at meetings.
Target Completion: Throughout project.
Estimated Cost: $14,023

Task 6: Additional Field Visits

Consultant and sub-consultants shall make additional field visits to the R-1 Area to evaluate issues in more depth than will be possible under Task 2, as needed based on their professional judgment or, as resources allow, as requested by the City. These visits shall directly relate to issues for the report on the R-1 Area. Consultant anticipates that this task shall include field verification for a survey of vegetation in the R-1 Area, which shall be based initially on aerial photographs provided by the City. The budget for this task also allows a half-day or less visit to other parts of the City, as needed for the City-Wide report.
Deliverables: Brief e-mail messages summarizing the results of field visits.
Target Completion: End of July 2006 for R-1 report; end of October 2006 for City-Wide report.

Estimated Cost: $7,569

Task 7: Draft R-1 Report

Consultant, working in coordination with sub-consultants, shall draft a report evaluating the environmental basis for maintaining R-1 zoning in the City. The report shall use best available science and apply criteria from the Growth Management Act and decisions by the Central Puget Sound Growth Management Hearings Board and the courts. At a minimum, Consultant anticipates applying criteria from *Litowitz v. City of Federal Way* (Central Puget Sound Growth Management Hearings Board Case No. 96-3-0005), but Consultant shall be guided by the Contract Manager and the City's attorney regarding which criteria should be applied in the report and how the criteria should be characterized with respect to the City's legal obligations. The draft report shall take into account comments from the CAP, City staff and, if applicable, members of the Planning Commission and the City Council, but the report shall reflect the independent judgment of Consultant. It may recommend alternative zoning in some or all of the R-1 area, but the budget does not provide for analysis to justify any specific alternative zoning density. The report shall be provided in Word format for review by City staff, the CAP, the Planning Commission and the City's attorney.
Deliverables: Draft report, in Word format.
Target Completion: August 1, 2006.
Estimated Cost: $28,066

Task 8: Revise R-1 Report

The Contract Manager shall coordinate and organize City comments on the R-1 Report, with a target date of delivery to Consultant by August 18, 2006. Consultant shall attend one City Planning Commission meeting to discuss the report prior to the final delivery of comments. In consultation with the Contract Manager and sub-consultants, Consultant shall revise the R-1 Report based on comments received, and shall submit a final draft by August 31, 2006, with copies as described below.
Deliverables: Final R-1 Report, including 10 hard copies and five electronic copies in pdf format on compact discs.
Target Completion: August 31, 2006.
Estimated Cost: $11,341

Task 9: Research and Draft City-Wide Report

Consultant shall research and draft a report evaluating strategies the City could employ outside of the R-1 Area to improve protections of critical areas, which shall assume no change in existing buffers and other requirements of the City's critical area ordinance. At a minimum, the report shall evaluate regulations and programs to protect native vegetation and soils, amendments to the City's standard stormwater requirements, and opportunities to employ low-impact development techniques. The depth and extent of the report may be limited by available resources. Project Manager and Contract Manager shall refine the goals for this report prior to a draft report being developed. The draft report shall take into account comments from the CAP, City staff , the Planning Commission and the City Council, but the report shall reflect the independent judgment of Consultant. It shall be provided in Word format for review by City staff, the CAP, the Planning Commission and the City's attorney.
Deliverables: Draft report, in Word format.

Target Completion: October 13, 2006.
Estimated Cost: $18,464

Task 10: Revise City-Wide Report

The Contract Manager shall coordinate and organize City comments on the R-1 Report, with a target date of delivery to Consultant by October 24, 2006. Consultant shall attend one City Planning Commission meeting to discuss the report prior to final delivery of comments. In consultation with the Contract Manager and sub-consultants, Consultant shall revise the City-Wide Report based on comments received, and shall submit a final draft by October 31, 2006, with copies as described below.
Deliverables: Final City-Wide Report, including 10 hard copies and five electronic copies in pdf format on compact discs.
Target Completion: October 31, 2006.
Estimated Cost: $6,470

Task 11: Assist Adoption Process

Consultant shall attend up to two meetings of the City Planning Commission (in addition to meetings included in Tasks 8 and 10) to answer questions and assist the Commission in completing its reports and recommendations regarding the R-1 Area and issues raised in the final City-Wide Report. Consultant shall attend up to four City Council meetings to answer questions and assist the Council in taking final actions on the R-1 Area and issues raised in the final City-Wide Report. The budget also includes time for responses to e-mail and phone requests from the Planning Commission and City Council, following protocols established with City staff.
Deliverables: Handouts and other meeting materials; limited Power Point presentations, as requested; attendance at meetings.
Target Completion: Meetings on R-1 Area, September 2006; meetings on City-Wide issues, December 2006.
Estimated Cost: $21,396

Steward and Associates

Hourly Billing Rates
Effective January 1, 2006

Classification	Professional	Billing Rate
Principal/Senior Scientist	Cleveland Steward	$150.00
Policy Analyst	John Lombard	$125.00
Sr. Biologist/Biologist III	Janne Kaje	$105.00
Sr. Biologist/Biologist III	Eric Doyle	$105.00
Biologist II	Dustin Hinson	$90.00
Biologist II	Jacob Venard	$90.00
GIS Technician/Biologist I	Michael Maher	$75.00
Administrative Support		$50.00

Markup of Sub-Contractor's fees 10% of Sub-Contractor's fee

Reimbursable Expenses:

Mileage	IRS standard mileage rate
Printing/Photocopying (In House)	$0.10 per copy
	$1.00 per color copy
Fax	$1.00 per page
Other	Actual Cost

- Printing & Copying (Out of House)
- Postage & Shipping
- Meals/Travel Expenses
- Parking/Ferry Charges
- Long Distance Telephone/Teleconferencing

ATTACHMENT B

MAY 0 5 2006

CITY OF WOODINVILLE
PLANNING DEPARTMENT

Sustainable Development Program: Analysis and Recommendations

A Proposal Submitted to

The City of Woodinville

By

Steward and Associates
120 Avenue A, Suite D
Snohomish, Washington 98290

www.stewardandassociates.com

May 5, 2006

Introduction

Steward and Associates is pleased to submit this proposal to the City of Woodinville in response to your Request for Qualifications for environmental consulting services to assist your Sustainable Development Program. We believe we have assembled an excellent team that can meet the full range of the City's needs for this project, from technical and planning expertise to experience with the public and political processes.

After briefly reviewing our team, this proposal:

- Discusses our understanding of the Sustainable Development Program;
- Highlights the strengths of individual team members in each of the areas of expertise identified in the RFQ (and one additional subject area we believe is important to the success of this project);
- Reviews our preliminary proposed scope of services; and
- Summarizes our preliminary budget.

We understand that the City will work with the selected contractor to determine a final scope of services and budget. Resumes for all key team members are included as an appendix. References and examples of our work on related projects are included in the discussion of individual team members.

The Steward and Associates Team

The City's RFQ identifies the need for a wide range of technical expertise. Steward and Associates would be the prime contractor and overall project manager. We would also assign individuals to the project with expertise in fisheries biology, wildlife biology, wetland biology, and Geographic Information Systems. We are an environmental consulting firm specializing in salmon biology, with expertise in all related issues, from planning and regulations to fisheries and stream science.

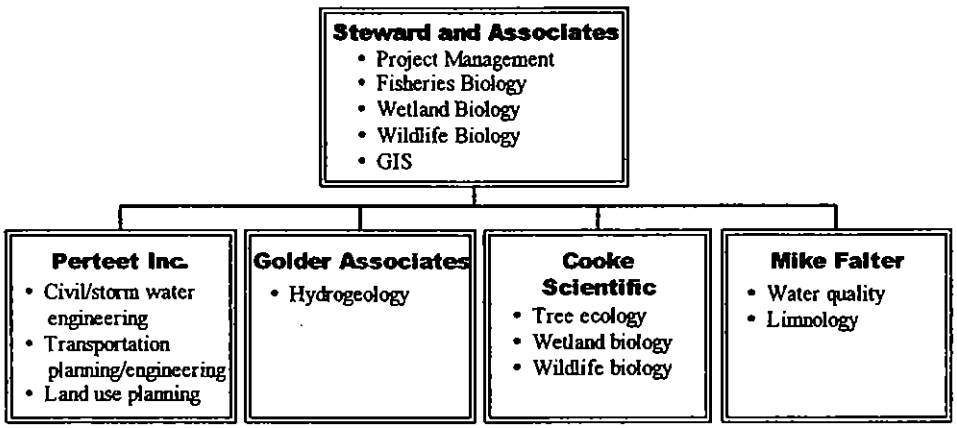
Since 2002, Steward and Associates has served as the City's liaison to the WRIA 8 (Greater Lake Washington Watershed) salmon conservation planning process. We have also assisted the City in the past with its grant application to purchase key parcels of land under the Little Bear Creek Land Acquisition Project; with its public outreach and education program to promote awareness of environmental stewardship and enlist community support for efforts to recover wild salmon; and, with the delineation and management of a wetland adjacent to the "Tent City" location in the lower Bear Creek corridor.

Perteet Inc. provides our team with expertise in civil engineering, low impact development and related stormwater issues, transportation engineering (including multi-modal transportation planning), and land use planning. Perteet is one of the region's premier planning and design firms for transportation, utilities and surface water management. Steward and Associates has worked with Perteet on numerous projects in recent years.

Others on our consulting team include Golder Associates, with expertise in hydrogeology; Cooke Scientific, with expertise in terrestrial and wetland ecology, with salient expertise in

plant community ecology and forestry; and Professor Mike Falter, a limnologist and water quality expert who we believe will be invaluable for our team's ability to evaluate Lake Leota in the City's R-1 zone.

The following figure summarizes the roles and relationships of team members.



Understanding of the Project

Our team has extensive experience with the City of Woodinville. Joel Birchman, P.E., who would lead Perteet's contribution to the project, was the City's first Public Services Administrator and led development of the Transportation, Utilities and Capital Facilities elements in the City's first Comprehensive Plan. John Lombard, overall Project Manager, has represented the City in WRIA 8 planning processes since 2002. He also was King County's Lake Washington Watershed Coordinator from 1996 to 2000, which provides him with an excellent understanding of the Little Bear Creek, Bear Creek and Sammamish River systems. Cleve Steward, Principal and Senior Scientist of Steward and Associates, has been a member of the Steering Committee overseeing development of the WRIA 8 salmon conservation plan since its inception in 1998. As a University of Washington fisheries graduate student, Cleve conducted research on Bear Creek in the early 1980's, and has extensive experience studying salmon and their habitats in Lake Washington and its tributaries. He is also director of the Sustainable Fisheries Foundation, and a member of the Technical Recovery Team for the Lower Columbia and Willamette River regions, and would be able to apply his knowledge and experience to Woodinville's Sustainable Development Program.

Sarah Cooke of Cooke Scientific was responsible for the Wetland Inventory for the City as part of the King County wetland inventory, and assisted the City with third party reviews of development proposals for critical areas impacts and mitigation from 1997 to 2000. Other team members have performed additional work for the City or in the Woodinville area, as discussed below.

In our role as the City's consultant, and as friends and acquaintances of many Woodinville residents, we truly appreciate the unique qualities and vision reflected in the saying,

"Country living, city style." Woodinville has been distinguished as a "Tree City USA" since 1996, and has explicitly acknowledged the benefits of preserving its "northwest woodland character" in its design and development guidelines. The City has been a regional leader in supporting protection and restoration of Little Bear Creek and the Sammamish River, and has supported WRIA 8 efforts to protect and restore Bear Creek as one of the most productive salmon streams in lowland Puget Sound and one of the "Tier 1" priorities for the Lake Washington watershed.

At the same time, we recognize that the City wants to promote the vitality and diversity of its economy and that it is experiencing steady residential growth. The City must meet a variety of requirements of the Growth Management Act, including both the accommodation of its share of regional growth and protection of its critical areas. The City Council must ultimately balance all of these objectives in setting policy both for Woodinville as a whole and for its different neighborhoods, including the R-1 zone that will be the primary (though not exclusive) focus of this project.

The temporary building and land use moratorium that the City Council has established in the R-1 zone is obviously of great interest to City residents, developers and businesses in the area. The information developed through this project and the resulting decisions and actions taken by the City will be carefully scrutinized and widely discussed. For this reason, we believe it is crucial that the City and your consultant work closely with the Citizen Advisory Panel (CAP) that the City is forming. Although much of the work for this project will unavoidably take place during the summer, we propose that the project team meet regularly with the CAP during this period, and that CAP members be kept informed of progress through e-mails and phone conversations between meetings.

It is important that CAP members understand the legal requirements the City is obligated to meet, including key decisions by both the courts and the Growth Management Hearings Boards. They must also understand how scientific knowledge and uncertainty relate to meeting GMA requirements. The key GMA standard at issue for the R-1 zone is the so-called "Litowitz Test," which was first articulated in *Litowitz v. City of Federal Way* (Central Puget Sound Growth Management Hearings Board Case No. 96-3-0005):

> [W]hen environmentally sensitive systems are large in scope (e.g., a watershed or drainage sub-basin), their structure and functions are complex and their rank order is high, a local government may...choose to afford a higher level of protection by means of land use plan designations lower than 4 du/acre. (Litowitz v. City of Federal Way, Final Decision and Order, July 22, 1996)

Other relevant cases include *Kaleas, Horst and Futurewise vs. City of Normandy Park* (Central Puget Sound Growth Management Hearings Board Case No. 05-3-0007c) and *Fuhriman II vs. City of Bothell* (Central Puget Sound Growth Management Hearings Board Case No. 05-3-0025c).

However, in *Viking v. Holm* (155 Wn.2d 112), the State Supreme Court stated last year that Growth Management Hearings Boards do not have the authority to establish "bright line" definitions of acceptable standard densities in urban or rural areas, such as 4 units/acre. We

would defer to the City's attorney as to how the City wishes to evaluate its options regarding density requirements. Whatever conclusion is reached should be shared with the CAP, since it will likely play an important role in the City's final decision regarding how to proceed.

Our technical study would primarily focus on the potential effects of changes in development density of the R-1 area on critical areas that, following the Litowitz criteria, are large in scope, with complex structures and functions and a high rank order. We believe that the two critical areas that best fit these criteria and are affected by the R-1 zone are Cold Creek (a tributary of the Bear Creek system) and Lake Leota, though we may identify others during our study. Our evaluation would also consider possible impacts on public health and safety caused by increased densities, such as contamination of critical aquifer recharge areas or destabilization of geologically hazardous areas. We recognize that the effects of density can be mitigated through the application of low impact development techniques, special stormwater requirements, tree retention, expanded critical area protections and other regulatory and management approaches. We will work with the City and the CAP to identify the range of potential options, and to recommend actions that are most likely to meet GMA requirements and the City's goals. We will also work with the City and the CAP to identify other parts of Woodinville and other factors that influence anadromous fish habitat, and will expand our study as appropriate. Finally, we will ensure that this project is coordinated and consistent with other related City initiatives, such as the transportation concurrency program.

Key Team Members

This section of our proposal discusses the qualifications of key team members, focusing on the areas of expertise that the City identified as a high priority in its RFQ. For each team member, we also provide references and examples of relevant previous experience.

Project Manager

John Lombard, Senior Policy Analyst at Steward and Associates, would manage this project. He would have overall responsibility for our final products and be our lead representative with City staff, the CAP, Planning Commission and City Council.

John has managed numerous large projects for Steward and Associates, including the Snohomish ESA Strategy, Oak Harbor's critical areas update and the Camano Island Nonpoint Pollution Prevention Plan, discussed further below. He has been Woodinville's liaison to the WRIA 8 salmon conservation planning process since 2002, representing the City on the WRIA 8 Technical Committee, which is responsible for developing the technical foundation for the WRIA 8 plan. Before coming to Steward and Associates in January 2002, John was in the Director's Office of the King County Department of Natural Resources, where he oversaw development of the Sammamish River Corridor Action Plan, in coordination with the cities of Woodinville, Redmond, Bothell and Kenmore as well as the U.S. Army Corps of Engineers. From 1996 to 2000, he was King County's Lake Washington Watershed Coordinator, working with all 30 local governments in the 700-square-mile area to protect and restore salmon habitat and water quality and address regional flooding hazards.

As Senior Policy Analyst at Steward and Associates, John has managed our contracts to assist the cities of Bothell, Snohomish, Oak Harbor and Roslyn to update their critical area regulations. In Oak Harbor, we were responsible for updating the City's entire critical area code and advising on related policies in its comprehensive plans. The Snohomish ESA Strategy included a thorough field evaluation of aquatic and wetland habitat and water quality throughout the City's Urban Growth Area, as well as a comprehensive review of City activities that affect the environment, particularly fish habitat. The Strategy prioritized City resources and recommended new or amended City programs and regulations to meet the City's environmental goals, including compliance with the Endangered Species Act, Clean Water Act, Growth Management Act and Shoreline Management Act. John is currently managing our contract with Island County to develop the Camano Island Nonpoint Pollution Prevention Plan. This involves facilitating a citizen-based Watershed Management Committee, coordinating with implementing agencies, and drafting the Plan for adoption by the Board of Island County Commissioners and approval by the Washington Department of Ecology.

John is the author of Saving Puget Sound: A Conservation Strategy for the 21st Century, to be published by the American Fisheries Society and the University of Washington Press in Fall 2006. The book develops a proposal to conserve the major ecosystems of the Puget Sound region in the face of long-term population growth. Details are available at www.savingpugetsound.com.

References:

Woodinville Liaison to WRIA 8 Planning Process
Yosh Monzaki
Surface Water Engineer
City of Woodinville
yoshm@ci.woodinville.wa.us
Tel. (425) 877-2294

Oak Harbor Critical Areas Update
Larry Cort
Senior Planner
City of Oak Harbor
larry.cort@oakharbor.org
Tel. (360) 279-4513

Hydrogeologist

Bob Anderson has been practicing hydrogeology in Washington State since 1987 and has addressed groundwater resource issues from both a physical standpoint (groundwater quantity and quality) and a jurisdictional standpoint (regulatory management issues). He will provide input to the team on groundwater protection issues, particularly the influence of groundwater on baseflow to Cold Creek. He has evaluated relationships between streamflows, groundwater levels, development patterns, and climatic cycles in the Puget Sound area. Bob has prepared groundwater management plans and wellhead protection plans that quantify, to varying degrees and levels of detail, vulnerability to both water quality and

water quantity. He has addressed water supply vulnerability in Snohomish County, Cross Valley Sole Source Aquifer, and Bear Creek Watershed as a component of water supply planning.

Mr. Anderson is currently under contract to Snohomish County in support of the Critical Aquifer Recharge Area components of the County's Critical Areas Ordinance. His familiarity with local groundwater conditions, combined with regulatory familiarity related to groundwater protection at both state and local regulatory levels is unique to the Steward project team.

References:

Cross Valley Sole Source Aquifer
Gary Hajek
Manager
Cross Valley Water District
Tel. (360) 668-6766 ext 102

Snohomish County Critical Aquifer Recharge Areas
Bill Leif
Water Quality Manager
Snohomish County Public Works, Surface Water Management
Tel. (425) 388-3464 ext 3418

Civil/Stormwater Engineer

Dean Franz has more than 21 years experience in designing and managing both public and private sector civil engineering projects. Dean is a recognized leader in Sustainable Development. He served as an advisor on the committee for determining Low Impact Development Credits in drainage analysis as part of the Washington Department of Ecology stormwater program.

While working on Low Impact Development Standards for Snoqualmie Ridge II, Dean developed LID drainage standards to be implemented by the City of Snoqualmie, with the goal of achieving a high level of stormwater quality management and environmental protection of the receiving waters. The work included preparation of construction cost estimates using LID techniques as compared with conventional drainage design. Dean gave presentations to the Planning Commission and City Council on the benefits and uses of LID techniques for surface water management.

Working for the city of Marysville, WA, on their Ash Avenue Park-n-Ride project, Dean designed the drainage system, stormwater quality treatment system, pavement with brick pavers, and the sanitary sewer and grading using Low Impact Development techniques. This resulted in a construction cost savings of over $300,000 for drainage facilities on the project. Brick paver areas were used to dispose of stormwater and to provide water quality treatment using an amended soil media beneath the pavers. Dean also designed a sanitary sewer pump station and force main to serve the surrounding residential properties.

Dean also designed a rain garden, which was incorporated into the drainage system for 51st Avenue at 108th Street, in Snohomish County, WA. The rain garden is an LID technique that provides water quality treatment and shallow-depth detention for the management of stormwater. The resulting aesthetic and functional benefits were well received by the County.

References:

Low Impact Development Standards, Snoqualmie Ridge II
Gina Estep
Associate Planner
City of Snoqualmie
Tel. (425) 888-5337

Ash Avenue Park-n-Ride
Jeff Massie
Physical Engineer
City of Marysville
Tel. (360) 651-5100

51st Avenue at 108th Street
Steve Dickson
Physical Engineer
Snohomish County
Tel. (425) 388-6442

Transportation Engineer/Assistant Project Manager

Joel Birchman has more than 32 years of experience in the public and private sector. He has solid credentials as an accomplished project manager and utility designer engineer. He has an in-depth background in permitting and multi-agency coordination as well as the right-of-way acquisition process and coordination of record keeping that is necessary for a project to remain in compliance with governing agency standards.

While at the City of Woodinville, Joel led the effort and the Citizens Advisory Panels in the development of its first Transportation, Utilities, and Capital Facilities Plan Elements for the GMA Comprehensive Plan. Because of the quality and thoroughness of the Woodinville Comprehensive Plan, the state's Department of Community, Trade, and Economic Development uses the Woodinville Comprehensive Plan as a model for newly incorporated cities. At the completion of the comprehensive planning process the City of Woodinville began the process to annex the Grace area north of the City and across the King-Snohomish County line. As part of the annexation study, Joel identified the infrastructure financial, capital, and service impacts. This study included the storm water utility, gas tax, and development permit revenues that could result from the annexation. There were also numerous coordination issues that had to be resolved with the existing special purpose districts within the annexation area.

Joel completed the Cemetery Creek Trunk Sewer Feasibility Study for the City of Snohomish. This study looked at the feasibility of extending a 24-inch trunk sewer into the

unincorporated areas within the City's GMA growth boundary. The cost of construction and financing of the trunk sewer were not only determined, but the study also projected the offsetting revenues from connection fees, utility rates, development fees, and property taxes.

References:

Transportation, Utilities, and Capital Facilities Plan Elements for the GMA Comprehensive Plan
Mick Monken
Physical Engineer, Public Works Director
City of Woodinville
Tel. (425) 489-2700

Cemetery Creek Trunk Sewer Feasibility Study
Larry Bauman
City of Snohomish
Tel. (360) 568-3115

Land Use Planner

Patricia Love brings 16 years of planning and environmental review experience to Perteet Inc. As the Senior Planner for the City of Mukilteo, Patricia was responsible for implementing the directives of the Growth Management Act by preparing Comprehensive Plan Amendments, Subarea Plans, Zoning Code Amendments, Environmental compliance at the State and Federal level, and policy changes while working interactively with the City Council, Planning Commission, and citizen groups.

As the leader of Mukilteo's City Comprehensive Plan Amendment team, Patricia prepared and managed several major rewrites and updates to the City's Comprehensive Plan during her 14 years with the City. With the 2004 Comprehensive Plan update, Patricia led the City's efforts to determine if they City met the State's urban density definition of four units per acre. This effort involved preparing a land use inventory of the Single Family Residential RD 12.5 zone. Land uses inventoried included: critical areas, parks and open space, roadways, storm drainage facilities, and public utilities. To determine if the City was compliant with the Hearings Board guidance on urban densities, all of the inventoried items were subtracted from the gross land area. This analysis identified the net buildable land area, which resulted in slightly less than four units per acre. As a result, reasonable measures, such as a cottage housing ordinance, were adopted by the City.

As project manager for Mukilteo's Harbour Pointe Master Plan Update, Patricia prepared amendments to the Master Plan and the various segregated 'sectors' for specific land use, density, critical areas, transportation facilities, open space, drainage alternatives, and utilities. She analyzed wetlands, fish and wildlife, geotechnical data, and traffic reports to evaluate land use alternatives, and determined what type of mitigation would be necessary to approve the selected land use alternatives. Patricia was responsible for processing the Master Plan through the City's public review process. She also made environmental determinations and helped prepare staff reports, findings, and recommendations. Final approval was gained through presentations to the Planning Commission and City Council at public hearings.

In her capacity as Senior Planner at the City of Mukilteo, Patricia provided current and long range planning and SEPA expertise. Her knowledge of current planning was instrumental to understanding how policy and regulations affect the built environment. Patricia was the City's lead planner on writing and implementing the City's zoning and development code amendments for ten years. These land use code amendments included Critical Areas Code Amendments: Fish and Wildlife, Wetlands, and Geologic Sensitive Areas Regulations. With Perteet, Patricia helped draft the Geologic Sensitive Areas Ordinance for the City of Oak Harbor, and an update to the City of Mukilteo's Wetland Ordinance that was approved by the Central Puget Sound Growth Hearings Board.

References:

Mukilteo Comprehensive Plan Amendments
Heather McCartney
FAICP
City of Mukilteo
Tel. (425) 355-4141

Harbour Pointe Master Plan Update
Heather McCartney
FAICP
City of Mukilteo
Tel. (425) 355-4141

Oak Harbor Zoning Code Amendments
Larry Cort
City of Oak Harbor
Tel. (360) 279-4500

Fisheries Biologist

Cleve Steward, principal scientist and owner of Steward and Associates, is a fisheries biologist and consultant with over 30 years experience and education in salmon and trout ecology and management, both as a government employee and as a consultant. He has extensive experience in the fisheries management field and has undertaken numerous projects for federal and state agencies, Indian tribes, universities, private firms, and environmental groups from throughout the region. He is a recognized authority on the habitat and migratory requirements of juvenile salmonids and has broad expertise in freshwater ecology and fisheries management. He is frequently solicited to provide technical analysis, policy guidance, and expert opinion for projects related to wetland ecology, surface water management, watershed impacts, salmon hatchery impacts, salmon smolt passage survival and behavior, and monitoring and evaluation techniques.

Cleve has served as a citizen representative on the WRIA 8 Steering Committee since its inception, and is a longstanding member of the NOAA Fisheries-appointed Technical Recovery Team for the Lower Columbia-Willamette River. He would provide project management oversight, fisheries science expertise, and QA/QC services.

References:

Lower Columbia and Willamette Technical Recovery Team
Paul McElhany
TRT Chair
NOAA Fisheries, National Marine Fisheries Service
paul.mcelhany@noaa.gov
Tel. (206) 860-5608

Dustin Hinson is a fisheries biologist with Steward and Associates and has an advanced degree in aquatic ecology. He was the lead field biologist on the Snohomish ESA Strategy, assessing stream, wetland and riparian habitat across the City's Urban Growth Area and developing recommendations for restoration projects and protection priorities on the Snohomish and Pilchuck Rivers as well as three smaller creek systems. He has worked closely with John on all of our contracts helping local governments update their critical area regulations, including testifying before the Snohomish City Council and the Oak Harbor Planning Commission. Dustin has worked extensively with tribes, federal agencies, non-governmental organizations and universities on issues related to fisheries management and aquatic community response to habitat alteration and degradation.

References:

Larry Bauman
City of Snohomish ESA Response Strategy
City Manager
City of Snohomish
bauman@ci.snohomish.wa.us
Tel. (360) 568-3115

Additional references for Dustin Hinson may be found in the Wetland Biologist section below.

Wildlife and Wetland Biologist

Sarah Cooke has 19 years of experience in wetlands ecological research and environmental consulting, in the Pacific Northwest. She specializes in habitat creation, restoration and enhancement projects, both in design and implementation. Sarah excels in permitting assistance on the local, state, and national level. She was a co-senior investigator for the Puget Sound Wetland and Stormwater Management Research Program, a 10-year total wetland ecosystem study conducted under the auspices of the Environmental protection Agency, The US Geological Survey, Washington State, and King County in Washington State. Sarah has more experience in developing assessment methodologies than any other private wetlands consultant in the PNW. She has extensive experience in classroom instruction of wetlands ecology, restoration ecology and implementation, delineation protocols, functional assessment, weed identification and control, hydric soils, and wetland plant identification. She has 16 years experience in managing multidisciplinary teams, supervising subcontractors, and generating reports, and marketing from a consulting perspective. Sarah currently teaches restoration ecology and implementation, wetland

botany, and weed ecology and control at Portland State University. She is a former instructor for the Wetland Certification Program at the University of Washington and Wetland Ecology and Science for the graduate program at the Evergreen State College. She is also the senior author/editor of the *A Field Guide to the Common Wetland Plants of Western Washington & Northwestern Oregon.*

Sarah Cooke performs on average 25 delineations a year. Sarah has performed hundreds of delineations with 18 years of experience, and has experience in atypical and problem area wetlands. She has taught wetland delineation methodology for the US Army Corps of Engineers and the City of Seattle planning department wetland delineation classes. She verifies wetland boundaries as part of her third party review.

References:

King County Wetland and Stream Inventory
Erik Stockdale
Wetlands Staff
Washington State Department of Ecology
Tel. (206) 649-7061

Patrick Stockdale
Project Planner
Snohomish County
(425) 388-3311 ext 2745

Dustin Hinson is also Steward and Associates' lead wetland biologist, and frequently performs critical area studies regarding development impacts on streams and wetlands for both local governments and developers. In addition, Dustin reviews submitted development applications for the Cities of Snohomish and Mount Vernon for ecological and regulatory consistency. Dustin has provided assistance to City of Woodinville staff regarding the management of a wetland adjacent to the "Tent City" location in the lower Bear Creek corridor.

References:

Woodinville "Tent City" Wetland Management
Yosh Monzaki
Surface Water Engineer
City of Woodinville
yoshm@ci.woodinville.wa.us
Tel. (425) 877-2294

Additional references for Dustin Hinson may be found in the Fisheries Biologist section above.

Tree Ecologist

Sarah Cooke is also a forestry ecologist and terrestrial plant community expert. She possesses an experienced understanding of native vegetation and how birds and wildlife

utilize vegetated habitat such as the tree canopy. Sarah has worked on projects involving the role of the tree canopy in basin hydrography, and in addition she has extensive experience working with mitigation plans that address impacts to riparian corridors associated with critical areas.

References:

Keith Niven
Planning Director
City of Issaquah MDRT
Tel. (425) 837-3430

Tom Hruby
Senior Ecologist, Shorelands
Washington State Department of Ecology
Tel. (360) 407-7274

Limnologist and Water Quality Expert

Mike Falter is a professor of limnology and aquatic ecology and the University of Idaho in Moscow. He is responsible for developing research programs in aquatic resources as well as teaching upper division and graduate courses in limnology, aquatic ecology and the management of lakes, streams, and reservoirs. With an emphasis on water body management planning as well as lake and stream ecology, Dr. Falter has designed and led more than 100 limnological projects on lakes, streams, and reservoirs of the United States, Africa, and Australia. While consulting for a variety of federal, state, regional, and private entities, Dr. Falter has detailed aquatic ecology, assessed sediment and nutrient loading, and designed management plans for long-range optimization of water body uses.

At the University of Idaho, Dr. Falter developed and taught undergraduate and graduate courses including Limnology, Aquatic Pollution Ecology, Wildland Field Ecology, International Land Use Planning, Fish Biology, and Aquatic Restoration Ecology. Since leaving the University of Idaho, he has continued these research and management issues on a number of projects for public and private entities.

He has been active in continuing education for federal, state, and industrial resource managers via workshops and continuing education courses. He guided 55 Master's and Doctoral students as major advisor and continues with graduate and Web-based teaching since leaving the University.

References:

Ralph Myers
Water Quality Program Supervisor
Idaho Power Company
RMyers@idahopower.com
Tel. (208) 388-2358

Phillip Cernera
Director Lake Management Dept.
Coeur d'Alene Tribe
lakemanagement@cdatribe-nsn.gov
Tel. (208) 686-6008

GIS Technician

Michael Maher is Steward and Associates' lead Geographical Information Systems analyst and cartographic specialist. A mapping component is an invaluable part of any plan and remarkably useful for conveying concepts and information about any area under examination. Michael has extensive experience producing high-quality environmental and natural resources map products for wide and varying audiences. As lead author on NOAA Fisheries' "Atlas of Salmon and Steelhead Habitat in the Oregon Lower Columbia and Willamette Basins," Michael created hundreds of watershed-scale maps depicting basin conditions and salmonid habitat. Michael has a comprehensive background utilizing GMA and critical areas data in identifying conservation priorities and employing GIS-based methods of environmental problem solving. As evidenced by his work with the NOAA Northwest Fisheries Science Center's "Lewis River Case Study" team, Michael is familiar with mapping current and future landscapes while considering planned land use and restoration / preservation actions.

References:

Atlas of Salmon and Steelhead Habitat in the Oregon Lower Columbia and Willamette Basins
Paul McElhany
Conservation Biologist
NOAA Fisheries NWFSC
paul.mcelhany@noaa.gov
Tel. (206) 860-5608

Lewis River Case Study Team
Ashley Steel
Quantitative Ecologist
NOAA Fisheries NWFSC
ashley.steel@noaa.gov
Tel. (206) 860-3406

Preliminary Scope of Services

We consider the following to be a very preliminary and general scope of services, which we have developed based on our current understanding of the project. We expect to revise both the scope and accompanying budget after further discussion with the City and our initial assessment of project-related issues.

At the outset of the project, we would want to meet with the City to discuss the scope of work in greater detail. We understand that the City is uncertain of some details at this stage, and so it would be prudent to convene an initial meeting to jointly review and refine the scope of work. The meeting may include a site visit, but we would expect to return later for a more extensive tour of affected areas in Woodinville, focusing on the R-1 zone and the adjacent Cold Creek Natural Area. We hope to receive copies of all project-relevant documents from the City and review them prior to undertaking an extended tour so that we could identify the most relevant issues and places to visit.

Given the importance of the CAP to this entire project, we would want to work with the City from the very beginning to think through how the CAP can add the greatest value to the project while minimizing time demands on its citizen volunteers. We expect there might be as many as four CAP meetings during the months of June and July, when most of the work on this project would presumably take place. CAP meeting agendas might conceivably include:

- An orientation to the goals and constraints of the project and the scope of work ahead;
- A review of existing knowledge and existing protections for critical areas that are in or are affected by the R-1 zone, and how they might be impacted by increases in density;
- A review of preliminary findings of the study, and their implications for recommendations;
- A review of preliminary recommendations for the draft report, due August 1.

During the same time period, team members would make further field visits to the City and the R-1 zone, as needed, and consult with local experts on key issues. The Project Manager would be available for briefings to the Planning Commission and City Council, or their individual members, as directed by City staff.

We would deliver our draft R-1 Area report by August 1 for review by staff, the CAP, the Planning Commission and the City's attorneys. The Project Manager and individual team members would be available to answer questions during this review. We anticipate attending at least one meeting of the CAP and the Planning Commission, perhaps in a joint session. By the end of the month, we would make final revisions to the R-1 Area report, based on comments from the review.

In September, we anticipate attending both a Planning Commission meeting and at least one meeting of the City Council to answer questions about the R-1 report, and to provide advice during their deliberations prior to the end of the six-month moratorium. We also would

begin drafting the City-wide report, working in consultation with City staff, the CAP, the Planning Commission and the City's attorney. We would provide a draft of this report by October 13, and a final report based on review comments by the end of the month. In November and December, we would again anticipate attending both a Planning Commission meeting and at least one meeting of the City Council, to answer questions about our report and provide advice regarding actions the City may take based on it.

Preliminary Budget

Given the uncertainty regarding the final scope of work, we have developed a tentative budget based on the full $150,000 the City has allocated for this project. After we meet with the City to discuss details of a final scope of work, including how some responsibilities may be shared between City staff and the consultant team, we may be able to offer a reduction in our proposed budget.

About 40% of our proposed budget is allocated to working directly with the CAP, Planning Commission and City Council. Close communication with all three bodies will be extremely important to the ultimate success of this project; however, the time allotted to briefing these parties and receiving their input and guidance could potentially be reduced.

Project success will be measured by the City's ability to implement our recommendations in a way that a substantial majority of interested citizens can understand and support, and by the measure's ability to withstand legal scrutiny if appealed to the Central Puget Sound Growth Management Hearings Board or the courts.

Title	Budget Allocation
Project Manager	$32,000
Hydrogeologist	$22,000
Civil/Stormwater Engineer	$12,000
Transportation Engineer	$12,000
Land Use Planner	$10,000
Fisheries Biologists	$12,000
Wildlife Biologists	$8,000
Wetland Biologists	$8,000
Tree Ecologist	$6,000
Limnologist	$20,000
GIS Technician	$8,000
Total	**$150,000**

Where individual team members play multiple roles, their contributions have been divided across those positions. Where multiple team members are subsumed under the same title, the budget allocation reflects their combined contributions. Budget allocations include administrative and other costs (e.g., mileage, copying, etc.).

Appendix A: Résumés

John Lombard

Senior Policy Analyst
2002- present

John Lombard is a senior policy analyst with more than 13 years experience in watershed management, basin planning, development regulations, intergovernmental coordination and endangered species policy. He currently manages our work advising clients on issues relating to salmon recovery, watershed planning and compliance with the Endangered Species Act, Growth Management Act and other state and federal regulations.

Recently, Mr. Lombard has been managing the firm's contracts advising local governments with updates of their critical area regulations. He also managed our contract to develop an Endangered Species Act Strategy for the City of Snohomish, which serves as a comprehensive strategy for the City to prioritize its resources to meet its environmental goals and comply with federal and state environmental laws, including the Clean Water Act, the Growth Management Act and the Shoreline Management Act, in addition to the Endangered Species Act.

Education

Bachelor of Arts with honors, 1983: Washington University, St. Louis, MO
Degree Emphasis: Politics, Philosophy and Economics.

Professional Background

King County Department of Natural Resources (KCDNR)
Senior Policy Analyst, Director's Office, 2000–2001

Oversaw development of Action Plan for the Sammamish River, which connects Lake Sammamish and Lake Washington. Advised King County water supply planners on issues related to salmon and watershed planning. Assisted development of King County Executive's Air Quality Initiative, to reduce emission of greenhouse gases and pollutants from county operations and facilities.

King County Department of Natural Resources (KCDNR)
Lake Washington Watershed Coordinator, 1996-2000

Led coalition of 30 local governments, public/private Steering Committee, scientists and interested citizens developing salmon recovery plan for the 700-square-mile Greater Lake Washington watershed. Created partnership of 20 local governments and Corps of Engineers to construct $2.4 million project at Ballard Locks to improve passage for juvenile salmon. Facilitated technical, citizen and government prioritization of $10 million of habitat projects in Lake Washington watershed for submittal to the Salmon Recovery Funding Board. Managed team of eight responsible for acquiring more than 1,500 acres of prime salmon habitat, identifying and prioritizing factors limiting salmon recovery in watershed, and managing and coordinating more than $2 million of research.

Metropolitan King County Council, *Legislative Analyst*, 1992-1996

Lead staff to King County Council on utility issues. Responsible for adoption of plans guiding land use and capital expenditures to protect salmon, improve water quality and reduce flood hazards in four stream basins covering 150 square miles. Led revision of policies governing water and sewer utilities in 1994 comprehensive plan. Annually reviewed $100-200 million budgets for Health and Public Works departments.

St. Louis Mayor's Office, St. Louis, MO, *Administrative Assistant to the Mayor*, 1985-1990

Developed policy, wrote speeches and served as community liaison for Mayor of St. Louis. Staffed Tax Reform Commission, which revised the city's entire system of business taxes and fees. Oversaw development of Hope House, one of largest transitional housing programs for homeless families in the country.

St. Louis Business Journal, St. Louis, MO, *Reporter*, 1983-1985

Reported on auto industry, Monsanto, court cases and other news and feature stories.

Golder Associates

Robert H. (Bob) Anderson, L.Hg.

Principal Hydrogeologist

QUALIFICATIONS

- Experience managing multi-disciplinary water supply and watershed management teams
- Experience working with stakeholder groups and multiple technical and policy objectives
- Familiarity and experience with characterization of aquifer systems throughout Central Puget Sound
- Familiarity with urban, residential, and agricultural issues related to land use, water quality, and groundwater

YEARS OF EXPERIENCE: 20

EDUCATION

B.S. Geology, University of Washington, Washington, 1983.

M.S. Geology, University of Wisconsin, Milwaukee, Wisconsin, 1987.

AFFILIATIONS

Registered Washington Professional Geologist :, Hydrogeology Specialty license #636

SELECTED PUBLICATIONS

Anderson, R., 2002. Conjunctive Use and River Enhancement (CURE): Integrated use of ground water and surface water for habitat enhancement and consumptive use. AWWA Pacific Northwest Chapter Annual Conference, Eugene, OR.

Dugan, R., and Anderson, R. H., 2000. Groundwater Exploration in Alaska. American Water Specialty Conference Proceedings: Water resources in Extreme Environments. Anchorage, Alaska, April 2000.

Anderson, R.H., 1999. The Importance of Groundwater to Municipal Water Supply in Washington. American Water National Conference Proceedings: Watershed Management to Protect Declining Species. Seattle, WA, Dec. 1999.

Anderson, R.H., 1997. Development of Groundwater Resources - Issues and Approaches for Mitigation of Streamflow Impacts, 2nd Annual Symposium on the Hydrogeology of Washington State. Olympia, WA, September, 1997.

Anderson, R.H., 1995, Beyond Water Witching, Civil Engineering, July, 1995.

Mr. Anderson is a Principal Hydrogeologist at Golder Associates with over 20 years experience in water resources characterization and planning, focused primarily in the Pacific Northwest. He has completed significant water resources assessments and technical projects involving the assessment and protection of groundwater and surface water sources in collaboration with local planning committees, technical advisory groups, and regulatory agencies. He was an invited member of a technical panel supporting Washington Department of Ecology policy on the issue of surface water impacts from groundwater withdrawals. He has completed wellhead protection plans, groundwater management plans, watershed plans, habitat conservation plans (HCP), aquifer storage and recovery (ASR) projects, and many technical hydrological assessments.

Relevant topical experience

Mr. Anderson has addressed water resource issues from both a physical standpoint (resource issues) and jurisdictional standpoint (regulatory management issues). He has evaluated relationships between streamflows, groundwater levels, development patterns, and climatic cycles that are relevant to the Pacific Northwest. He has addressed water supply vulnerability as a common component of water supply planning, and for implementation of regulatory programs that require characterizing vulnerability at a local level. Mr., Anderson has prepared groundwater management plans and wellhead protection plans that quantify, to varying degrees and levels of detail, vulnerability to both water quality and water quantity. Mr. Anderson is currently under contract to Snohomish County to address Critical Aquifer Reacharge Area (CARA) elements of the County's Critical Areas Ordinance.

Cross Valley Water District Wellhead Protection Plan Snohomish, Washington

Project Manager for wellhead protection plan for the Cross Valley Sole Source Aquifer. Objective of the project was to delineate wellhead protection areas around 10 municipal supply wells, conduct an inventory of potential contaminant sources and develop management strategies. Work involved developing conceptual hydrogeologic model, constructing a hydrogeologic database, preparing a groundwater flow model and capture zone delineation, and conducting an inventory of potential contaminants. The contaminant inventory included a risk analysis using EPA methods and was automated in a database/GIS format to allow updating. Wellhead protection strategies were also evaluated including development of contingency plans, spill response plans, and public involvement plan.

Critical Aquifer Recharge Area Delineation Everett, Washington

Delineated critical aquifer recharge areas for Snohomish County. Collaborated with aquifer protection committee and developed mapping approaches and regulatory framework based on compilation of similar recharge protection programs throughout the Pacific Northwest. Calculated fixed radius wellhead protection areas for every Group A and B water system in Snohomish County. Developed a checklist system that addressed aquifer protection issues for County permitting processes.

Western Snohomish County Groundwater Management Plan Washington

Appendix A:

Resumés

Golder Associates

Robert H. (Bob) Anderson, L.Hg.

Principal Hydrogeologist

QUALIFICATIONS

- Experience managing multi-disciplinary water supply and watershed management teams
- Experience working with stakeholder groups and multiple technical and policy objectives
- Familiarity and experience with characterization of aquifer systems throughout Central Puget Sound
- Familiarity with urban, residential, and agricultural issues related to land use, water quality, and groundwater

YEARS OF EXPERIENCE: 20

EDUCATION

B.S. Geology, University of Washington, Washington, 1983.

M.S. Geology, University of Wisconsin, Milwaukee, Wisconsin, 1987.

AFFILIATIONS

Registered Washington Professional Geologist :, Hydrogeology Specialty license #636

SELECTED PUBLICATIONS

Anderson, R., 2002. Conjunctive Use and River Enhancement (CURE): Integrated use of ground water and surface water for habitat enhancement and consumptive use. AWWA Pacific Northwest Chapter Annual Conference, Eugene, OR.

Dugan, R., and Anderson, R. H., 2000. Groundwater Exploration in Alaska. American Water Specialty Conference Proceedings: Water resources in Extreme Environments. Anchorage, Alaska, April 2000.

Anderson, R.H., 1999. The Importance of Groundwater to Municipal Water Supply in Washington. American Water National Conference Proceedings: Watershed Management to Protect Declining Species. Seattle, WA, Dec. 1999.

Anderson, R.H., 1997. Development of Groundwater Resources - Issues and Approaches for Mitigation of Streamflow Impacts. 2nd Annual Symposium on the Hydrogeology of Washington State, Olympia, WA, September, 1997.

Anderson, R.H., 1995. Beyond Water Witching, Civil Engineering, July, 1995.

Project manager for development of management plan including groundwater flow and water quality evaluations, risk assessment, and interaction with a 35-member Groundwater Advisory Committee. A geohydrology assessment identified and prioritized potential groundwater impacts throughout the County, which includes urban, rural, agricultural and forest land-uses. Technical analyses were presented regarding groundwater use, stormwater and wastewater infiltration, and groundwater vulnerability to contamination from many sources including commercial/industrial facilities and transportation spills. The technical work was completed largely within the ARC/INFO GIS software and using existing coverages for the project area.

Snohomish County Comprehensive Plan Support Everett, Washington
Prepared Groundwater section of Comprehensive Plan and evaluated land use effects on aquifer recharge and baseflow to streams. Analysis relied on GIS database containin g land use and land cover characteristics for various alternatives, combined with surface hydrologic modeling conducted by the county.

Lower Issaquah Valley Wellhead Protection PlanIssaquah, Washington
Project Manager for wellhead protection plan for the Lower Issaquah Valley. Objective of the project was to delineate wellhead protection areas around six municipal supply wells. Work involved developing conceptual hydrogeologic model, groundwater flow modeling and capture zone delineation, installation of monitoring wells, water-level and water quality monitoring program, inventory of potential contaminants, evaluation of wellhead protection strategies, development of contingency plans, spill response plans, and public involvement plan.

Grand Ridge Development Groundwater Analysis Issaquah, Washington
Performed several water quantity and water quality analyses of possible impacts from a proposed urban development on an aquifer recharge area: A probability-based mass-balance water quality analysis to assess sewer options and stormwater infiltration scenarios; Geophysical exploration to evaluate stratigraphy and identify preliminary locations for proposed stormwater infiltration facilities; and Groundwater flow modeling to evaluate possible groundwater quantity impacts resulting from the development

Aggregate Site Permit -Third Party Review Snohomish Co., Washington
Third-party technical review of hydrogeologic aspects of an Environmental Impact Statement (EIS) for a proposed expansion of the High Rock Gravel Mine near Monroe. The High Rock site is located near domestic water supplies and wetlands and was the site of a rare "aquifer break" in 1992. An independent analysis of the hydrogeology was conducted and recommendations for permitting conditions were submitted to Snohomish County. The findings of the review and recommendations were submitted to a hearings examiner and testimony was presented during an appeal of the EIS.

Cross Cascade Pipeline EIS Snohomish, Washington
Project manager for development of initial response comments for an Environmental Impact Statement proposed to route a gasoline pipeline through wellhead protection areas and a sole source aquifer in Snohomish County. Response was expanded for submittal as testimony for hearings regarding the proposed project.

Dean Franz, PE — Surface Water Manager

Education:
BS, Civil Engineering / Walla Walla College
Registration:
Professional Engineer, Washington 1990, Idaho 2000

Dean Franz has more than 21 years experience in designing and managing both public and private sector civil engineering projects. Dean is a recognized leader in Low Impact Development (LID) techniques. He has provided LID presentations to several organizations, including the City of Redmond, City of Kirkland, City of Snoqualmie, and the North Puget Sound Drainage Group. Dean worked with the City of Snoqualmie on providing Low Impact Development (LID) design alternatives. He has provided the city with a detailed analysis on LID techniques, an impact assessment compared with conventional drainage design, and cost comparisons for utilizing LID techniques for road collectors and single-family residential neighborhoods. He served as an advisor on the committee for determining LID Credits in drainage analysis, as part of the Washington Department of Ecology storm water program.

Relevant Project Experience

Snoqualmie Ridge II – Low Impact Development, Snoqualmie, WA

Owner Contact: Nancy Tucker, Sr. Planner
Owner Ph. (425) 888-5337

This project entailed preparing low impact development (LID) drainage standards to be implemented by the City of Snoqualmie, for the goal of achieving a high level of stormwater quality management and environmental protection of the receiving waters. Dean worked with City staff on preparing development standards, and he gave presentations at public meetings on the benefits and uses of LID techniques for surface water management. These presentations were made at the Planning Commission and City Council meetings. The work also included doing an environmental study on the benefits of LID, and preparing construction cost comparisons using LID techniques as compared with conventional drainage design.

Dean coordinated with multiple-interdisciplinary teams on this project, including a wetland biologist, stream biologist, hydrogeologist, planner, land-use attorney, and landscape architect.

Ash Avenue Park-n-Ride – Marysville, WA

Owner Contact: Jeff Massie, Asst. City Engineer
Owner Ph. (425) 651-5100

Dean designed the drainage system, stormwater quality treatment system, pavement with brick pavers, the sanitary sewer and grading for this park-n-ride, using Low Impact Development (LID) techniques. This resulting in a construction cost savings of over $300,000 for drainage facilities on the project. Brick paver areas were utilized to dispose of stormwater and to provide water quality treatment using an amended soil media beneath the pavers. Dean also designed a sanitary sewer pump station and force main to serve the surrounding residential properties.

Low impact pavement design

Appendix A:

Resumés

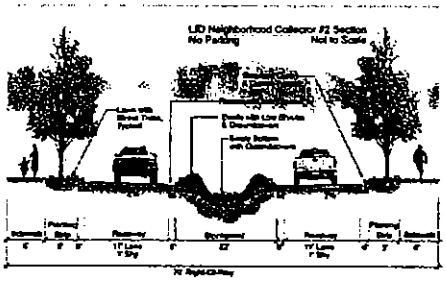
Dean coordinated with multiple-interdisciplinary teams on this project, including an electrical engineer, and maintenance staff at the City.

This project received the ACEC Silver Award for "Exceeding Client Needs", 2004.

51st Avenue at 108th Street – Snohomish County, WA

Owner Contact: Bruce Duvall, PE

Owner Ph. (425) 388-6404



LID Road Section

Dean designed the drainage system using a rain garden in the center of the roundabout. The rain garden is a Low Impact Development (LID) technique that provides water quality treatment and shallow-depth detention for the management of stormwater. This provided a landscape area in the road corridor that was aesthetically positive and well received by the County. Dean also conducted a backwater analysis for the upgrading of an existing storm trunk pipe system that conveyed stormwater from the surrounding area through the intersection. Dean coordinated with multiple-interdisciplinary teams on this project, including environmental and maintenance staff at the County.

Appendix A:

Resumés

Joel Birchman, PE Role: Public / Private Investment Strategy

Joel Birchman has more than 32 years of experience in the public and private sector. As Vice President at Perteet, he provides oversight and leadership especially in the areas of municipal services and developing and administering funding opportunities for our clients. He has solid credentials as an accomplished project manager and utility designer engineer. He has an in-depth background in permitting and multi-agency coordination as well as the right-of-way acquisition process and coordination of all record keeping so necessary for a project to remain in compliance with governing agency standards.

Joel has worked extensively with ISTEA, TIB, FEMA, and HUD Block Grant programs. Under these programs, he has prepared grant applications, supervised preparation of construction documents, prepared invoices, and successfully completed the federal and state audit process. Joel provides the record keeping systems for these projects to ensure that all guidelines of the grant regulations were being met. Joel has a unique understanding of federally funded projects. In addition to administering federally funded projects, Joel and his staff have helped clients obtain more than $46 million in grant funding in the last five years

Relevant Project Experience:

- Transportation, Utilities, and Capital Facilities Plan Elements for the GMA Comprehensive Plan – Woodinville, WA. While at the City of Woodinville, Joel led the effort and the Citizens Advisory Panels in the development of its first Transportation, Utilities, and Capital Facilities Plan Elements for the GMA Comprehensive Plan. Because of the quality and thoroughness of the Woodinville Comprehensive Plan, the state's Department of Community, Trade, and Economic Development uses the Woodinville Comprehensive Plan as a model for newly incorporated cities.
  At the completion of the comprehensive planning process the City of Woodinville began the process to annex the Grace area north of the City and across the King-Snohomish County line. As part of the annexation study, Joel identified the infrastructure financial, capital, and service impacts. This study included the storm water utility, gas tax, and development permit revenues that could result from the annexation. There were also numerous coordination issues that had to be resolved with the existing special purpose districts within the annexation area.
- Cemetery Creek Trunk Sewer Feasibility Study – Snohomish, WA. Joel completed the Cemetery Creek Trunk Sewer Feasibility Study for the City of Snohomish. This study looked at the feasibility of extending a 24-inch trunk sewer into the unincorporated areas within the City's GMA growth boundary. The cost of construction and financing of the trunk sewer were not only determined, but the study also projected the offsetting revenues from connection fees, utility rates, development fees, and property taxes.
- 48th Avenue Sewer Extension, Water Main Replacement and Roadway L.I.D. – Mountlake Terrace, WA. Joel administered the Local Improvements District for a major street widening project and the design of sanitary sewer extensions to areas within the City that were not currently receiving sanitary sewer service. The project included the installation of over one mile of 12-inch water transmission line. The L.I.D. was combined with F.A.U.S. funds to finance this project. This project received the 1991 Local Program of the Year award from APWA/WSDOT due to the combining of four different funding sources, its design challenges, and project management.

Appendix A:

Resumés

Patricia Love — Project Manager, Environmental and Community Planning

Patricia is an expert in Comprehensive Plan Amendments, Subarea Plans, Zoning Code Amendments, and State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA) compliance.

Patricia Love brings 16 years of planning and environmental review experience to Perteet Inc. As the Senior Planner for the City of Mukilteo, Patricia was responsible implementing the directives of the Growth Management Act by preparing Comprehensive Plan Amendments, Subarea Plans, Zoning Code Amendments, Environmental compliance at the State and Federal level, and policy changes while working interactively with the City Council, Planning Commission, and citizen groups.

Her community planning experience continued to expand at Perteet. While at Perteet she helped prepare the Arlington Transportation Plan Element on their comprehensive plan, drafted a critical areas ordinance for Oak Harbor, and drafted a re-write of the City of Mukilteo's wetland ordinance in response to a Growth Hearings Board remand decision.

Patricia brings an understanding and background of interagency coordination at the State and local agency levels working with Snohomish County, Washington State Community Trade and Economic Development, Department of Ecology, Washington Department of Fish and Wildlife and Department of Natural Resources, and the Washington State Department of Transportation.

Relevant Project Experience:

Comprehensive Plan – Mukilteo, WA

As the leader of the City Comprehensive Plan Amendment team, Patricia prepared and managed major rewrites and updates to the City's Comprehensive and Harbour Pointe Master Plan for nearly ten years. Updates included revisions to the land use, critical areas, housing, parks, utilities, and transportation elements. This work required coordination with the local sewer, water, and school districts, as well as with County and State representatives. In addition to preparing the proposed amendments, Patricia was responsible for ensuring that each of the Comprehensive Plan updates was compliant with the Growth Management Act, environmental requirements, and public review processes. Public involvement included presenting the Comprehensive Plan updates and amendments at workshops, open houses, Planning Commission and City Council public hearings, and to citizen organizations.

With the 2004 Comprehensive Plan update, Patricia lead the City's efforts to determine if they City met the State's urban density definition of four units per acre. This effort involved preparing a land use inventory of the Single Family Residential RD 12.5 zone. Land uses inventoried included: critical areas, parks and open space, roadways, storm drainage facilities, and public utilities. To determine if the City was compliant with the Hearings Board guidance on urban densities, all of the inventoried items were subtracted from the gross land area. This analysis in a net buildable land area, which resulted in slightly less than four units per acre. As a result Reasonable Measures, such as a cottage housing ordinance, was adopted by the City. These Reasonable Measures would allow and increase in the underlying density without compromising the general character of the neighborhoods.

Harbour Pointe Master Plan Update - Mukilteo, WA

For ten years, Patricia was the City's project manager on preparing amendments to and implementing the Harbour Pointe Master Plan. Harbour Pointe is a 2,350-acre Master Planned Community located in the southern

portion of the city, with approximately 4,600 housing units, 420,000 square feet of commercial/retail development, 3.3 million square feet of industrial space, four schools, a library, and around 500 acres of open space.

As project manager, Patricia prepared amendments to the Master Plan and the various segregated 'sectors' for specific land use, density, critical areas, transportation facilities, open space, drainage alternatives, and utilities. As the City's project manager, she managed and processed amendments to the Master Plan consistent with city policies and regulations; analyzed wetland, fish and wildlife, geotechnical, traffic reports to evaluate land use alternatives, and determined what type of mitigation would be necessary to approve the selected land use alternatives. Patricia was responsible for processing the Master Plan through the City's public review process, issued environmental determinations, prepared staff reports, findings, and recommendations. Final approval was through presentations to the Planning Commission and City Council at public hearings.

Subarea Plan Amendments and Creation of Development Standards - Mukilteo, WA

Patricia was the project manager responsible for three major successive subarea plan amendments and adoption of corresponding development standards. These projects required coordinating between the property owner, consultants, City departments, interested public and community groups, and outside agencies. The subarea plans and development standards were negotiated and then reviewed through a public process, which included environmental review, public hearings, Planning Commission review and final adoption by the City Council. As project manager, Patricia was responsible for negotiating and drafting development regulations acceptable to both the City of Mukilteo and the property owners. Development regulations drafted through implementing ordinances addressed a range of standards including: permitted uses; residential density, residential and commercial development standards; landscaping, buffers, transition zones, open spaces, parking, roadway standards, trail standards, building and plaza design guidelines, signage, sensitive/critical area mitigation, airport compatibility, and modification and flexibility options.

This in-depth level of planning analysis and environmental assessment allowed future development to occur without additional studies or environmental review. The end result allowed a submitted proposal to be permitted out rightly if it met the minimum requirements of the approved plan - no addition environmental review, studies, or public hearings were required.

- Boeing Development Agreement, Approved April 2004: Project rezone and Comprehensive Plan Amendment from Industrial Park to Single Family Residential with development options to build up to 150 standard single family residential, compact, or cottage housing units on a 40-acre parcel.
- Mukilteo Town Square Development Agreement; Approved December 2002: Project rezone and Comprehensive Plan Amendment from Industrial Park to Planned Community Business to allow a neighborhood shopping center (up to 250,000 square feet) on approximately 25 acres of land next to the Mukilteo Speedway.
- Village Center Development Agreement; Approved October 1998 (PSRC Vision 2020 Award): Project rezone and Comprehensive Plan Amendment from Industrial Park to Planned Community Business to allow a mixed-use community consisting of small lot single family residential units, multi-family apartments / condominium units, open space, trails and mixed-use commercial retail space on 135 acres.

Appendix A:

Resumés

Zoning Code Amendments – Mukilteo, WA

Patricia Love, in her capacity as Senior Planner at the City of Mukilteo, provided current and long range planning and SEPA expertise. Her knowledge of current planning was an asset and used to understand how policy and regulations affect the built environment. Patricia was the City's lead planner on writing and implementing the City's zoning and development code developments for ten years. Major land use code amendments included:

- Mukilteo Zoning Code Update (Integration of Snohomish County zoning standards into the City's regulation after an annexation)
- Critical Areas Code Amendments: Fish and Wildlife, Wetlands, Geologic Sensitive Areas Regulations
- Cottage Housing Ordinance
- Project Permit Processing (Original and Update)
- School and Park Impact Fees
- SEPA / GMA Integration Ordinance
- Wireless Communication Facilities
- Permitted Use and Bulk Regulations
- Sign Code
- Assisted with the Downtown Business District Design Standards
- City Engineering Development Standards Resolution

Zoning Code Amendments – Perteet Inc.

As a Project Manager for Perteet Inc., Patricia has continued working on Comprehensive Planning and Zoning Code Amendments for various agencies within the Puget Sound area. Patricia helped with the City of Arlington's Transportation Plan Element of the City's Comprehensive Plan, she wrote the Geologic Sensitive Areas Ordinance for the City of Oak Harbor, and she drafted an update to the City of Mukilteo's Wetland Ordinance that was approved by the Central Puget Sound Growth Hearings Board.

Cleveland R. Steward, III

Principal

1992- present

Steward and Associates principal and lead scientist Cleve Steward is a fisheries scientist and consultant with over 25 years experience and education in salmon and trout ecology and management, both as a government employee and as a consultant. His firm – Steward and Associates – provides technical assistance in analyzing environmental impacts, complying with governmental regulations, and resolving conflicts involving fisheries and aquatic resources, with emphasis on water management, watershed analysis, habitat restoration, and fisheries research and management.

Mr. Steward serves in a variety of roles providing technical analysis and policy guidance on salmon recovery, delisting criteria, limiting factors, and habitat restoration measures. He has extensive experience in the fisheries management field and has undertaken numerous projects for federal and state agencies, Indian tribes, universities, private firms, and environmental groups from throughout the region. He is a recognized authority on the habitat and migratory requirements of juvenile salmonids and has broad expertise in freshwater ecology and fisheries management. He is frequently solicited to provide expert opinion and help resolve conflicts involving fisheries and aquatic resources, including surface water management, watershed impacts, salmon hatchery impacts, salmon smolt passage survival and behavior, and monitoring and evaluation techniques.

Education

Ph.D. Candidate, Dissertation in progress: University of Idaho, Moscow, ID
Degree Emphasis: Fishery Science

Master of Science, 1983: University of Washington, Seattle, WA
Degree Emphasis: Fishery Science

Bachelor of Science, Summa cum laude, 1978: University of Montana, Missoula,
Degree Emphasis: Wildlife, Aquatic Option

Professional Experience

Steward and Associates, Snohomish, WA.

Principal, 1992- present

Owner and lead consultant in a firm that specializes in fisheries management, ESA recovery and compliance planning, biological assessments, research design and implementation, Columbia River and Puget Sound fisheries issues, dam-related impacts and relicensing, dispute resolution, and programmatic review for public agencies, Indian tribes, and non-profit conservation groups. Clients include the Bonneville Power Administration, National Marine Fisheries Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, Northwest Power Planning Council, various Indian tribes (Nez Perce, Yakama, Cowlitz, Quileute, and Skokomish) Seattle Aquarium, Seattle Public Utilities, University of Washington, Boeing, Save Our Wild Salmon, Trout Unlimited, American Rivers, URS, various law and engineering firms, and others. Responsible for several contracts; author of key publications.

In 2000, Mr. Steward was appointed by the National Marine Fisheries Service to serve as a scientific advisor to federal and state agencies engaged in the recovery of threatened and endangered salmon and steelhead in the Willamette and Lower Columbia Rivers. Mr. Steward also serves on the Greater Lake Washington Watershed Steering Committee and Technical Committee. He also serves as technical advisor to Bonneville Power Administration on matters of implementation and compliance with habitat provisions set forth in the current Biological Opinion for Federal Columbia River Power System. Mr. Steward has also worked extensively with the

Appendix A:

Resumés

Lower Columbia River Fish Recovery Board, supervising watershed assessment work in support of salmon recovery planning in 5 counties in southwest Washington.

Sustainable Fisheries Foundation, Snohomish, WA
Executive Director, 1994- Present
Co-founded an international (U.S. and Canada) 501(c)(3) research and education foundation in 1994 to promote a balanced approach to fisheries resource management and use, so that Pacific salmon and trout populations remain viable, productive, and accessible to future generations. The SFF works closely with other non-governmental and scientific organizations on a number of salmon-related initiatives, most notably the development of a Sustainable Fisheries Strategy for West Coast Salmon and Trout Populations; the Timber, Fish and Wildlife process in Washington State; and the King County Watershed Resource Inventory Area (WRIA) 8 (Greater Lake Washington Watershed) Conservation Plan.

As Director of the SFF, Mr. Steward provides scientific oversight and represents the interests of the environmental community in salmon recovery planning and watershed assessment and management processes. He sits on the WRIA 8 Steering Committee and the King County Technical Advisory Committee to direct Limiting Factors Analysis and Conservation Plan development for WRIA's 7, 8, and 9.

For his efforts on behalf of salmon conservation, Mr. Steward was named co-recipient of the President's 1997 Conservation Award, presented by the American Fisheries Society.

Dustin Hinson

Fisheries Biologist II/Wetland Ecologist
2002-Present

Dustin R. Hinson is a fisheries biologist and wetland ecologist with an advanced degree in aquatic ecology. He is Steward and Associates' lead wetland ecologist and has completed the Army Corps of Engineers Wetland Delineation and Management Training Program. Mr. Hinson has worked extensively with local governments, tribes, state and federal agencies, non-governmental organizations, and universities in managing a variety of wetland and fisheries projects that include technical field surveys and delineations, assessment of habitat function, design of mitigation and aquatic restoration plans, and analysis of environmental impacts to aquatic species and habitats.

Education

Master of Science, 2003: University of Idaho, Moscow, ID
Degree Emphasis: Environmental Science (Aquatic Ecology)

Bachelor of Science, 1999: University of Idaho, Moscow, ID
Degree Emphasis: Fishery Resources (Management Option)

Continuing Education

Preparing Shoreline Characterizations for SMP Updates, Workshop - 2006
Coastal Training Program, Washington State
Certified Wetland Delineator and Manager, 2003
Richard Chinn Environmental Training, Inc.
Army Corps of Engineers Wetland Delineation and Management Training Program

Professional Background

Idaho Power Company, Boise, ID, *Consulting Fisheries Biologist*, 2002

Prepared a written report regarding the status of an endangered aquatic snail species occurring in the Middle Snake River of southern Idaho. Job duties included using a GIS, personal communication, literature search, data manipulation, statistical analysis, and technical report writing.

University of Idaho, Moscow, ID, *Graduate Research Assistant and Teaching Assistant*, 2002

Characterizing the benthic sediment and associated aquatic communities in the mid-Snake River, Idaho. This work included data processing, supervision of lab technicians, analyses, manuscript and report writing. Teaching assistant for a graduate level aquatic restoration ecology course.

University of Idaho, Moscow, ID, *Graduate Research Assistant*, 2000-2001

Collected benthic sediment, aquatic macrophytes, and aquatic macroinvertebrates to assess various point-source impacts on the mid-Snake River, Idaho. This work included organizing and leading a field crew, operating a prop-powered river vessel, and measuring and recording water quality/community data.

University of Idaho, Moscow, ID, *Fisheries Field and Laboratory Technician*, 1997-2000

Identified aquatic macrophytes and aquatic macroinvertebrates and calculated various diversity indices. Quantified attached benthic algae communities through chlorophyll analysis. Field duties included operation of a Smith-Root electrofishing vessel, netting and identification of fishes, measuring and recording meristics, extraction of stomach contents, trolling for larval fish, gill netting, and radio telemetry. Laboratory duties included extraction of otoliths, and identification of fish stomach contents and benthic macroinvertebrate samples.

Appendix A:

Resumés

Cooke Scientific

4231 NE 110TH STREET
SEATTLE, WA 98125
COOKESS@AOL.COM

PHONE: (206) 695-2267
FAX: (206) 368-5430
WWW.COOKESCIENTIFIC.COM

Sarah Spear Cooke, Ph.D.

Wetlands Ecologist, Soil Scientist, Plant Ecologist and Taxonomist

Expertise

- Wetlands creation, restoration, and enhancement , CAD design and implementation
- Wetlands delineation and delineation methodology instruction
- Invasive weed identification and development of control strategies, control manuals, and field oversight of control efforts
- Regulatory and Permitting Assistance, on local, state and national levels
- Wetland Functional Evaluation, including the "SAM" method and a botanical expert on the development of the State wetland manual
- Masters in Botanical taxonomy, Doctorate in Botany and soils, specializing in wetland plants
- Author *A Field Guide to the Common Wetland Plants of Western Washington & Northwestern Oregon,* published by the Seattle Audubon Society
- Certified soil scientist (hydric soils), soils mapping and classification
- Watershed Analysis
- Rare plant surveys and mapping
- Mine reclamation ecology and uplands restoration

Dr. Cooke has 19 years of experience in wetlands ecological research and environmental consulting, and 20 years of experience in ecological and geological research, in the Pacific Northwest. She specializes in habitat creation, restoration and enhancement projects, both in design and implementation. She excels in permitting assistance on the local, state, and national level. She was a co-senior investigator for the Puget Sound Wetland and Stormwater Management Research Program, a 10-year total wetland ecosystem study conducted under the auspices of the Environmental protection Agency, The US Geological Survey, Washington State, and King County in Washington State. Dr. Cooke's areas of expertise include: wetland and stream inventories, delineation, restoration/mitigation designs, baseline studies, permitting, and monitoring programs; weed identification and control; rare plant surveys and vegetation mapping; soil assessments; watershed analysis; and environmental assessments in the region. She has more experience in developing assessment methodologies than any other private wetlands consultant in the PNW. She has extensive experience in classroom instruction of wetlands ecology, restoration ecology and implementation, delineation protocols, functional assessment, weed identification and control, hydric soils, and wetland plant identification. She has 16 years experience in managing multidisciplinary teams, supervising subcontractors, and generating reports, and marketing from a consulting perspective. She currently teaches restoration ecology and implementation, wetland botany, and weed ecology and control at Portland

State University. She is a former instructor for the Wetland Certification Program at the University of Washington and Wetland Ecology and Science for the graduate program at the Evergreen State College. She is also the senior author/editor of the *A Field Guide to the Common Wetland Plants of Western Washington & Northwestern Oregon.*

Education

Ph.D., University of Washington, Dissertation title: The Edaphic Ecology of Two Northwest American Composite Species. Major: Botany, Geology, and Soils; minor Statistics, Plant Physiology, and Genetics

M.S., Plant Taxonomy, University of Washington, 1987.

Honors Degree, Geobotany, McGill University, 1979.

B.S., Biology and Geology, McGill University, 1979.

Undergraduate studies in Biology and Geology at Purdue University 1974-76.

Experience

- Self-employed, Cooke Scientific. Seattle Washington. Projects include wetland mitigation (restoration, enhancement, and creation), wetland delineations, weed identification and control, wetland inventories, wetland functional assessments, wetland and sensitive areas permitting (federal, state and local jurisdictions), rare plant surveys, vegetation and soil mapping, environmental evaluations, environmental impact statements, watershed analysis, and mine reclamation, third party regulatory review for various small jurisdictions. 2003-present.
- Instructor, Washington State Wetland Rating System in Western Washington. Coastal Training Program, Washington State Department of Ecology, classroom instruction, and field trips. 6-class contract, 2005- 2006.
- Instructor, Weeds of the Pacific Northwest. Portland State University, Portland, Oregon. Syllabus development, classroom instruction, and field trips. Summer 2004.
- President Pacific Northwest Chapter Society of Wetland Scientists. May1999- May 2000. Executive Vice President SWS PNW Chapter 1998-1999.
- Instructor, WNPS Native Plant Stewardship program, King, Snohomish, Pierce Counties, Washington Native Plant Society, Syllabus development, classroom instruction, Fall 1996- present.
- Instructor, Habitat Restoration, Portland State University, Portland, Oregon. Syllabus development, classroom instruction, and field trips. Fall 1998- present.
- Owner, Cooke Scientific Services, Inc. Seattle, Washington. Principal Scientist and President of company. Projects include wetland mitigation (restoration, enhancement, and creation), wetland delineations, wetland inventories, wetland functional assessments, wetland and sensitive areas permitting (federal, state and local jurisdictions), rare plant surveys, vegetation and soil mapping, environmental evaluations, environmental impact statements, watershed analysis, and mine reclamation in upland and wetland areas. 1995-2003.
- Instructor, Wetland Plants of the Pacific Northwest; Winter trees and shrubs; and Grasses, Sedges, and Rushes. Portland State University, Portland, Oregon. Syllabus development, classroom instruction, and field trips. Spring 1998- present.

Appendix A:

Resumés

- Principal Scientist, wetlands group, Pentec Environmental Inc., Edmonds, Washington. Started, marketed, and managed the wetlands group. Projects included wetland mitigations (restorations, enhancements and creations), wetland delineations, wetland inventories, wetland functional assessments, wetland and sensitive areas permitting (federal, state and local jurisdictions), rare plant surveys, vegetation and soil mapping, environmental evaluations, environmental impact statements, watershed analysis, mine reclamation in upland and wetland areas. 1990 – 1995.

Awards

- International fellow. Society of Wetland Scientists. Dr. Cooke was one of three internationally scientists recognized by the SWS for our contributions to Wetland Science. 2003.
- Elected President, Society of Wetland Scientists, Pacific Northwest Chapter. 1999-2000.
- Best Paper Award. International Serpentine Conference, Society of Serpentine Ecology. 1999.
- Sigma Xi, Forestry Society. Elected to be a member of the Washington State Chapter of Sigma Xi, the professional Foresters Society. 1994.

C. Michael Falter, PhD

May, 2006

Limnology & Aquatic Ecology

Professor Emeritus, University of Idaho, Dept. of Fish & Wildlife Resources
736 Homestead Place, Moscow, ID 83843-3241
Voice/Fax 208-882-3676 cmfalter@moscow.com

Aquatic Ecology Specialist in Lakes, Streams, and Reservoirs

- Environmental assessment & controlling factors analysis
- Lake ecology & management
- Organism identification & population monitoring
- Ecological restoration analysis & planning

Dr. Falter specializes in domestic and international activities in aquatic ecology where multi-disciplinary and teamwork approaches, often with engineering and hydrological specialists, are emphasized.

Education:

B.S.	Kansas State University	1964	Fish and Wildlife Biology
M.S.	University of Pittsburgh	1966	Limnology
Ph.D.	University of Idaho	1969	Fisheries and Aquatic Sciences

Professional Experience:

Professor of Limnology and Aquatic Ecology, College of Natural Resources, University of Idaho, Moscow, Idaho, 1969-2002; Emeritus Professor since 2002.
Responsibilities included developing research programs in aquatic resources as well and teaching upper division and graduate courses in the aquatic sciences. Research and teaching was in limnology, aquatic ecology, and management of lakes, streams, and reservoirs.

Career Emphasis Areas:

Lake and reservoir ecology
Stream and river ecology
Aquatic pollution ecology
Assessment of specific aquatic impacts on fish and other aquatic organisms
Biomonitoring
Eutrophication response of lakes, streams, and reservoirs
Water body management planning

Dr. Falter designed and led more than 100 limnological projects on lakes, streams, and reservoirs of the United States, Africa, and Australia from 1969-2006. These projects, conducted for a variety of federal, state, regional, and private entities, detailed aquatic ecology, assessed sediment and nutrient loading, and designed management plans for long-range optimization of water body uses.

At the University of Idaho, Dr. Falter developed and taught undergraduate and graduate courses including Limnology, Aquatic Pollution Ecology, Wildland Field Ecology, International Land Use Planning, Fish Biology, and Aquatic Restoration Ecology. Since leaving the University of Idaho, he has continued these research and management issues on a number of projects for public and private entities.

He has been active in continuing education for federal, state, and industrial resource managers *via* workshops and continuing education courses. He guided 55 Master's and Doctoral students as major advisor and continues with graduate and Web-based teaching since leaving the University.

Appendix A:

Resumés

Michael Maher

Biologist I/GIS Technician
2005-Present

Michael Maher is a GIS analyst and ecologist with extensive experience working with data related to salmon populations and recovery planning. With a background in ecology and conservation biology, Mr. Maher has also developed substantial expertise in statistical analysis, scientific writing, database management, and implementing GIS-based methods of environmental problem solving. Mr. Maher has worked extensively with the Lower Columbia / Upper Willamette Technical Recovery Team and as part of this work, he has compiled, developed and analyzed GIS and ecological data necessary for salmon recovery planning in the Pacific Northwest. Mr. Maher is experienced working with data types including vector data, GRID data, remotes sensing imagery, and other appropriate data layers for identifying conservation priorities.

Education

Bachelor of Science, 2003: University of Washington, Seattle, WA
Degree Emphasis: Biology

Continuing Education

Preparing Shoreline Characterizations for SMP Updates, Workshop - 2006
Coastal Training Program, Washington State

Professional Background

NOAA Fisheries / NWFSC, Seattle, Washington
Research Biologist, 2003-2005

Received a post-educational fellowship to conduct work and research with NOAA Fisheries. Worked to create a GIS database of the historical salmonid populations for the Willamette / Lower Columbia Technical Recovery Team involving the collection, editing and compilation of numerous hydrologic and biologic datasets. Created a map oriented "habitat atlas" for all the watersheds and concurrent ESA listed salmonid populations in the Willamette / Lower Columbia Recovery Domain. The task involved compiling a list of potential data types and sources, assessing data quality, developing consistent approaches and protocols for analysis, contacting key personnel, acquiring data and performing GIS analyses. The final product is a book of maps along with their accompanying text, charts and tables (due to be published by NOAA Fisheries in 2005). Worked on the Lewis River Case Study Project with a team of fisheries biologists to develop a Decision Support System which analyzes a suite of model outputs and restoration scenarios to help watershed managers with difficult recovery planning decisions.

University of Washington, Seattle, Washington
Research Assistant, 2001-2003

Experience in HPV laboratory doing research procedures, gels, dishwashing, autoclaving, database/computer manipulation, slide making/filing. Experience with handling hazardous chemicals and samples.

University of Washington, Seattle, Washington
Botany Teaching Assistant, 2002

Prepared for and managed a laboratory section of Botany 113, summer quarter 2002. Taught plant identification and classification techniques to full class of students. Prepared quizzes, graded tests, collected plant material from Eastern Washington and local sites.

Qualifications for Environmental Consulting Services for Sustainable Development Program Woodinville, Washington

Prepared for
City of Woodinville

May 5, 2006
06-4-1600-036

PENTEC ENVIRONMENTAL
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Delivering smarter solutions

Anchorage

Qualifications for Environmental Consulting Services for Sustainable Development Program Woodinville, Washington

Boston

Prepared for
City of Woodinville
17301 133rd Avenue NE
Woodinville, WA 98072

Denver

Edmonds

May 5, 2006
06-4-1600-036

Prepared by
Hart Crowser, Inc. - Pentec Environmental

Philadelphia

RECEIVED

MAY 05 2006

CITY OF WOODINVILLE
PLANNING DEPARTMENT

Portland

Seattle

A Division of Hart Crowser, Inc.
120 Third Avenue South, Suite 110
Edmonds, Washington 98020-8411
Fax 425-778-9417
Tel 425-775-4682

QUALIFICATIONS FOR ENVIRONMENTAL CONSULTING SERVICES FOR SUSTAINABLE DEVELOPMENT PROGRAM WOODINVILLE, WASHINGTON

PROJECT UNDERSTANDING

We are pleased to submit our qualifications to assist the City of Woodinville (City) in reviewing critical areas within the City, assessing the impact of development on these areas and providing protective measures to minimize the impact of proposed development. Our project team has reviewed the Request for Qualifications, the Supplemental Findings in Support of Development Moratorium, and Zoning and Critical Areas maps for the City of Woodinville.

We believe that fulfilling the following objectives best accomplish the goals of the project by:

- Cataloging, mapping and detailing critical areas within the limits of the City of Woodinville;
- Applying a priority ranking system based on intrinsic values of the critical areas, with discussion between City planners and our team; and
- Determine potential impacts of various levels of development on the critical areas and suggesting appropriate measures to provide protection to the crucial values of the critical areas

PRELIMINARY SCOPE OF SERVICES

Our proposed scope of work will address each of the bulleted items listed above in much more detail.

Delineation of Critical Areas

We will begin with the City's Identified Critical Areas map and "ground-truth" this map by visiting sites to perform initial data collection in representative locations. We will also complete reconnaissance-level investigations of remaining selected areas within the City limits to determine if other critical areas exist that are not currently shown on the map. These areas will be divided into subcategories, depending on the type of critical areas. For example, wetlands, streams and other critical habitat areas will be separated from geologic landslide and steep slopes to

allow the expertise of our individual staff members to focus on their areas of specialty.

Given that most of Woodinville's critical areas likely have already been mapped and have associated ratings we will compile existing data where possible. We will perform a brief field verification of these areas to gather any new data and confirm the existing ratings. Other locations will be scouted and given an appropriate standardized rating (such as applying the Western Washington Wetland Rating System to wetlands) as well as quantitatively evaluated with our developed criteria matrix.

Criteria Matrix and Critical Areas Ranking

Then we will develop a matrix of critical area criteria, in coordination with the City's planners, that will be used to assess the intrinsic values for each category of Critical Area. This will include, but will not be limited to:

- Present state of development in and adjacent to the critical area;
- Amount of native vegetation in habitat-related critical areas;
- Overall size of critical area;
- Level of complexity of structure and functions of critical area;
- Functions of the critical area within the greater ecosystem; and
- Overall rank of relevant categorization within standardized state and local ranking systems.

A functional assessment will be completed for all wetlands. We will use either the Draft Western Washington Rating System that was recently released for comment or the second edition of this document (1993). Stream function will be assessed based on published watershed management plans, our knowledge of these basins, and site reconnaissance of the areas. We have not included detailed habitat inventories in our scope. Those stream reaches known to provide spawning habitat for federally listed fish species (i.e., Chinook salmon or bull trout) or large and structurally diverse wetlands associated with streams and frequently flooded areas will be assumed to constitute high-functioning systems.

All of this information and other relevant characteristics, as defined by the developed critical area criteria matrix, will be compiled to provide a relative ranking of critical areas.

Obviously, given that the risk of loss or impact to different types of critical areas has different consequences, it will not be completely relevant to compare certain types

of critical areas with other types. The loss of a large wetland complex, for example, will have drastically different consequences from the development of landslide hazard area. So while it will be important to be able to compare the relative impact of development, rank order cannot be determined based only on science, some level of policy decision(s) will likely be required by the City.

Development Impacts and Protective Measures

This list will then serve as a starting point for addressing the impacts of proposed development on each location. We will investigate the impacts of multiple levels of development that will likely include commercial development, high-density residential, low density residential or a no development alternative. Additionally, we will provide recommendations for protection measures for individual critical areas or where applicable regional groups of critical areas.

Our intent is to develop a relatively precise, defensible and repeatable method based on accepted mapping, science, and classification schemes that provide a relative ranking of the critical areas within the city limits of Woodinville. The analysis also will identify the relative sensitivity of the critical areas to disturbance and any level and characteristics of existing disturbance or degradation. Upon discussions with the City we will better be able to determine the ultimate goals of this project and focus our efforts in a more succinct manner.

HART CROWSER, INC. – PENTEC ENVIRONMENTAL QUALIFICATIONS

We are uniquely qualified to perform this analysis as our diverse mix of scientists and engineers have been delineating and working with critical areas for approximately 20 years. We also regularly identify, analyze and determine potential impacts of development with respect to these critical areas.

We work regularly with local municipalities, specifically the City of Bothell and the City of Mukilteo, to provide technical oversight, review of proposed development and delineation of critical areas. However, we also work regularly with developers on similar projects determining potential impacts to critical areas, recommending mitigation and developing impact analysis. This provides us with a dual perspective into the methods and impacts that result from development projects as well as the review methods employed by local municipalities.

Our list of projects shown below demonstrates the large list of municipalities that we work with, as well as our expertise working with all types of local critical areas involved in this project (and others, such as marine habitat and shorelines). We have completed more than fifty projects for the City of Bothell over the past 8

years. Most of these projects have involved third party reviews of critical areas studies prepared for proposed development projects. Given that Woodinville shares a border with Bothell, we feel that we have developed a comprehensive understanding of the critical areas and sensitive environments in the region, particularly streams, wetlands, steep slopes, and Fish and Wildlife Habitat Conservation Areas. We have gained this understanding through the process of completing third party reviews of these projects as well as the completion of a Bothell-wide mitigation opportunities and constraints analysis and a multitude of other critical areas project work in the region for various clients.

Our staff has extensive experience in the following subject areas: hydrogeology, fisheries biology, wildlife biology, wetland biology, tree ecology, Geographic Information Systems (GIS), and engineering geology, environmental, civil and geotechnical engineering. The staff members on our team who fill these rolls are listed below in the Key Staff section of this Statement of Qualifications (SOQ), and their individual specialties are detailed in the Cost Breakdown section of this SOQ. Additionally, we have several existing subconsultant agreements in place with local firms to provide the necessary remaining areas of expertise such as surveying and land use planning.

Bothell Litowitz Test

We have previously authored a report for the City of Bothell that employed a version of the Litowitz test to determine relative rankings of critical areas in the subareas of Bothell. The specific purpose of this project was to facilitate examination of whether the zoning densities below the bright line of four dwelling units per acre (DU/ac) rendered in past Central Puget Sound Growth Management Hearings Board (CPSGMHB) decisions was justified in four subareas of the City of Bothell. This test was developed from the final decision and order in Litowitz et al. v. City of Federal Way (Case No. 96-3-0005). In this case, the CPSGMHB determined that lower than four DU/ac zoning densities can be warranted to better protect critical areas. It is our understanding through discussions with Carl Smith, former Planner for the City, that the City already has a copy of this report and that this Request for Qualifications has some basis on this report and the outcome provided to the City of Bothell.

This Bothell project had a number of similarities with the proposed description of this project. It is our belief that our experience in developing appropriate criteria for use in the Bothell Litowitz test will provide unique and valuable insight into creating a similar methodology for determining appropriate rank of critical areas in Woodinville.

region and for four years as a field engineer for Hart Crowser performing work related to geotechnical and environmental remediation projects.

James E. Starkes, Senior Project Fisheries Biologist. Mr. Starkes has 14 years of experience as a fisheries biologist, evaluating the effects of anthropogenic activities on anadromous fish and their habitats. Since the listing of the Puget Sound chinook salmon and bull trout, Mr. Starkes has been deeply involved with ESA issues including research, ESA program development, and regulatory permitting and compliance. He has managed two bull trout monitoring programs in the Puget Sound basin, one of which was an acoustic tagging study to electronically monitor the movements of anadromous bull trout in tidal freshwater and marine environments. He managed juvenile salmon monitoring programs as part of biological opinions issued by NMFS (now NOAA Fisheries) to determine the migratory timing and potential exposure of juvenile chinook salmon to contaminated sediments. Mr. Starkes is a project manager on the environmental team assisting the City of Tacoma in the environmental cleanup and redevelopment of the City's waterfront along the Thea Foss Waterway of Commencement Bay. He has conducted field investigations collecting fish, sediments, surface water, and benthic community samples in stream, lake, and estuarine systems.

Arthur J. Fleming, P.E., Civil Engineer. Mr. Fleming is a civil engineer with more than 26 years of experience in civil engineering in a wide variety of contexts. He is experienced in the project management and design of civil and mechanical phases of fish hatcheries, fish passage structures, and fish ladders. Mr. Fleming also designs storm drainage systems, pumping systems for dewatering systems, site development projects, municipal water supply projects, and roadway stabilization projects. He has provided hydraulic design of piping and weir systems for small and large dams. Mr. Fleming's restoration experience includes evaluating alternative restoration sites for mitigation projects from a design perspective, and designing created wetlands that enhance wildlife habitat.

Bruce Rummel, Associate Biologist. Mr. Rummel approaches environmental consulting with over 25 years of professional experience. In the field of wetland conservation, Mr. Rummel has sought to balance protection of wetland functions with resource development, according to applicable regulations. He has performed over a score of wetland delineations, verifications, and assessments on projects in transportation, communications, and retail, utility, and recreational development. This work has included meeting with governmental agencies responsible for implementing wetland protection regulations. He has applied the Washington State Wetland Rating System to determine a wetland rating for an area under consideration for development. In separate projects, Bruce has designed a wetland replacement area to mitigate effects of a site development and planted a designed wetland area for process water treatment. He has prepared a technical

memorandum on identification and analysis of issues in wetland restoration in the Duwamish Waterway/Elliott Bay area; this report discussed the types of wetland habitats that could be created, historical habitat types in the estuary, selection criteria for sites, costs, and an assessment of potential sites in the estuary.

Celina Abercrombie, Wetland Ecologist and Restoration Specialist. Since 2000, Ms. Abercrombie has performed research and analysis of fish and marine mammal species and habitat in the Puget Sound region. She has completed studies of biological and ecological natural functions, the influence of human development impacts, policy and regulations related to natural resource use and conservation, and assessment and design of restoration and mitigation solutions. Celina has performed wetland delineations and categorizations, and prepared wetland and buffer mitigation plans, impact analyses, restoration, planting and monitoring plans. Celina has performed environmental and habitat assessments in a range of Northwest ecosystems including: freshwater and saltwater wetlands; streams and rivers; lakes; and marine shorelines. Celina also manages projects for environmental permitting requirements.

Roy E. Jensen, L.H.G., Associate Hydrogeologist. Mr. Jensen is a senior-level hydrogeologist with 27 years of experience. He has managed and directed environmental investigation and remediation projects for numerous properties. These projects have spanned a wide range of contamination issues, involved multiple stakeholders and potentially responsible parties, and included evaluation of cost responsibility. Roy will provide hydrogeologic services, as needed. He has managed geologic and hydrogeologic investigations for a variety of industrial and governmental clients. Responsibilities include planning, developing, directing, conducting, and overseeing technical analysis for dewatering and for groundwater and surface water investigations. He has expertise in groundwater monitoring, tidal influence studies, groundwater and contaminant transport modeling, and borehole geophysics. Roy is familiar with a wide range of Washington State and federal regulations such as MTCA, CERCLA, RCRA, and many other through his work on environmental assessment and remediation projects. His dewatering experience has given him a solid understanding of NPDES and local municipal water treatment and disposal regulations.

Chris Gardner, GIS Specialist. Chris has 6 years of experience in geology and GIS systems. His expertise includes collection and plotting of GPS data for production purposes, from report figures to large-scale maps. His experience with GIS-related tasks includes digitizing, layer/theme creation, layer/theme re-projection, layer/theme editing, data sourcing, data conversion and compilation; and map design, annotation, and production.

PREVIOUS EXAMPLES OF RELEVANT EXPERIENCE

City of Bothell, Litowitz Test, Bothell, Washington. We worked in cooperation with the City of Bothell to perform a quantitative ranking of critical areas in multiple chosen subareas of the City of Bothell. The Litowitz Test is the name given to a part of a relatively recent CPSGMHB decision in Litowitz et al. v. City of Federal Way (Case No. 96-3-0005). In final decision and order of that case, the CPSGMHB established the Litowitz Test for determining when it may be reasonable to adopt a zoning density of less than four DU/ac to better protect the functions and values of environmentally sensitive or critical areas as required by the Growth Management Act (GMA). Pentec worked together with the City's planners to develop a matrix of criteria to apply this test to critical areas within the portions of the subareas being considered. The purpose of this project was to develop an accurate, repeatable, and defensible method for evaluating whether additional protection provided by lower zoning densities was warranted to protect sensitive areas meeting the Litowitz Test criteria. The method was intended to produce objective information to assist the City's Department of Community Development and Planning Commission in their GMA-required code and comprehensive plan updates.

City of Bothell, Bothell Wetland and Stream Mitigation Opportunities and Constraints Analysis, Bothell, Washington. We prepared a wetland and stream mitigation opportunities and constraints analysis for properties owned by the City of Bothell. The focus of this study was to evaluate whether the City of Bothell has sufficient available area and opportunities to mitigate potential impacts of planned transportation projects and to determine if there may be opportunities to allow portions of Bothell lands to be used by developers for mitigating their project-related impacts. This analysis also evaluated potential future mitigation needs from proposed municipal transportation projects and development. To perform this analysis we reviewed applicable City of Bothell planning documents, created a matrix, with input from the City of Bothell staff, for evaluating potential mitigation sites and applied the matrix to applicable sites within the project area. This resulted in recommendations for wetland and stream mitigation locations within four local drainage basins and potential difficulties associated with each location.

Snohomish County, Update of Critical Areas Ordinance, Snohomish County, Washington. We worked in cooperation with Snohomish County Planning and Development Services and Perkins Cole to update the County's Critical Areas Ordinance (CAO). Our biologists and geotechnical engineers were responsible for preparation of technical reports identifying the best available science (BAS) for the protection of sensitive areas, including streams, wetlands, and geologically sensitive areas to ensure that the CAO update revisions comply with the BAS mandate of the Growth Management Act. Staff scientists and engineers collaborated with County staff to develop a range of alternatives to be considered as part of the SEPA process

and generation of the final scientific rationale for the recommended alternative and development of the BAS consistency for each component of the revised CAO.

Snohomish County, Implementation of Growth Management Act, Snohomish County, Washington. We directed this interdisciplinary critical areas evaluation for the western portion of Snohomish County and 21 participating cities. The purpose of the study was to assist the County and cities with Growth Management Act implementation by developing a classification system for critical areas including fish and wildlife conservation areas, geologically sensitive areas, and wetlands; producing maps for each critical area; developing and writing draft ordinances for each critical area; and participating in citizen involvement meetings. The classification systems gave local jurisdictions a mechanism for determining the type, class, or category and quality of each critical area resource. Information provided to the County and cities was considered and incorporated into the planning process and protection ordinances, policies, and guidelines for three critical areas as required under the Growth Management Act.

Confidential Client, Chinook Salmon Critical Habitat Assessment, Idaho. We conducted field surveys to determine if habitat conditions in a small tributary to the Salmon River in south-central Idaho justified designation of these reaches as critical habitat for endangered Chinook salmon. We performed a detailed habitat inventory of the creek in question to characterize the type of habitat (e.g., pools, riffles) and current habitat conditions (e.g., substrate composition, pool frequency, structure). The habitat inventory was stratified by geomorphic channel type to identify the range of variability that exists in the creek. Habitat conditions in each channel type were compared to documented habitat requirements for Chinook salmon to determine adequacy for designation as critical habitat. Current habitat conditions were also compared with habitat conditions in a neighboring stream of similar geomorphic type that has not experienced the mining-related disturbance of the study stream. The location and extent of Chinook habitat in the undisturbed drainage were used as a guide to estimate the location and extent of Chinook habitat that may have existed in the study creek prior to placer mining.

City of Mukilteo, Use of Best Available Science in City of Mukilteo Buffer Regulations, Mukilteo, Washington. We assisted the City of Mukilteo in updating their critical areas ordinances to comply with the GMA that requires municipalities to include BAS in their CAO to protect the functions of critical areas. Our report to the City of Mukilteo identified existing mechanisms for protection of streams and wetlands; provided an overview of existing CAO provisions for protecting streams and wetlands; identified existing streams, wetlands and buffers and the associated functions; and presented an analysis of the effectiveness of existing stream and wetland buffers for protecting steam and wetland functions compared to larger stream and wetland buffers.

City of Everett and Port of Everett, Water Resources Inventory Area (WRIA) 7, 8 and 9 Technical Committee Experience, multiple locations, Washington. Since 1999, Pentec has served as the City of Everett and Port of Everett technical representative on WRIA 7 Fish Technical Committee, a body of fishery biologists, aquatic scientists, and planners engaged in development of a conservation plan for salmonids in that basin. In WRIA 7, we have completed several writing tasks that aided in the preparation of a multi-agency conservation plan for salmonids in the watershed. Also, from 1998 through 2001, we represented the Port of Seattle on the Green/Duwamish watershed (WRIA 9) Fish Technical Committee and the Planning Work Group, again providing key written analyses that have been incorporated into WRIA salmon recovery documents. Finally, in 2001 we assisted the WRIA Technical Committee with habitat mapping and modeling as input to the IDT salmon population response analysis.

PROFESSIONAL REFERENCES

Mr. Graham Anderson, Senior Planner
Port of Everett
2911 Bond Street
Everett, WA 98201
(425) 388-0703
Fax (425) 388-0702
grahama@portofeverett.com

Ms. Heather McCartney, Planning Director
4480 Chennault Beach Road
Mukilteo, WA 98275
(425) 355-4141 Ext. 226
Fax (425) 347-4544
hmccartney@ci.mukilteo.wa.us

Mr. Jeff Smith, Senior Planner
City of Bothell
9654 NE 182nd Street
Bothell, WA 98011
(425) 486-8152 Ext. 4439
Fax (425) 486-2489
jeff.smith@ci.bothell.wa.us

WAYNE C. ADAMS, E.G.

Principal – Regional Office Manager

EDUCATION

M.S., Geography and Environmental Engineering, Johns Hopkins University, 1996

REGISTRATIONS

Symposium on Watershed Assessment in Washington State, NMFS, Seattle, Washington 1997

AFFILIATIONS

American Geophysical Union, Hydrology Section

Mr. Adams has gained extensive technical experience in geotechnical engineering design and construction observation. He has completed a wide range of projects from studies such as environmental impact statements, to sub-surface investigations through engineering design and construction observation. He has applied these skills successfully in several specific areas including but not limited to; landslide remediation, expert witness testimony, third party review, quantitative analyses of landslides, shallow building foundations, pile supported foundations, reinforced earth retaining walls, earth dam embankments, infiltration/detention ponds, waste disposal containment structures, mine closures, road/slope grading and drainage plans. He has been the primary design engineer - team leader for plans and specifications created for bid, cost estimates, submittal reviews and construction observation. He has successfully completed project management and principal-in-charge duties on numerous engineering, geology and construction projects.

REPRESENTATIVE PROJECT EXPERIENCE

Washington State Department of Natural Resources, Slope Hazard Assessment System for Washington's Forested Land, WA. Principal researcher to develop guidelines for evaluation of mass movement on forested land in Washington State. Work on this project was guided by the Sediment, Hydrology and Mass Wasting Steering Committee (SHAMW) to provide methods to identify and rate potential site-specific slope stability problems associated with proposed or existing forest roads.

Washington State Department of Transportation, I-90 Snoqualmie Pass East EIS, Hyak, WA. Project manager and technical lead for Final Geology and Soils Discipline Report to complete Environmental Impact Statement. Alternatives included tunnels and improved safety conditions along 15-mile corridor of high hazard areas. Worked directly with Transportation Department personnel to address local concerns and design constraints.

Chief Seattle Council of the Boy Scouts of America, Pulali Point, WA. Project Manager and lead investigator of engineering geology for hazard assessment of steep slopes to support Timber Harvest Plan. Site covers approximately 80-acre parcel of mixed timber infected with root rot. Project work required close coordination with Washington Department of Natural Resources hydrogeologist. Included evaluation of opposing professional opinions and developing defensible arguments for permit application addressing Class IV Special designation.

Washington State Department of Transportation I-90 Snoqualmie East Improvement Project Draft EIS. Project Engineer for the Geology and Soils

Discipline Report section of the EIS in 2002. The project involved widening and safety improvements for a 15-mile section of the I-90 from Hyak to Easton, Washington. Wayne was responsible for writing the draft EIS describing for engineering geology and soil hazards. He reviewed the site conditions and project documents that had been developed in support of the EIS, and reviewed hazard mapping, and rock quarry development. He evaluated three alternative alignments and the impact of those alternatives on existing conditions and hazards. He also evaluated potential impacts to aquifer systems and high avalanche hazard areas. Two of the alternatives involved tunneling; one included elevated sections over Lake Keechelus.

Gifford Pinchot National Forest, Vancouver, WA. Supervised geological engineers in surface and subsurface investigations. Completed engineering analyses and recommendations in preliminary forest road locations, construction, and reconstruction. Directed three field teams to complete geotechnical hazards mapping. Oversaw and completed landslide site investigations for road construction and bridge foundations. Participated in a rock bolt installation study for logging tower anchors, and joint set mapping and stress testing to confirm installation methods to support "tower" logging operations.

City of Bothell, Bridlewood Project, Bothell, WA. Project Manager for engineering geology third party review of steep slopes and landslide issues at proposed development.

City of Bothell, Wayne Golf Course Project, Bothell, WA. Review Team leader third party review of steep slopes, groundwater and landslide issues at proposed two phase development in ancient landslide area.

Eaglemont Golf Club, Culvert Removal Project, Mount Vernon, WA. Project manager for site investigation and soil engineering review of 900 feet high valley fill over arched culvert. Removal of fill and culvert required for salmon habitat restoration. Challenges included developing recommendations for removal of deleterious fill.

JONATHAN P. HOUGHTON, PH.D.

Senior Principal Marine/Fisheries Biologist

EDUCATION

Ph.D., Intertidal Ecology, College of Fisheries, University of Washington, 1973. Dissertation: Intertidal ecology of Kiket Island, Washington, with emphasis on age and growth of *Protothaca staminea* and *Saxidomus giganteus* (Lamellibranchia: Veneridae)

A.B. *cum laude*, Biology, Harvard University, 1964

REGISTRATIONS

Ecological Risk Assessment Short Course - Society of Environmental Chemistry and Toxicology, 1994

AFFILIATIONS

Washington Public Ports Association

Society of Environmental Toxicology and Chemistry

American Institute of Fisheries Research Biologists, (former chapter vice-director)

Western Society of Naturalists

Society for Ecological Restoration

Pacific Estuarine Research Society

Dr. Houghton is a senior biologist with more than 33 years of consulting experience in the Pacific Northwest, the Rocky Mountains, and Alaska. This experience has met a wide range of client needs, including baseline studies, environmental impact assessment, natural resources injury assessment, ecological risk assessment, and mitigation and remediation planning. He is equally comfortable working in freshwater, marine, or estuarine environments. Dr. Houghton is very familiar with NEPA and SEPA regulations, and the ESA and its implications for project permitting and operation. He has prepared numerous biological assessments to assist federal agencies in meeting the requirements of Section 7 of the ESA and has conducted a detailed review of a biological opinion prepared by NMFS (now NOAA Fisheries). In addition to an excellent working knowledge of freshwater and estuarine habitat requirements of anadromous salmonids, Dr. Houghton has strong professional relationships with scientists working on ESA issues within NOAA Fisheries and USFWS in Washington and Oregon.

REPRESENTATIVE PROJECT EXPERIENCE

City of Edmonds, Marine Outfall Repair, Baseline Surveys, Edmonds, WA. Directed surveys of eelgrass along the route of the City of Edmonds' existing and proposed marine sewage outfall. Negotiated a mitigation and monitoring plan to replace eelgrass that would be disturbed by rebuilding the line. Directed eelgrass transplanting to supplement natural recolonization of the work area by eelgrass.

City of Tukwila, Application of Best Available Science to Riparian Conditions, Tukwila, WA. Analyzed the City of Tukwila's buffer requirements in shoreline areas including the Green and Duwamish Rivers. Evaluated whether the City's current or proposed buffer requirements are consistent with best available science (BAS) and, where not consistent, described potential modification necessary to meet BAS requirements. Provided any justifications for not meeting BAS.

City of Everett, Shoreline Buffer Evaluation, Everett, WA. Analyzed the City of Everett's buffer requirements in shoreline areas including Port Gardner Bay (nearshore) and the Snohomish River estuary. Evaluated whether the City's current or proposed buffer requirements are consistent with best available science (BAS) and, where not consistent, described potential modifications necessary to meet BAS requirements. Provided any necessary justifications for not meeting BAS.

Port of Edmonds, Master Plan, Endangered Species Act (ESA) Response Planning, Edmonds, WA. Provided environmental perspective on team preparing a revised

master plan for the Port. Participated in planning sessions evaluating alternative port facilities, locations, and priorities. Developed analysis of environmental implications of alternatives in light of the existing environmental constraints and the recent listings of Puget Sound salmonids as threatened under ESA.

City of Everett, Snohomish Estuary Wetland Integration Plan (SEWIP) Salmon Overlay, Everett, WA. Directed revisions to the SEWIP to reflect the recent listings of anadromous fish under the Endangered Species Act and the need for a regional restoration plan. Activities included facilitating an interagency technical committee preparing a model to describe listed-salmonid habitat functions in the Snohomish Estuary. Conducted field surveys to score 132 assessment units throughout the estuary using the model. Prepared a management plan that defines the use of the model and the field data in compensatory mitigation actions within the estuary and in development of a restoration plan for the estuary.

City of Bellevue, North Fork Snoqualmie Water Supply Project, King County, WA. Directed studies of effects of a proposed water supply/hydropower project on fish habitat in the reservoir and downstream areas. Studies included application of instream flow incremental methodology (IFIM) to assess effects of flow changes on resident and anadromous salmonids, as well as assessment of mitigation/enhancement options for small tributary streams.

Mobrand Biometrics, Lake Washington (WRIA 8) Salmon Recovery Planning, King County, WA. Participating on a team of fisheries experts on the Lake Washington drainage in modeling fish habitat responses in the river, lakes, ship canal, and adjacent nearshore areas. Used previously developed habitat model to characterize function of estuary and nearshore habitats.

Port of Edmonds, Willow Creek Outlet Channel Improvement Assessment, Edmonds, WA. Directed an evaluation of the potential benefits of daylighting the outlet of an intertidal marsh and the potential for establishment of self-sustaining salmon runs in marsh tributary streams.

Port of Everett, Union Slough Intertidal Wetland Restoration and Mitigation Bank, Lower Snohomish Estuary, WA. Managed permitting activities for the restoration of a ± 32-acre agricultural site to a tidally influenced brackish marsh. Conducted detailed studies of seasonal use of adjacent habitats by juvenile salmonids, and used results to develop detailed site-restoration plans. Currently negotiating with agencies to develop a memorandum of understanding that will allow the Port to use the restored saltmarsh/mudflat complex as a mitigation bank. The project received the 2001 Environmental Improvement Award from the American Association of Port Authorities in the Mitigation category.

Port of Grays Harbor, Environmental Assessment of Newskah Creek for Proposed Channel Realignment, Grays Harbor, WA. Performed SEPA environmental assessment of Newskah Creek and adjacent upland areas in conjunction with the proposed development of a regional airport. Conducted surveys of wetlands and terrestrial vegetation, aquatic invertebrates, and water quality. Developed mitigation plans for the loss of existing habitat.

DEREK R. ORMEROD, P.E.

Water Resources Engineer/Wetlands Hydrologist

EDUCATION

M.S., Environmental Fluid Mechanics and Hydrology, Stanford University, 2004

B.S., Environmental Engineering, Brown University, 1993

REGISTRATION

Professional Engineer, Water Resources Engineering (Civil)

Derek has participated in a wide variety of project activities, including wetland and buffer installation and oversight, wetland and critical area delineation, critical areas project review, hydrologic projects, stream habitat surveys, surface water computer modeling, stormwater and water quality monitoring, marine fisheries investigations, marine and freshwater habitat evaluations and mapping, eelgrass transplanting, GIS, GPS, site supervision, and construction monitoring. Previously Derek worked as a contract employee for several environmental engineering firms in the Puget Sound region and for four years as a field engineer for Hart Crowser performing work related to geotechnical and environmental remediation projects.

REPRESENTATIVE PROJECT EXPERIENCE

Swanson Wetland Mitigation and Stormwater Management, Paine Field, Mukilteo, WA. Supervised installation of a 13-acre, 11,000-plant wetland mitigation with multiple subcontractors. Managed on-site stormwater to comply with specific hydrologic conditions.

Multiple Wetland Delineations, Various sites, WA. Performed wetland and critical areas field delineations and generated reports for a variety of residential and commercial development projects ranging from 1 to 20 acres.

Geodecke South Wetland Mitigation, Auburn, WA. Performed regulatory support for a wetland delineation and conceptual mitigation report of a Public Works upgrade project impacting wetlands adjacent to the West Valley Highway.

Bothell Amphitheater Wetland Mitigation Project, Bothell, WA. Performed annual monitoring of constructed wetland mitigation project. Evaluated habitat enhancement performance standards and wetland and riparian hydrology and vegetation performance and created monitoring report.

Hydrologic Computer Modeling, Centralia, WA. Performed hydrologic modeling of a creek impoundment associated with expansion of a mine. This included two separate watershed and creek systems, with multiple iterations to determine applicable regulatory requirements.

Wetland Rating System, Mukilteo, WA. Performed field analysis of updated State of Washington Wetland Rating System to all of the wetlands within the City limits of Mukilteo, WA.

Discharge Monitoring, Port of Seattle Wetland Mitigation Project, Auburn, WA.

Performed monitoring of discharge into the Green River from groundwater dewatering activities for wetland mitigation project. Worked with regulators and administrators to determine appropriate sampling methods and standards, as well as performing and analyzing samples.

Sunrise Development Wetland 41, Pierce County, WA. Performed hydrologic analysis of wetland prior to development of surrounding area. Met with regulators to discuss the impacts from construction regarding the hydrologic regime of the wetland and adjacent critical areas.

Port of Everett Marina Water Quality Study, Everett, WA. Performed water quality monitoring and analyzed resultant data to determine water quality and resultant trends within the 12th Street Marina.

Sea-Tac International Airport Groundwater Mapping, SeaTac, WA. Coordinated and performed extensive explorations for the Port of Seattle's Third Runway expansion and related projects. The focus was subsurface mapping of groundwater and soil units, using 150 borings (30 in wetlands monitored by USACE), 150 test pits, 100 monitoring well installations, water infiltration testing, and groundwater slug rod testing.

Wetland Buffer Enhancement, Washington Mutual Development Center, SeaTac , WA. Performed installation of a critical areas buffer enhancement, including the installation of 100: 30-foot Cedar trees, invasive vegetation removal and installation of an irrigation system.

Lebanon Area Wide Groundwater Study, Lebanon, OR. Boring and installation of approximately 30 groundwater monitoring wells in several different water units, including discrete soil sampling and groundwater analysis.

Sewer Outfall Replacement, Bellingham, WA. Analyzed multiple alternatives to determine most cost-effective solution for replacing an on and offshore sewer outfall from the Post Point Wastewater Facility. Used AutoCAD to map alternatives.

Proposed Buckhorn Mine SEIS, Okanagan County, WA. Used computer modeling to determine amount of sedimentary erosion generated by multiple storm design events for a proposed mine site and prepared summary report for the United States Forest Service Supplemental EIS.

TransAlta Centralia Mining Corporation, Centralia, WA. Performed hydrologic modeling of a creek impoundment associated with expansion of a mine. This included two separate watershed and creek systems, with multiple iterations to determine applicable regulatory requirements.

Former Unocal Bulk Facility, Edmonds WA. Supervised upland and wetland removal of petroleum and heavy metals contaminated soils. Performed oversight and documentation of construction personnel and soil verification sampling. Performed quarterly groundwater monitoring and sampling.

Knik Arm Beach Seining, Anchorage, AK. Participated in fieldwork for marine fisheries impact assessments of proposed development in the Knik Arm of Cook Inlet. In addition, performed data analysis with large data set to determine relevant trends for report generation.

JAMES E. STARKES, B.S.
Fisheries Biologist

EDUCATION

B.S., Fisheries, University of Washington, 1983

AFFILIATIONS

American Fisheries Society

Mr. Starkes has 14 years of experience as a fisheries biologist, evaluating the effects of anthropogenic activities on anadromous fish and their habitats. Since the listing of the Puget Sound chinook salmon and bull trout, Mr. Starkes has been deeply involved with ESA issues including research, ESA program development, and regulatory permitting and compliance. He has managed two bull trout monitoring programs in the Puget Sound basin, one of which was an acoustic tagging study to electronically monitor the movements of anadromous bull trout in tidal freshwater and marine environments. He managed juvenile salmon monitoring programs as part of biological opinions issued by NMFS (now NOAA Fisheries) to determine the migratory timing and potential exposure of juvenile chinook salmon to contaminated sediments. Mr. Starkes is a project manager on the environmental team assisting the City of Tacoma in the environmental cleanup and redevelopment of the City's waterfront along the Thea Foss Waterway of Commencement Bay. He has conducted field investigations collecting fish, sediments, surface water, and benthic community samples in stream, lake, and estuarine systems.

REPRESENTATIVE PROJECT EXPERIENCE

Washington State Department of Ecology, Nearshore Impact Assessment of the Maury Island Gravel Mine, Puget Sound, WA. Managed the preparation of a nearshore impact assessment of the Maury Island Gravel Mine. Conducted an assessment of the potential impacts of a proposed mining operation to critical nearshore marine resources and habitats. Analyzed potential impacts, including noise, turbidity, habitat loss, chemical contaminants, prop wash, light shading, sand and gravel spills, and longshore sediment transport. Directed assessment to the newly listed Puget Sound chinook salmon and several candidate species including Pacific herring, walleye pollock, Pacific hade, Pacific cod, and copper, brown, and quillback rockfish.

City of Kent, Rock Creek Watershed Studies, Kent, WA. Conducted salmonid spawning survey in Rock Creek, a tributary of the Cedar River. Enumerated spawning sockeye and coho salmon, and steelhead trout, in five reaches of the stream. Conducted carcass surveys to determine carcass retention within the stream.

King County Department of Natural Resources, State of the Nearshore (SON) Report, Water Resource Inventory Areas (WRIAs) 8 and 9, Puget Sound, WA. Managed and co-authored the SON report with Battelle Pacific Northwest National Laboratory. Conducted a comprehensive assessment and review of the nearshore literature of central Puget Sound, Washington. Provided a current, fundamental understanding of major ecological conditions, habitat, processes, and resources that

occur in the nearshore zone of WRIAs 8 and 9 within central Puget Sound. Developed a comprehensive summary of the nearshore ecosystem in WRIAs 8 and 9 that serves as a foundation for future work and decision making.

Water Resource Inventory Area (WRIA) 9 Scientific Technical Committee, King County, WA. As a member of this planning group responsible, under the ESA, for implementing salmonid recovery programs in the Green/Duwamish basin, identified, evaluated, and prioritized restoration strategies and scientific research. Scoped studies addressing habitat decline and baseline data needs. Identified and prioritized crucial data gaps that exist within the basin.

City of Bothell, Schnitzer Business Park Development Third Party Review of Biological Evaluations (BE), Bothell, WA. Project manager conducting third party reviews of two BEs for the City of Bothell, Department of Community Development. Provided expertise and permitting experience to the City in evaluating BEs produced by other contractors on building development projects adjacent to North Creek, a chinook salmon bearing stream within the City. Evaluated the effects and take analyses in the BEs, prepared recommendations on conservation measures, and reported all findings to the City.

City of Tacoma, Public Works Department, Biological Evaluations (BEs), Tacoma, WA. Managed and prepared eight separate BEs as required under Section 7c of the ESA. Evaluated the potential impacts of several large-scale development projects proposed in the Thea Foss Waterway and Ruston Way shore of Commencement Bay, Washington. These BEs evaluated the potential for the proposed projects to affect Puget Sound chinook salmon, bull trout, and bald eagles-all listed as threatened under the ESA. BEs also evaluated the potential impacts of pile driving, construction disturbances, runoff, and overwater structures.

Washington State Department of Natural Resources, Ecological Risk Assessment (ERA) of the Cherry Point Herring Stock, Puget Sound, WA. Conducted a screening ERA of the Cherry Point herring stock, a candidate species for listing under ESA. Applied risk assessment methodologies to evaluate the impact of natural and anthopogenic stressors on the Cherry Point herring stock from a proposed pier extension project. Analyzed local and regional temperature regimes, the lack of vegetation and spawning substrate, food supply, disease, predation, fishing, light shading, wave shading, vessel traffic, ship ballast, and contaminants.

ARTHUR J. FLEMING, B.S., P.E.
Civil Engineer

EDUCATION

B.S., cum laude, Civil Engineering, West Virginia University, 1977

REGISTRATIONS

Registered Professional Engineer, State of Washington, 20309

Registered Professional Engineer, State of Alaska, CE6697

Registered Professional Engineer, Territory of Guam, 748

AFFILIATIONS

Tau Beta Pi

Chi Epsilon

American Society of Civil Engineers

Mr. Fleming is a civil engineer with more than 26 years of experience in civil engineering in a wide variety of contexts. He is experienced in the project management and design of civil and mechanical phases of fish hatcheries, fish passage structures, and fish ladders. Mr. Fleming also designs storm drainage systems, pumping systems for dewatering systems, site development projects, municipal water supply projects, and roadway stabilization projects. He has provided hydraulic design of piping and weir systems for small and large dams. Mr. Fleming's restoration experience includes evaluating alternative restoration sites for mitigation projects from a design perspective, and designing created wetlands that enhance wildlife habitat.

REPRESENTATIVE PROJECT EXPERIENCE

City of Everett, Wastewater Treatment Plant Expansion, Everett, WA. Project Engineer for design of all civil/site work and outside piping for the City of Everett's wastewater treatment plant. Project included design of two major river crossings, a 36-inch water pipeline, and a 60-inch combined sewer outfall pipeline, plus two 48-inch plant outfalls.

City of Goldendale, Pumping Station, Goldendale, WA. Project Engineer responsible for the design of a 6-MGD pumping station, a 16-inch forcemain, and an 18-inch effluent pipeline for wastewater treatment facilities. Performed a hydraulic transient analysis on the forcemain, and verified results by instrumenting the forcemain during start-up testing.

City of Bremerton, Bremerton Overwater Park Mitigation Project, Bremerton, WA. Project Engineer responsible for verifying sunlight-shadow calculations for Overwater Park, and evaluating alternative mitigation beach restoration sites. Evaluated several off-site mitigation options which consisted of improving other nearby existing beach habitat areas.

City of Everett, Snohomish River Bicycle Path, Everett, WA. Project Engineer for the design of a 2-mile paved bike path along the Snohomish River and Union Slough. The path was constructed along an existing dike which required extensive repairs in some areas, primarily replacing unsuitable soils with imported fill. The path also included several pull-out areas to facilitate construction and to provide space for future amenities. The bicycle path was built as part of the City of Everett's wastewater treatment plant expansion project.

City of Seattle, Booster Pump Station Expansion, Seattle, WA. Project Engineer

during construction of the Water Department's expansion of the First Hill Booster Pump Station and construction of a new Broadway Booster Pump Station. Each station had a capacity of approximately 11 MGD.

City of Bellingham, Intake Pipeline, Bellingham, WA. Project Manager for a detailed investigation of the City's municipal water supply pipeline in Lake Whatcom. Participated on a team of divers to observe the exterior and interior of the pipeline, and collected samples of the various support components. Upon completion of the investigation phase, a design package was prepared to retrofit several components.

City of Blaine, Primary Water Supply Well Pump Replacement, Blaine, WA. Designed and specified a replacement well pump for one of the City's primary water supply wells. Also designed a pump for a new well.

City of Issaquah, Well Pump Design, Issaquah, WA. Designed and specified a well pump for the City's new Well #6. The system was designed to be expanded from the current City water right of 800 gpm to 1,300 gpm (the well's capacity) in the future when a new water right is obtained.

City of Yakima, Irrigation Master Plan, Yakima, WA. Project Manager for the detailed investigation (Phase 1) of the City's municipal irrigation system; prepared a Master Plan (Phase 2) for the City's 60-year-old irrigation system. The investigation phase was accomplished by digging test pits and cutting out small sections of the pipeline. A video camera was used to view more than 400 feet of the pipe interior at each test pit. An ultrasonic thickness gage was used to measure pipe thickness, and coupons were sampled for corrosion. During Phase 2, hydraulic models were developed to investigate pipeline modifications, such as sliplining, and costs were developed to determine the most cost-effective method of rehabilitating the system.

City of Portland, Aquifer Storage and Recovery Well, Portland, OR. Performed a detailed study of technologies available for sealing electrical connections to pressurized wells.

BRUCE W. RUMMEL
Associate Biologist

EDUCATION

Fish 507: Special Topics in Wetlands; College of Fisheries, University of Washington, Summer Quarter 1990

M.S., Oceanography, Department of Oceanography, University of Washington, 1976

B.S., Life Sciences, Department of Biology, Massachusetts Institute of Technology, 1971

In the field of wetland conservation, Mr Rummel has sought to balance protection of wetland functions with resource development, according to applicable regulations. He has performed over a score of wetland delineations, verifications, and assessments on projects in transportation, communications, and retail, utility, and recreational development. This work has included meeting with governmental agencies responsible for implementing wetland protection regulations. He has applied the Washington State Wetland Rating System to determine a wetland rating for an area under consideration for development. In separate projects, Bruce has designed a wetland replacement area to mitigate effects of a site development and planted a designed wetland area for process water treatment. He has prepared a technical memorandum on identification and analysis of issues in wetland restoration in the Duwamish Waterway/Elliott Bay area; this report discussed the types of wetland habitats that could be created, historical habitat types in the estuary, selection criteria for sites, costs, and an assessment of potential sites in the estuary.

REPRESENTATIVE PROJECT EXPERIENCE

City of Bothell, ME@Canyon Park LLC, Bothell, WA. Performed review for City of Bothell to mitigate wetland impacts of commercial development. Assessed wetland functional values. Visited site and reviewed planting plans to assure compliance with municipal code. Recommended actions for City to take to assure success of mitigation plan.

City of Bothell, West Ridge Bothell Gateway, Bothell, WA. Performed review for City of Bothell to mitigate wetland impacts of commercial development. Reviewed wetland delineation, functional assessment, and application of municipal code to compensatory mitigation. Provided conclusions to City on compliance of project and factors that could require adjustment in mitigation plan.

Rick Bussey, Bussey Property, Bellevue, WA. Performed wetland reconnaissance on 1.7-acre parcel to determine wetland status according to Washington State Department of Ecology wetland identification and delineation methods. Prepared letter report on finding of nonwetland status.

Scott Foss, Foss Property, Renton, WA. Performed wetland delineation on 10.7-acre parcel according to Washington State Department of Ecology wetland identification and delineation methods. Assessed wetland functional values. Prepared letter report documenting wetlands and showing buffer areas.

Fort McMurray, Alberta, Canada. Researched planting techniques and planted cattails (Typha sp.) in created wetland used to treat wastewater from oil sands

processing operation.

King and Snohomish Counties, WA. Performed wetland assessments, delineations, and verifications on 10 sites in King and Snohomish Counties. Projects included wetland assessment, delineation, and verification by federal three-parameter method (soil, hydrology, plant cover) and determining wetland rating according to methods established by Washington Department of Ecology.

Habitat Restoration, Seattle, WA. Prepared technical memorandum on identification and analysis of issues in wetland restoration in the Duwamish Estuary. Memorandum discussed types of wetland habitats that could be created; historical habitat types in the estuary; selection criteria for sites; costs; and an assessment of potential sites in the estuary.

Old Colony Railroad Project, Boston, Massachusetts. Delineated wetlands for commuter railroad project, including 10 station sites and portions of right of way. Met with and described program to local groups responsible for wetland protection (conservation commissions).

Stamski and McNary, Inc., Acton, Massachusetts. Delineated wetlands, designed wetland replacement areas, prepared permit applications for residential subdivisions and site developments. Developed outline of environmental protection procedures for site development. Met with and described development plans to local groups responsible for wetland protection (conservation commissions.

Kupper Associates, Piscataway, NJ. Performed drainage analysis using United States Department of Agriculture Soil Conservation Service Technical Release 55 TR55) methods and Hydro/Plus applications software for residential subdivision and commercial developments. Wrote drainage reports. Prepared environmental impact statements (EIS) for residential subdivisions and commercial developments.

CELINA ABERCROMBIE

Wetland Ecologist and Restoration Specialist

EDUCATION

M.S., Environmental Studies, The Evergreen State College, Currently Pursuing

Wetland Delineation Training & Field Practicum (Wetland Training Institute)

Advanced Biological Evaluation (BE) Training (Washington State Department of Transportation)

B.A., English, University of Washington, 2000

Since 2000, Ms. Abercrombie has performed research and analysis of fish and marine mammal species and habitat in the Puget Sound region. She has completed studies of biological and ecological natural functions, the influence of human development impacts, policy and regulations related to natural resource use and conservation, and assessment and design of restoration and mitigation solutions. Celina has performed wetland delineations and categorizations, and prepared wetland and buffer mitigation plans, impact analyses, restoration, planting and monitoring plans. Celina has performed environmental and habitat assessments in a range of Northwest ecosystems including: freshwater and saltwater wetlands; streams and rivers; lakes; and marine shorelines. Celina also manages projects for environmental permitting requirements.

REPRESENTATIVE PROJECT EXPERIENCE

Buckman Wetland Delineation, Mason County, WA. Performed wetland delineation and categorization for lacustrine-fringe wetland associated with Star Lake. Prepared impact analysis and restoration plan for proposed single-family residence.

Brown Wetland Delineation, Mason County, WA. Performed wetland delineation and categorization for forested slope wetland. Prepared impact analysis and restoration plan for proposed garage.

Kukuk Habitat Management Plan, Mason County, WA. Developed Habitat Management Plan, Impact Analysis and Restoration Plan to address unpermitted activities within the Fish and Wildlife Conservation Area buffer of a Type 1 stream. Site assessment and mitigation for proposed development.

Norris Wetland Delineation, Mason County, WA. Performed wetland delineation and categorization for isolated, depressional wetland. Assisted with preparation of impact analysis and restoration plan to address unpermitted site preparation activities.

Grotjan Wetland Restoration, Mason County, WA. Prepared environmental permitting documents for restoration work on a Category II lake-fringe wetland associated with Tenas Lake. Oversaw restoration crew.

Munro Wetland Delineation, Mason County, WA. Performed wetland delineation and categorization for isolated, depressional wetland associated with Coon Lake.

Hood Canal Communications Environmental Report, Mason County, WA. Prepared environmental report for rural utility service project for five project areas within

Mason County.

Pontius Wetland Delineation, Thurston County, WA. Performed wetland delineation and categorization of Category III depressional wetland. Prepared impact analysis and restoration plan to address unpermitted site clearing for proposed single-family residence.

Provasoli Wetland Delineation, Thurston County, WA. Performed wetland delineation and categorization of Category II palustrine depressional wetland.

Little Water Rights Permit, Thurston County, WA. Performed site assessment to determine drainage and hydrologic connections for water rights permit. Analyzed hydrologic and geographical data.

Orin Group Site Assessments, King, Pierce and Clark Counties, WA. Performed several site assessments for proposed cellular tower construction. Examined topography, vegetation, water features and adjacent development. Prepared written report and photographic documentation of site conditions.

Allen Habitat Management Plan, Mason County, WA. Developed Habitat Management Plan, Impact Analysis and Restoration Plan to address unpermitted activities within the Fish and Wildlife Conservation Area buffer of a marine shoreline. Prepared report addressing restoration of unstable slope using bioengineering treatments and installation of compensatory plantings.

Dalton Restoration, Clark County, WA. Site assessment and installation supervision of riparian buffer restoration project.

Jones Wetland Delineation, Ocean Shores, WA. Performed wetland delineation and categorization of mosaic wetland system.

Central Washington University, Mason County, WA. Performed wetland delineation and categorization for riverine and estuarine wetlands associated with an unnamed drainage and Hood Canal.

Forberg Wetland Delineation, Lacey, WA. Performed wetland delineation and categorization for Category II lake-fringe wetland associated with Southwick Lake.

ROY E. JENSEN, L.H.G.
Senior Hydrogeologist

EDUCATION

M.S. 1983, Geology, Loma Linda University

B.S. 1979, Medical Technology, Walla Walla College

B.S. 1978, Biology. Walla Walla College

Geology and Hydrogeology, Postgraduate Work, 1983-1988, South Dakota School of Mines and Technology, Rapid City, SD.

LICENSES/CERTIFICATES

Licensed Geologist and Hydrogeologist, WA

Registered Professional Geologist, OR

Registered Geologist, CA

Licensed Well Driller, WA

Registered Site Assessor, WA

Roy is a senior-level hydrogeologist with 27 years of experience. He has managed and directed environmental investigation and remediation projects for numerous properties. These projects have spanned a wide range of contamination issues, involved muliple stakeholders and potenially responsible parties, and included evaluation of cost responsibility. Roy will provide hydrogeologic services, as needed. He has managed geologic and hydrogeologic investigations for a variety of industrial and governmental clients. Responsibilities include planning, developing, directing, conducting, and overseeing technical analysis for dewatering and for groundwater and surface water investigations. He has expertise in groundwater monitoring, tidal influence studies, groundwater and contaminant transport modeling, and borehole geophysics. Roy is familiar with a wide range of Washington State and federal regulations such as MTCA, CERCLA, RCRA, and many other through his work on environmental assessment and remediation projects. His dewatering experience has given him a solid understanding of NPDES and local municipal water treatment and disposal regulations.

REPRESENTATIVE PROJECT EXPERIENCE

Remedial Design Investigations. Frontier Hard Chrome Superfund Site, Vancouver, WA. Conducted multiple-phase hydrogeologic investigations in support of a remedial design of a dissolved chromium plume at a Superfund site for the EPA. Conducted site investigations consisted of borings, installation of wells, borehole geophysics, aquifer testing, and development of a groundwater and well log database, water level measurements, and groundwater and soil sampling. Developed and conducted a two phased groundwater level monitoring program that demonstrated that water levels at the site were directed related to the stage of the tidally-influenced Columbia River. Developed a flow and transport model using MODFLOW and MT3DMS to understand historical changes in plume configurations and predict plume behavior. Transport model was used to evaluate potential of natural attenuation to reduce chrome groundwater concentration.

Groundwater/Surface Water Interaction Study, Renton, WA. Conducted a groundwater/surface water interaction study of the Cedar River adjacent to the Renton Airport and a major aircraft manufacturing facility for the Boeing Company. The study determined the hydraulic influence of the Cedar River on the fate and transport of several petroleum and solvent groundwater plumes.

Dewatering Plan, Renton, WA. Developed a dewatering plan for the Boeing Company to support the construction of large municipal sewer line. The work consisted of reviewing the local hydrogeology and using the computer program

FLOWPATH to predict the quantity of pumping required, to provide the necessary and cone of depression to dewater the sewer trench and prevent the movement into areas of the aquifer not impacted by contaminated groundwater.

Hydrogeologic Assessments, Various Sites, Puget Sound Region, WA. Completed numerous hydrogeologic assessments of properties as required for land use planning and environment impact studies. Typical tasks included the following: (1) Reviewing the available geologic, hydrologic and soil information relative to the site and surrounding areas; (2) Conducting a reconnaissance of the site and adjacent areas; (3) Evaluating the vegetation, soil, geology and water conditions at the site by completing on-site explorations; (4) Collecting representative environmental media samples to evaluate site conditions and determine pertinent characteristics; (5) Evaluating hydrologic conditions by reviewing available regional and local data and on-site explorations; (6) Assessing site-specific conditions in accordance with federal, state and local regulations; (7) Performing a hydrogeologic assessments and evaluating potential changes to the sites conditions; (8) Developing and providing recommendations for mitigating environmental concerns.

Technical Review, Various Sites, Regions 9 and 10, WA, OR, AK, CA. Provided technical hydrogeology review in support of groundwater investigations of over 20 Superfund and Department of Defense sites for EPA Regions 9 and 10 (Washington, Oregon, Alaska, California). At the direction of the EPA project manager, reviewed and evaluated work plans, groundwater investigation reports, groundwater model reports and other technical documents.

Technical Review, Various Sites, Commencement Bay, WA. Provided technical review for the EPA for various proposed or constructed sediment disposal sites in the Hylebos, Blair, Theo Foss, Sitcum and Milwaukee Waterways within the Commencement Bay Superfund sites. Tasks included review of the work plans, groundwater investigations and remedial designs to determine if they meet the projects and protectiveness to human health and the environment.

Groundwater Remedial Alternative Analysis, Aerojet Superfund Site, Sacramento, CA. The objective of this project for the EPA was to evaluate six groundwater remedial alternatives at a large aerospace design and manufacturing facility. The proposed remedial alternative consisted of extracting groundwater contaminated with perchlorate from four separate aquifers and discharging treated water to a local stream drainage. To meet the projects objectives developed several powerful tools based on particle tracking to predict the extent of the plume and determine the relative efficiency of extraction wells for the various remedial alternatives. An existing flow model was modified and adapted for use for particle tracking using MODPATH. A tool was developed to process the files generated by MODPATH in order to compare the various remedial alternatives.

Wetlands Assessments. Various Sites, Puget Sound Region, WA. Completed several wetland assessments and recovery plans to meet regulatory requirements for environmental assessments.

Groundwater Monitoring Plan, Gravel Mining Operation, Pierce County, WA. Developed a groundwater monitoring work plan to monitor impacts of gravel mining operation on water quality of a critical drinking supply aquifer. There was a concern that the mining operation would impact water quality by increasing salt-water intrusion.

CHRIS GARDNER

Field Geologist, GIS Specialist

EDUCATION

B.S., Geological Sciences, 1995, University of Washington

Chris has 5 years of experience with a variety of environmental and geotechnical drilling techniques associated with groundwater well installations. He has extensive experience sampling, developing, and slug-testing groundwater wells. Chris is skilled in collecting and analyzing down-hole pressure transducer data generated from slug tests and long-term hydrogeologic monitoring efforts. His data compilation and presentation skills have been used for many Port of Seattle reports.

Chris has 6 years of experience in geology and GIS systems. His expertise includes collection and plotting of GPS data for production purposes, from report figures to large-scale maps. His experience with GIS-related tasks includes digitizing, layer/theme creation, layer/theme re-projection, layer/theme editing, data sourcing, data conversion and compilation; and map design, annotation, and production.

Chris also performs construction observation activities, including augercast pile installation, soldier pile installation, tieback anchor installation and stress testing, nuclear density testing, subgrade inspection using T-Probe, and placement and compaction of structural and non-structural backfill. He is experienced with soil sampling and headspace readings using PID, and completing borehole logs during Geotechnical/Environmental Hollow-Stem Auger/Strataprobe borehole drilling operations.

REPRESENTATIVE PROJECT EXPERIENCE

Rock Creek Basin GIS Services, Auburn, WA. Hart Crowser is working on a hydrogeologic study for the City of Kent to characterize the groundwater flow and surface water interactions, to assess the impact of continued water supply withdrawals from Clark Springs. Chris developed detailed land use maps using current aerial photography to overlay higher resolution topographic base maps. His work involved extensive data layering and annotation. The ArcMap GIS has been used to categorize sub-catchments on a parcel-by-parcel basis to quantify land use developments, vegetation cover, and soil type. This will facilitate analysis and potential management alternatives.

Post Point Outfall GIS Services, Bellingham, WA. This project involves assistance with a submerged CSO outfall that had become filled with sediment in up to 200 feet of the offshore segment. Hart Crowser surveyed eelgrass using Hart Crowser's proprietary Sea-All™ underwater video system, which features a Differential Global Position System. Chris integrated aerial photography data, underwater video data, and GPS data into a GIS map. The map was used to evaluate alternatives to determine the most cost-effective pipeline rehabilitation alternatives that minimize

disturbance to the eel grass bed, reducing the need for mitigation. Hart Crowser and Chris are being highly responsive to client schedule needs for this project.

Landfill 9 GIS Services, Fort Lewis, WA. Created a GIS map of a 14-acre abandoned landfill used for disposal of vegetation, medical waste, and municipal waste. The map incorporated new soil boring and monitoring well locations. The work was done for the Corps of Engineers and Fort Lewis Public Works.

Monorail Development GIS Services, Seattle, WA. Created EDR maps associated with environmental site assessments for development of a regional transit system. The Monorail Green Line will cover a 14-mile route to connect the urban downtown area with neighborhoods.

Coal Creek Steam Vent GIS Services, Cougar Mountain, WA. Used a LiDAR base GIS map to display locations of coal seam features for the Office of Surface Mining.

City of Bellingham Eel Grass and WWTP GIS Services, Bellingham, WA. Integrated aerial photography data, underwater video data, and GPS data into GIS map.

Embankment Fill Monitoring Program (EFMP), SeaTac, WA. Chris developed and slug-tested the 15 monitoring wells installed to form the EFMP monitoring well network. Additionally, Chris was a member of the team that performed monthly groundwater sampling of the EFMP network wells for the duration of the 18-month baseline study. Chris is currently working to analyze slug test data collected from EFMP replacement wells.

Thea Foss Waterway, Tacoma, WA. Assisted with installation of pressure transducers that are being used to monitor settlement during deposition of dredged sediments at this Superfund site.

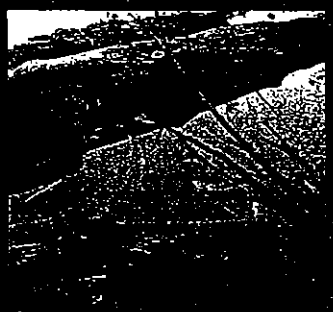
Seattle Packaging Property, Seattle, WA. To assess soil contamination from industrial activities, sampled sediments and oversaw installation of groundwater sampling wells.

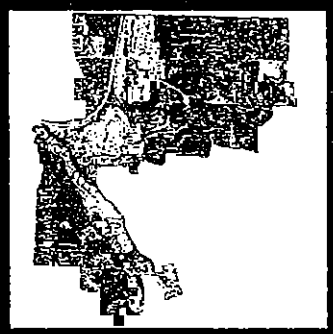
Seattle Art Museum Park, Seattle, WA. Supervised contractors during excavation of contaminated soil. Screened soils using PID. Conducted stockpile and verification confirmation chemical sampling and analysis.

Port Angeles Graving Dock Geotechnical and Hydrogeologic Study, Port Angeles, WA. Chris observed the completion of 5 geotechnical borings and the installation of 3 monitoring wells. His oversight responsibilities included logging soils during borehole drilling activities and observing monitoring well installations. Additionally, Chris performed well development tasks and assisted with both pumping test execution and relative elevation surveying of the installed dewatering and monitoring wells.

Confidential Client Groundwater Well Installation and Monitoring, Eastern WA. Chris observed drilling, installation, and development activities associated with several monitoring wells. Air rotary drilling techniques were used to advance select borings on the site to depths as great as 150 feet within the gravelly soils encountered. Chris logged, screened (using a PID), and sampled soils during drilling of the borings. Additionally, Chris returned to the site as a groundwater sampling team member and completed a comprehensive sampling effort.

ATTACHMENT D





CITY OF WOODINVILLE
REQUEST FOR QUALIFICATIONS
ENVIRONMENTAL CONSULTING SERVICES FOR SUSTAINABLE DEVELOPMENT PROGRAM

Prepared for:

City of Woodinville
Department of Community Development
17301 133rd Avenue NE
Woodinville WA 98072

Prepared by:

The Watershed Company
1410 Market Street
Kirkland WA 98033
p 425.822.5242
&
AHBL
2215 North 30th Street
Suite 300 Tacoma WA 98403
p 253.383.2422

May 2006

THE WATERSHED COMPANY

SCIENCE & DESIGN

RECEIVED

MAY 05 2006

CITY OF WOODINVILLE
PLANNING DEPARTMENT

May 5, 2006

Ray Sturtz
Community Development Director
City of Woodinville
17301 133rd Avenue NE
Woodinville, WA 98072

Re: RFQ for Environmental Consulting Services for Sustainable Development Program

Dear Mr. Sturtz and City staff:

The Watershed Company is pleased to respond to your request for qualifications for environmental consulting to include a review and assessment of Woodinville's critical areas, an analysis of potential development impacts and recommendations for protection. We have assembled an outstanding and creative multidisciplinary team to cover the skills required and to ensure that the City meets state requirements pursuant to the Growth Management Act while it strives to protect the natural amenities so important to its unique woodland character.

The Watershed Company, a Kirkland-based environmental consulting firm with 23 years of experience in the assessment and restoration of critical areas, particularly streams, wetlands and wildlife habitat, will be prime consultant. **AHBL, Inc.,** of Seattle and Tacoma, national leaders in Low Impact Development (LID) research, techniques, design guidelines and site design, will provide a full range of engineering and planning support services. **Pacific Groundwater Group** of Seattle, leaders in the fields of hydrogeology and watershed assessment, will provide additional technical support for the project.

Our strengths for this work include:

- Outstanding qualifications and experience analyzing critical areas, prioritizing areas for protection and recommending preservation and enhancement measures in the context of growing population pressures,
- Experience in working with an extensive catalog of regional geospatial data, modeling ecological processes, modeling patterns of future development, facilitating conservation planning and producing powerful, highly communicative cartography and other graphics,
- Extensive knowledge of the requirements of the Growth Management Act, familiarity with Woodinville's natural resources and its Critical Area's Ordinance and the latest Low Impact Development ordinances and techniques, and
- Experience with creating satisfying and successful public process that involves, educates and coalesces the community through the use of scientifically-sound but easy to understand maps and documents as well as open and well-run public forums.

The Watershed Company has completed city-wide critical areas assessments, ordinances and conservation plans for multiple jurisdictions in the Puget Sound region, including the Kirkland, Monroe, Shoreline, Medina, Stanwood, and Mercer Island. Much of this work has been to

1410 Market Street Kirkland, WA 98033
425 822-5242 425 827-8136(f) watershedco.com

satisfy State Growth Management Act requirements. As well, the firm has completed corridor-wide protection plans for Thornton Creek in Seattle, the Sammamish River and Bear Creek in Redmond and Tibbetts Creek in Issaquah. The Watershed Company's multidisciplinary staff includes technically skilled biologists, planners, engineers, geologists, Geographic Information Systems specialists and landscape architects intimately familiar with local, state and federal environmental regulations and regional goals for resource enhancement. The firm's mission is to study and restore natural environments, drawing on the best scientific methods and aesthetic considerations. We have found that many human goals for growth can be achieved without harming the natural environment, but that this requires careful study and planning.

AHBL has been working with local jurisdictions and private developers to advance Low Impact Development (LID) in the Puget Sound region since 2001. This work has involved research and analysis of techniques, the development of LID ordinances and design guidelines for 11 jurisdictions, and the application of LID to specific site development projects. In addition to these services, AHBL works with public clients on GMA comprehensive plans, design standards and zoning codes, subarea planning and studies, public involvement, and development guidelines. AHBL was founded in 1969 to bring a collaborative approach to the development of built environments. Services include community and land use planning, civil and structural engineering, landscape architecture, and survey. The firm is committed to creative design, cost effective solutions, capturing and maintaining the sense of community, and integrating our area's natural and cultural heritage into our ever-changing communities.

Pacific Groundwater Group (PGG) is a water resource and environmental consulting firm that specializes in water-resource management, groundwater supply development, and hydrologic analyses related to land use change. Since 1987, the firm has assisted a wide variety of clients in solving complex water-resource and environmental challenges. PGG provides the hydrogeologic tools and analytical expertise needed to manage groundwater resources in the face of rapid growth, maintaining their quantity and quality for the future.

The City of Woodinville has been wise to take a breath and consider the impacts of development and how future growth can be more ecologically sustainable. The building and land use moratorium in the R-1 zone gives the City and its citizens time to study the potential environmental impacts of further growth and use this information to make informed decisions on the appropriate location and intensity of new development. The challenge will be to accommodate growth and allow reasonable use of private property, while protecting and enhancing the environment and quality of life. The goal of our team will be to bring appropriate scientific information to bear on these issues, craft thoughtful recommendations for consideration, and help you design and execute a public involvement process that builds informed consent for an ecologically and politically sustainable solution.

Materials, including the required statement of understanding, company profiles, relevant projects, references, scope and budget follow. We are eager to get started and meet your scheduled completion for the R-1 report in August and the City-wide report in October of 2006.

Sincerely,

A. William Way

President

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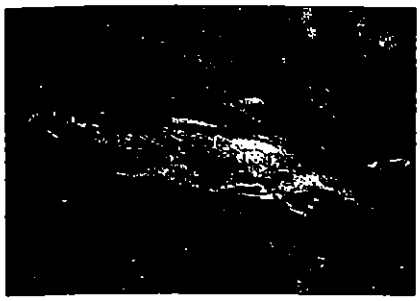
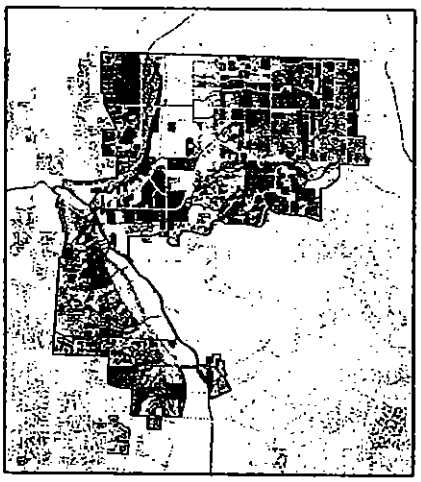
425 822-5242 425 827-8136(f) watershedco.com

Statement of Understanding: Maintaining natural resources and community character while accommodating growth



Preserving Woodinville's natural systems and character, while accommodating growth, has long been the central challenge and is a consistent theme in the City's Comprehensive Plan. The City Council's adoption last fall of a *sustainable development* goal reflects current efforts to cope with growth pressures in the community. The City recognizes that population growth must be managed in ways that maintain or improve Woodinville's quality of life, environmental attributes and Northwest woodland character. Consistent with the Growth Management Act, the City recognizes that it must "show it's work" in establishing appropriate zoning and development regulations. Additional information and specific implementation actions are necessary to protect critical areas and give special consideration to the protection of anadromous fisheries. At stake is not just compliance with state and federal law, but the very character of the City and the integrity of the physical environment.

Concerns are most acute in the Wellington and Lake Leota areas of the City, where the Comprehensive Plan allows up to four units per acre, but current zoning (R-1 Zone) allows only one dwelling unit per acre. The R-1 Zone includes the headwaters of Bear Creek, as well as a groundwater aquifer. Portions of the area also drain into Little Bear Creek and Woodin Creek. These streams are known to contain salmonids, including threatened Chinook salmon. Since incorporation, the City has allowed this portion of the City to be converted to the higher density through a public hearing process with developer-provided extensions of sewer lines. Two recent rezone and development proposals in this area, Wood Trails and Montevallo, have resulted in increased public concern. The City recently imposed a building and land use moratorium in the R-1 zone to allow for environmental studies and the development of protection measures. This decision gives the City time to study the potential environmental impacts of further development and use this information to make informed decisions on the appropriate intensity of new development.



In order to appropriately guide new development, the City must have sufficient information about the resources present and the natural processes and functions that are at risk. The goal is to better understand the ecological importance and contribution of the R-1 Zone and other portions of the City to the larger watershed. Documentation of the types of habitat and functions this area provides, the importance of these habitats and functions in regional ecology, and the impacts of potential conversion, is key to determining the location and level of necessary protection. This information will also be important for demonstrating compliance with GMA and related case law regarding the

provision of compact urban development and appropriate methods of critical area protection. With the recent *Normandy Park* decision by the King County Superior Court and the erosion of the "4 dwelling units per acre" bright line rule, the City has additional flexibility to determine appropriate levels and types of development. However, it must "do its homework" to demonstrate it is planning to meet GMA goals, as well as Endangered Species Act requirements.

Once a baseline of existing conditions information and the likely impacts of development are established, the City will evaluate various tools for managing growth. These tools include modifying the existing zoning and revising land use policies, regulations and practices to protect at risk resources. The challenge is to protect these resources while still meeting growth targets and allowing reasonable use of affected lands consistent with the Growth Management Act, takings case law and City policy. In addition to refining existing zoning, some of the tools that could be examined and implemented include broader definitions for critical areas, better development regulation metrics, Low Impact Development (LID) standards, additional tree retention incentives, land cover conversion controls, basin specific stormwater requirements, and perhaps even density transfer mechanisms.

This project would appear to be as much a planning and community development challenge as it is a scientific assessment. ***The successful team will not only help the City bring the community to a better understanding of the ecological resources at risk, but also help demonstrate how the interests of the various stakeholders can be balanced and how solutions to growth can be crafted that reflect the values of the citizens of Woodinville.***

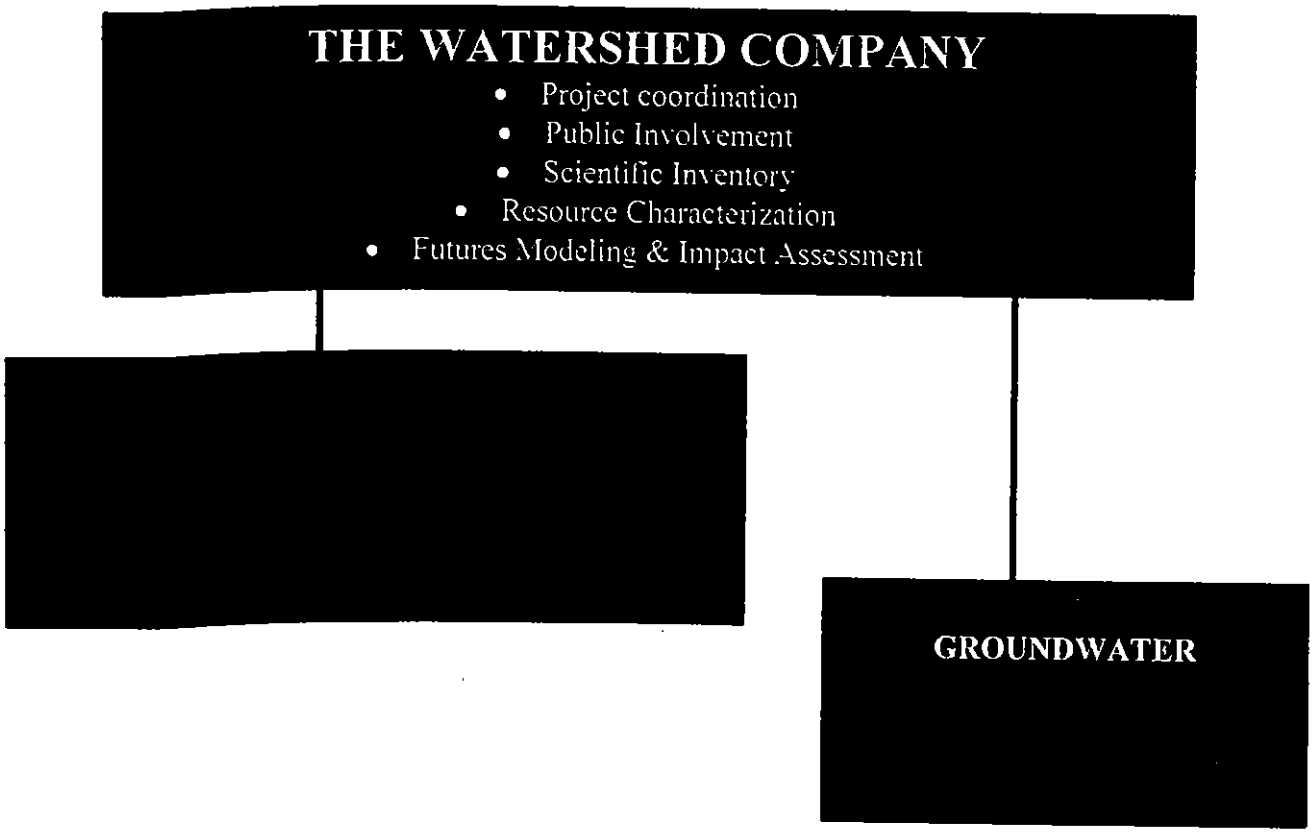
For these reasons, **The Watershed Company**, an award-winning environmental consulting firm specializing in the management and restoration of natural resources, has teamed with **AHBL,** a planning, engineering and design firm that is a recognized leader in Low Impact Development (LID), and **Pacific Groundwater Group**, hydrogeologists. In addition to technical skills and ethics that are beyond reproach, the team brings political sophistication and a respect for public process that allows it to do more that simply provide data and recommendations and then retreat to the ivory tower. Our team understands the need for information that City staff can use to establish and maintain credibility, build consent, and allow decision makers to implement actions that are both politically and ecologically sustainable.

With the recent development moratorium and the resulting public scrutiny, it is clear that the key to a successful outcome will be to engage the public in meaningful ways to help shape the focus of the study and the options that are considered. Learning from recent work by CommEn Space and The Cascade Land Conservancy, we will be able to use public involvement to help craft alternative futures and recommendations for consideration and provide a "bottom up" approach to building informed consent for a desired future outcome. The power that comes from stakeholder response to visual models is increasingly recognized by public involvement experts as an effective way to ensure citizens become invested in the process and responsible for the solutions.

Project Roles, Responsibilities and Key Staff

The City of Woodinville has identified an extremely rapid timeframe for this work in the RFQ. We believe the only way to meet the City's needs and expectations for this project is to assign a significant number of highly experienced staff who have the expertise to do the efficient assessment the City requires. The key will be to set up the project with clear goals and expectations so that we can move forward with the City from a clear base of understanding. The Watershed Company and AHBL have assigned an outstanding team of senior planners, engineers and scientists to the Woodinville Sustainable Development Program. We have established a clear delineation of leadership and functional responsibility within this team. The Watershed Company will coordinate all aspects of the project and lead the scientific inventory, resource characterization, futures modeling and impact assessment. AHBL will assist with impact assessment and lead the analysis of zoning, land use planning and code recommendations, including stormwater, street, and site development standards. The two firms will share responsibility for public involvement. The two firms will be supported by the specific technical expertise of the Pacific Groundwater Group.

Project Team Organization



Project Team

The Watershed Company

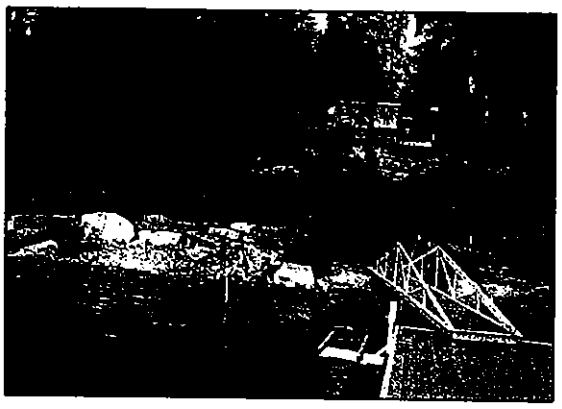
The Watershed Company has more than 24 years of experience in natural resources assessment and conservation planning, and restoration design. The firm includes a multi-disciplinary team of biologists, geologists, engineers, planners and landscape architects to perform an evaluation of natural resources, processes and structures in both the R-1 Zone and the City as a whole, with a specific focus on the protection of anadromous fish. The Watershed Company is currently working with Woodinville to ensure the adequacy of the Wood Trails and Montevallo EIS, and has done conservation planning, environmental impact assessment, code development and restoration project design throughout Western Washington, including current work for the cities of Lake Forest Park, Shoreline, Kirkland and Issaquah. Recent relevant projects include:

Kirkland Shoreline Master Plan Update, City of Kirkland, WA, 2005-2006. The Watershed Company is assisting the City with an update to its Shoreline Master Plan as required by the Washington Growth Management Act. Work so far includes a comprehensive inventory and characterization of the City's shorelines which describes existing conditions, assesses ecological functions and ecosystem-wide processes and provides the foundation and direction for development of the updated SMP. Field survey was supplemented with existing City documents and draft GIS maps, scientific literature, personal communications, aerial photographs, and internet data. The Watershed Company is assisting with development of GIS maps and required submissions to the Department of Ecology.

Shoreline Master Program Update/Shoreline Study - City of Marysville, 2005. The Watershed Company prepared the shoreline inventory and characterization report, including a restoration plan. Marysville's shorelines include Ebey Slough and Steamboat Slough, tidally influenced portions of the Snohomish River system, and Quilceda Creek. The analysis supported development of the Shoreline Master Program and the cumulative impacts analysis.

Shoreline Master Program Update/Inventory and Critical Areas Regulations – City of Monroe, 2001-2004. The Watershed Company conducted physical inventories and reviewed the literature to prepare a report examining current and historical fish and wildlife conditions in the Skykomish Basin, and in the in-City portions of the Skykomish River and Woods Creek for the SMP Update. The firm then assisted the City of Monroe with the update of its Critical Area Regulations as required by the Growth Management Act, Shoreline Management Act, and the federal Endangered Species Act.

Shoreline Mater Program Update and Shoreline and Stream Study – City of Stanwood, 2001-2002. The Watershed Company examined current and historical fish and wildlife conditions in the Stillaguamish Watershed, and in the in-City portions of the Stillaguamish River and Church and Douglas Creeks based on physical inventories and literature reviews. Our report included a best available science discussion and made recommendations for restoration of fish and wildlife habitat. It also proposed policies and regulations for inclusion in the Comprehensive Plan, Shoreline Master Program, and critical areas ordinances.



Critical Areas Regulations Update and BAS – City of Sammamish, 2005. The Watershed Company provided a review of the best available science (BAS) during the recent update to the critical areas regulations for the City of Sammamish. This included a review of the existing and proposed regulations based on the scientific literature and participation in the Citizen Advisory Committee meetings to describe the reasoning and justification for the proposed changes.

Lake Sammamish State Park Wetland, Stream and Lakeshore Restoration Plan – Washington State Parks Commission, 2005. The Watershed Company prepared an award winning sensitive area restoration plan for the 512-acre Lake Sammamish State Park in Issaquah as part of park master planning and redevelopment work. Watershed Company staff completed extensive field assessment of the landscape and then identified, evaluated, and ranked specific prospective project areas within the park for restoration of natural lands and associated buffers. Presentations were made to parks and citizens groups. The work won a Washington Association of Landscape Architects Honor Award, the highest possible, for environmental planning.

Shoreline Master Program Update/Inventory and Waterfront Sub-area Plan – City of Wenatchee, 2002-2003. The Watershed Company performed a shoreline inventory and analysis in support of both the ongoing visioning process for the development of the sub-area plan, and the update of Wenatchee's Shoreline Master Program (SMP). Our work won an American Planning Association award for natural resource assessment and planning.

Critical Areas Regulations Update and BAS - City of Mercer Island, 2002-2004. The Watershed Company assisted the City of Mercer Island with an update to its critical lands regulations to comply with the Washington State Growth Management Act and the Endangered Species Act. Revised regulations were developed in conjunction with "best available science" and other criteria and measured for consistency with the City's Comprehensive Plan. The Watershed Company participated in stakeholder meetings to ensure the revisions were consistent with the City's various interest groups.

Staff Assigned

President A. William Way, a stream protection and restoration pioneer with 29 years of relevant experience, will help shape the project vision, conceptual design and provide aquatic science expertise and quality control. Project manager, **Gabe Snedeker**, AICP, former Principal Planner for the City of Mercer Island, will coordinate the activities of the project team. Mr. Snedeker will provide the City with a single point of contact that can bridge the divide between science and public policy in the municipal context. He has a proven track record leading critical area inventories, ordinances, plans and assessments for local governments. His experience with watershed planning for the US Forest Service, as well as local government, will provide additional perspective. **Matt Stevenson,** with an impressive record of GIS landscape analysis and conservation projects for the non-profit CommEN Space, has joined The Watershed Company to harness the full power of this analytical tool for rapid watershed assessment and futures modeling.

Project Team

Professional Wetland Scientists **Jennifer Creveling** and **Hugh Mortensen,** will assess the wetland resources and functions. **Greg Johnston,** Certified Fisheries Professional, will address fisheries habitat issues and offer ideas for restoration and preservation. **Mark Indrebo,** Licensed Geologist and fluvial geomorphologist, brings specialized training and experience in stream flow and migration. **Mark Garff,** Registered Landscape Architect, has extensive knowledge of native plants and tree ecology. **Amy Myers** and **Suzanne Tomassi,** wildlife and wetland biologists, join the team to assist with field work and add their experience with Shoreline Management Plan updates. Fisheries biologist **Aaron Bosworth** will share his expertise with WRIA 8 resource goals

AHBL

AHBL, Inc., leaders in Low Impact Development (LID) research, techniques, design guidelines and site design, will provide a full range of engineering and planning support services. By demonstrating excellence and providing superior services over its 37-year history in the Puget Sound region, AHBL has grown to over 100 staff, including one of the largest private sector planning departments in the state. The firm's 17 planners have diverse backgrounds spanning urban design, municipal planning, landscape architecture, and private land use consulting. Clients for comprehensive long range and current planning services include public agencies, private developers, architects, and school districts. Municipal services include GMA comprehensive plans, annual updates and subarea planning and studies, development guidelines, public involvement, design standards and zoning codes. The firm has extensive experience with large-scale, multi-disciplinary projects and is skilled in explaining complex issues and concepts in a concise, straightforward manner to the public and appointed/elected officials. Recent relevant projects include:

Puget Sound Action Team Low Impact Development Assistance – Phase I & II. AHBL provided land use planning consulting services for Puget Sound Action Team. Services included consulting with 11 jurisdictions within the Puget Sound, including the cities of Bellingham, Marysville, Redmond, Issaquah, and Poulsbo; and Thurston, Kitsap, Jefferson, Whatcom, Clallam, and Snohomish counties. AHBL met with staff teams to determine the jurisdictions' interests and areas of concern in implementing low impact development (LID). AHBL then evaluated existing codes to determine impediments to implementation of and recommended amendments to facilitate the use of LID tools. AHBL also provided supplemental materials including LID facility maintenance specifications, roadway and parking standard comparisons, potential incentives, and existing LID documentation and standards from other jurisdictions. The project was completed in April, 2006. AHBL was subsequently selected to offer consulting services for Phase II of the project beginning in May of 2006, which will include working with the cities of Woodinville, Kirkland, Port Orchard, Edmonds, Port Angeles, Lacey, Normandy Park, and Mason County.

Sehmel Homestead Park, Gig Harbor, WA. AHBL is providing civil and structural engineering, land use planning, landscape architecture, and land survey services to Peninsula Metro Parks for the development of Sehmel Homestead Park. The 98-acre site is located in unincorporated Pierce County, near Gig Harbor and features steep slopes. Because of the site's location in a rural overlay district, the firm was required to utilize the Low Impact Development Chapter of the Pierce County Stormwater Management and Site Development Manual. This is the first major project being

designed under this newly adopted chapter. With a site complicated by steep slopes, and wetlands and their buffers, civil engineers achieved the following with the site design: retained over 65% of native soils and vegetation; minimized stream crossings; limited the impervious area to less than 10% through the use of pervious pavement and parking, and managed stormwater through the use of pervious pavement, a raingarden and sheet flow dispersion to maintain existing flow patterns.

Meadow on the Hylebos Low Impact Development, Pierce County, WA. AHBL is providing land use planning, civil engineering and landscape architecture services for this unique residential development in Pierce County. The private developer's vision is to create a residential community using Low Impact Development (LID) techniques as a demonstration project. AHBL has been working closely with Pierce County staff on LID regulations and the conceptual redesign of existing projects. The Meadow on the Hylebos is an opportunity to utilize the LID concepts within an actual 35-lot residential subdivision. Construction began in Spring of 2005. The 8.9-acre site is located between Milton and Fife in unicorporated Pierce County, at the geographic center of an urban growth area. The site is bisected by Hylebos Creek and an associated wetland, and contains soils with poor infiltration rates.

Staff Assigned

Associate Principal Julia Walton, AICP, will bring her 21 years of planning experience and award winning public involvement skills to bear. With assistance from The Watershed Company, she will use her expertise as a certified coach and facilitator to help the City lead the stakeholders through these complex issues. AHBL is the leading expert in LID ordinances in Western Washington and has done several developments that demonstrate the viability of the new codes and approach on the ground. AHBL LID Expert, **Len Zickler,** AICP, ASLA, will communicate the vision behind this approach to development and will be supported by **Doreen Gavin,** Principal/PE and **Laura Gringnon**, PE, who have specific expertise in the design of stormwater and street infrastructure. In addition to LID, AHBL has extensive experience with crafting comprehensive plans, subarea plans, zoning map refinement and code development throughout the Puget Sound. Senior Planners **Wayne Carlson** and **Owen Dennison** will provide the project team with additional planning and zoning muscle and depth.

Pacific Groundwater Group

PgG

Aquifer assessment and protection has been identified as an important issue in this study. Pacific Groundwater Group, leaders in the fields of hydrogeology and watershed assessment, will provide their geologic expertise. Pacific Groundwater Group (PGG) is a water resource and

environmental consulting firm that specializes in water-resource management, groundwater supply development, hydrologic analyses related to landuse change, and contaminant assessment/remediation. Since 1987, PGG has assisted a wide variety of clients in solving complex water-resource and environmental challenges throughout the Pacific Northwest. PGG offers extensive consulting experience and recognized expertise in groundwater and surface-water evaluations that incorporate disciplines ranging from geology, hydraulics, and chemistry to climate and soil science. Advanced tools for modeling groundwater flow, surface water / groundwater connections, wellhead capture, and deep percolation for recharge analyses are used. Recent Relevant Projects include:

WRIA 17 Level I Assessment, Jefferson County, WA. PGG performed a Level 1 assessment of Salmon Snow Watershed. The firm characterized precipitation patterns, water-right allocations, groundwater quality, hydraulic continuity, groundwater use and groundwater recharge (for a water-budget analysis), and relationships between land use and groundwater. Because of its efficiency for handling large data sets, the firm used GIS approaches to maintain data, perform analyses, and generate maps.

South King County Groundwater Management Plan, King County, WA. PGG assisted South King County in the development of a comprehensive Groundwater Management Plan. Services included: characterizing the hydrogeology of the area, developing a database and GIS for the project, designing and implementing a network for long-term data collection

City of Redmond Wellhead Protection Plan, Redmond, WA. PGG characterized the hydrogeology near five supply wells owned by the City of Redmond. The hydrogeologic setting of the area featured glacial and alluvial aquifers, as well as surface water bodies such as the Sammamish River, Lake Sammamish, and several creeks. We delineated wellhead-protection areas using an analytical-element groundwater model (TwoDAN) and compiled a contaminant database. To identify contaminant sources, we queried governmental databases and linked the data to GIS. This approach allowed the City to graphically interpret the data for wellhead protection areas and prioritize threats to water quality.

Staff Assigned

Charles T. Ellingson, RPG/CGWP, principal hydrogeologist, brings 22 years of consulting experience in groundwater impact predictions. **Linton Wildrick,** RHG, associate hydrogeologist, brings 30 years of well-rounded experience, both as a private consultant and as senior hydrogeologist and technical supervisor for Ecology's Water Resources Program.

We believe that we have assembled a team that can quickly provide the City with the necessary required decision making tools. If there is any additional technical expertise that is identified after further refinement of the scope and completion of the data gap analysis based on the input of the consultant team, City and the Citizen's Advisory Panel (CAP), we are prepared to provide it.

References

The Watershed Company

- **Paul Stewart** ..... **(425) 587-3227**
  Deputy Director of Community Development, City of Kirkland
- **Richard Hart** ..... **(206) 236-3593**
  Director of Development Services, City of Mercer Island
- **Dave Davis** ..... **(425) 257-8913**
  Director of Engineering/Public Services, City of Everett

AHBL

- **Bruce Wulkan** ..... **(360) 725-5455**
  Stormwater Program Manager, Puget Sound Action Team
- **Joe Scorcio** ..... **(253) 798-4661**
  Asst Public Works Director, Pierce County
- **Mark Burlingame** ..... **(253) 564-8900**
  Public Works Director, City of Fircrest

Pacific Groundwater Group

- **Dan Smith** ..... **(360) 754-4140**
  Public Works Department, City of Tumwater
- **Lys Hornsby** ..... **(425) 277-5539**
  Public Works Department, City of Renton

Scope of Work

Task 1: Project Coordination

Our first goal will be to refine the focus of the City's Sustainable Development Program. This initial step is key to establish a shared vision and expectation for content and methodology contained in both the R-1 Zone Report and the City-wide Report. The Consultant will create draft informational materials and provide recommendations on public process design and facilitation as determined necessary by the City. In addition, the Consultant should confer with all other appropriate entities that may have useful scientific, technical or cultural information, including federal agencies, watershed management planning units, salmon recovery lead entities, universities and other institutions. The Watershed Company will manage and coordinate the work of AHBL and Pacific Groundwater Group and serve as the primary contact with the client.

- **Deliverables:** CAP kick-off informational materials, stakeholder scoping letter and initial coordination and scoping meeting with City staff. Note: project scope will be refined based on City and CAP input.

- **Completion:** June 2, 2006. Please note that this schedule assumes the contract is signed on May 26, 2006 as stated in the RFQ.

Task 2: Public Involvement

The City will convene a Citizen's Advisory Panel (CAP) for this study as a primary public involvement mechanism. The Consultant will work with the City to establish, manage and staff the CAP and identify any additional stakeholder involvement. Public involvement opportunities will also be provided through Planning Commission and City Council hearings. At part of this initial task, the CAP will provide input to the process of creating the overall strategy for this plan. The Consultant will work with the CAP and staff to determine the appropriate scale and level of detail of the analysis. The Consultant and City Staff will meet with the CAP at appropriate project stages to obtain information and feedback on specific tasks, and informed consent for desired future outcomes and recommendations.

- **Deliverable:** A public involvement plan and meeting schedule will be established. The plan will outline the strategy for effective and meaningful citizen involvement.

- **Completion:** June 2, 2006 (Public Participation Plan). Public participation will be ongoing throughout the project including, CAP, other identified stakeholders, Planning Commission and City Council.

Task 3: Existing Data Inventory and Collection

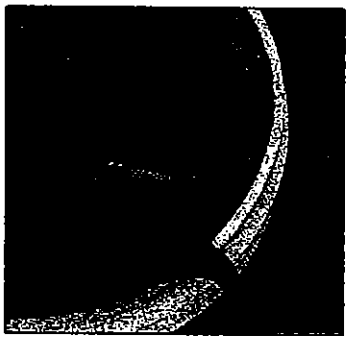
The Watershed Company, with assistance from other members of the team, will work with the City to identify and collect all pertinent and reasonably available data, plans, studies, inventories and other applicable information. These may include, but are not limited to, groundwater studies, recent surficial geology mapping, Little Bear and Woodin Creek Basin Habitat Assessment studies, WRIA 8 Chinook Salmon Conservation Plan,

existing critical area inventory, WA Trout data, USFS data, remote sensing data identified in Task 5, impervious surface coverage studies, and current and historical orthophotos (also see data sources in Task 5). The Consultant will review this information and, after consultation with the City and CAP, determine what additional data collection may be necessary to complete the analysis.

- **Deliverable:** Draft memo submitted to the City outlining existing data sources, data gaps and recommended data collection, including additional analysis of remote sensing data. The Consultant will assist the City in finalizing the Memo for discussion with CAP and stakeholders as appropriate.

- **Completion:** June 9, 2006

Task 4: Field Data Collection



Limited additional fieldwork, focusing on public lands and other accessible properties, will be performed to verify key assumptions and conditions, e.g. verification of stream and wetland presence, location and type and habitat quality. Prior to beginning this work, the Watershed Company will meet with the CAP and other stakeholders to obtain anecdotal information and closely review existing information for known or suspected features. The Watershed Company, aided by Pacific Groundwater Group, will deploy a team of senior scientists, including a stream biologist, professional wetland scientist, fluvial geomorphologist, wildlife habitat biologist and hydrogeologist, to perform a rapid field inventory. Data will be gathered and interpreted for specific processes and resources and will focus primarily on factors that influence anadromous fish habitat presence, abundance and quality.

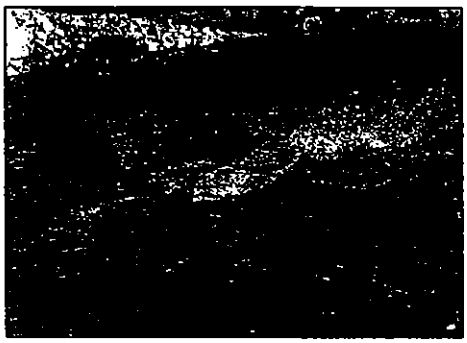
- **Deliverable:** Draft memo submitted to the City outlining data sources, maps, tables and field data collected, and discussion of any additional information that a description of geospatial data be collected at the project review level. Consultant will assist the City in finalizing the memo and discussion with CAP and stakeholders as appropriate.

- **Completion:** June 16, 2006

Task 5: Resource Characterization and Vulnerability Assessment

The Consultant will assess targeted areas of the City where there are known or potential critical areas, including streams, wetlands, steep slopes, geologic hazards, critical aquifer recharge areas, flood hazard areas and fish and wildlife conservation areas. In addition to the R-1 Zone, the Consultant will work with the CAP and staff to determine particular areas of the City that will be analyzed in greater detail and the level of detail necessary, particularly with regards to hydrogeology. Pacific Groundwater Group will provide support for groundwater issues determined to be necessary following

consultation with the City and the CAP. These may include delineating critical aquifer recharge areas and stream capture areas, assessing the origins and role of wetlands and groundwater factors which influence stream flow. The Consultant will assess the current hydrological conditions, identify limiting factors and current stresses on the system.



The assessments will evaluate the resources, processes, functions and habitat in these areas. Factors, such as the relative level and influence of impervious cover on hydrology, water quality and biodiversity will be considered. The use of local wells for local water supply and the location and extent of septic and sewer systems will also be considered. This assessment will occur at multiple scales, to facilitate rapid production of both the Draft R-1 Report and the City-wide Report. Factors considered may include, but are limited to:

- Salmonids and Other Native Fishes: Analysis of fish-bearing and salmon-bearing streams at the scale of the City and the watershed. (Data sources: streamnet, SSHIAP, DNR, DOE)
- Terrestrial Habitat & Connectivity: Analysis of habitat types and rare plant and animal species/communities (Data Sources: statewide habitat-type dataset developed by the Northwest Habitat Institute, ReGAP ecosystems, DNR Heritage, and WDFW PHS)
- Impervious Surface/Developed Land Cover: This is a measurement of the current extent of development, and can be measured several ways. (Data sources: King County Impervious Surface 15' grid, NOAA C-CAP 95-00 change data, ASTER [if necessary])
- Developed/Divisible/Developable Parcels: This analysis will determine the potential number of new structures that can be accommodated within the currently incorporated City limits under existing zoning. (King County Assessor parcel data, City of Woodinville zoning)-
- Calculation of Existing Water Balance: We will use an existing HSPF model or other techniques to determine precipitation fate and net impact on stream flow.

- **Deliverables:** A Draft *Resource Characterization and Assessment* will be submitted to the City. The report will include a narrative, as well as maps and data tables that provide concise information on the factors/questions list above. This assessment will eventually become the first half of both the R-1 Report and the City-wide Report. The R-1 Area and other areas of the City will be considered at a finer level of detail in this document and the organization will reflect this purpose and focus. Consultant will assist the City in finalizing the report and discussion with CAP and stakeholders as appropriate.

- **Completion:** June 30, 2006

Task 6 - Alternative Futures Modeling and Resource Impact Assessment

Borrowing from the recent work of Professor Stan Gregory and others, future land use, impervious surface coverage and land cover will be modeled for the R-1 areas and in the City as a whole based on no more than three (3) land use scenarios. Scenarios will be determined based on discussions with the City and CAP in early project phases and could include:

1) **No Action:** current development types allowed under the existing regulations are projected at least 20 years into the future based on recent growth trends. Under this scenario, rezones to no more than 4 units per acre are allowed R-1 Zone with the extension of sewer.
2) **Low Impact Development:** The same number of units are accommodated within the City, but in the R-1 zone and potentially other identified areas of the City, growth is clustered, larger stream and river corridors are substantially buffered, streets are narrower, and overall impervious surface expansion and loss of canopy cover is minimized.
3) **Zoning Refinement and LID:** Rezone of less sensitive portions of the R-1 area (based on the resource assessment) to allow a net density of four units per acre, establishment of other areas where density is more restricted. LID development occurs in identified areas of the City. Rezone may be contingent on implementation LID standards as a market incentive for landowners.
4) **Transfer of Development Rights (TDR) and Active Restoration:** The most ecologically and/or hydrologically sensitive areas of the City are enclosed by a TDR, and the new units that would have been built in these areas are transferred to higher density zones that have already been substantially developed. Streams, rivers, forests and other habitats are actively restored within identified areas and canopy cover is increased.

Modeling will incorporate assumptions about the City's future population growth rate and housing targets. Essentially, we will "fill up" all of the developable lots with the number of people and housing units we assume will be coming over the next 20 years, and distribute these people over the landscape under the chosen development scenarios. In addition to looking at impacts to riparian resources and land cover, the analysis will also incorporate data regarding groundwater, and thus summer streamflow, impacts. Water balances for the different development scenarios may also be calculated, including the effects of sewerage versus septic systems and the use of small wells versus use of regional water systems.

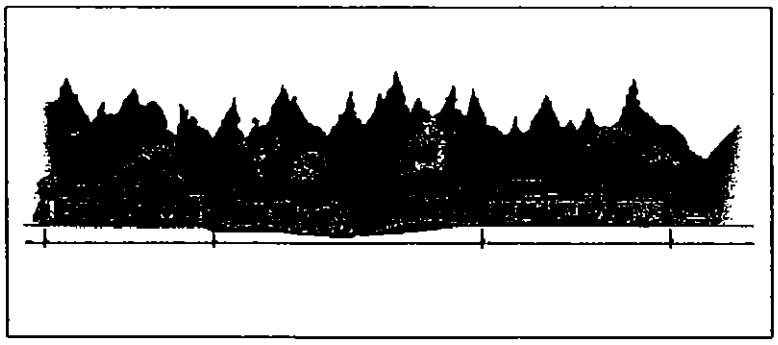
- **Deliverables:** Quantitative and qualitative outputs of the modeling will be provided. Each of the scenarios will be depicted visually with a map and photo-illustrations of the different patterns that would result from each scenario. Quantitative measures may include:

- Increase in impervious surface
- Area/percentage of habitat lost or degraded by habitat/ecosystem type
- Loss or degradation of habitat connectivity
- Length of stream lost or degraded by stream type (fish bearing, salmonid bearing, other)
- Area of wetlands degraded
- Area of floodplain encroachment
- Groundwater and summer streamflow impacts

The graphic representations with summary data will be presented to the CAP and other appropriate stakeholders. Rather than a "top down" approach where the Consultant and the City provide recommendations at this phase, stakeholders will be asked to provide their opinions and thoughts on their desired future. This approach is intended to engage the CAP and other stakeholders in a meaningful way, build informed consent and ensure the community's opinions and values are reflected in the reports.

- **Completions:** **July 14, 2006**

Task 7 – Policy and Code Options/Recommendations



Based on the feedback from the CAP and the City in Task 6 and environmental impact data obtained through the modeling, the Consultant will provide a draft memo outlining findings and recommendations for development intensities and potential revisions of City policies, regulations and development practices to meet GMA requirements related to anadromous fish resources, while allowing reasonable use of the affected lands and accommodating overall growth targets. In order to meet the client's schedule, the Consultant will begin crafting policy options and recommendations early in the project and will refine these based on the outputs of Task 5 and the stakeholder input in Task 6. Relevant cases and issues that have been ruled on by the Central Puget Sound Growth Management Hearings Board, as well as City policy, will be reviewed and applied to the analysis, as well as biologic and geologic factors. This analysis will occur at multiple scales, to facilitate both a report on the R-1 Zone as well as the City-wide report. At the City's discretion, the Consultant may provide a recommendation on how this analysis can be used for State Environmental Policy Act compliance purposes.

- **Deliverables**: Draft Policy and Code Options and Recommendations Memo.

- **Completion:** July 14, 2006

Task 8 – Draft R-1 Report Production

The Consultant Team will compile and refine the outputs of Tasks 2 through 7 related to the R-1 Zone into a coherent report for review by City Staff.

- **Deliverable:** Draft R-1 Zone Report
- **Completion:** August 1, 2006

Task 9 – Final Draft R-1 Report

Based on the review provided by staff, the Consultant Team will revise the draft report and prepare the final report. The Consultant will assist in further revision of the report as comments and direction are received from the Planning Commission and the City Council.

- **Deliverable:** Final Draft R-1 Report
- **Completion:** August 31, 2006

Task 10 – Draft City-wide Report

The Consultant Team will compile and refine the outputs of Tasks 2 through 7 into a coherent report for review by City Staff.

- **Deliverable:** Draft City-wide Report
- **Completion:** October 13, 2006

Task 11: - Final City-wide Report

Based on the review provided by staff, the Consultant Team will revise the draft City-wide report and prepare the final report. The Consultant will assist in further revision of the report as comments and direction are received from the Planning Commission and the City Council.

- **Deliverable:** Final City-wide Report
- **Completion:** October 31, 2006

Cost Breakdown of Budget Expenditures by Position Title

		TWC										AHBL						PGG	
TASK	DESCRIPTION	TWC Principal, PWS	Sr. Fish Biologist	Sr. Wetland/Wildlife Bio, PWS	Senior Planner, AICP	Sr. GIS Analyst/Modeler, AICP	Landscape Architect, ASLA	Geologist/Fluvial Geomorphologist	Environmental Engineer/Biologist	Biologist	Landscape/Graphics	AHBL Principal, AICP, ASLA, LEED AP	Assoc. Principal, AICP	Senior Project Manager, AICP, LEED AP	Senior Civil Engineer, PE, LEED AP	Civil Engineer, PE	Planner, AICP	PGG Hydrogeologist	TOTAL COSTS
1.0	Project Coordination	10	8		50	16							24					8	$12,620
2.0	Public Involvement	4	8	8	30	4		8			8	16	60	8	8	8	8	8	$23,130
3.0	Data Collection and Inventory		16		8	40		16	8									20	$10,320
4.0	Field Data Collection		32	16	8			24	8	16								8	$10,520
5.0	Resource Characterization and Assessment	8	24	16	8	40		16	8									40	$15,640
6.0	Futures Modeling & Impact Assessment	4	16	16	16	88		16	8							8	8	80	$25,620
7.0	Policy & Code Options/Recommendations	4	8	8	8	8		8				10	20	16	16	24	40	8	$21,860
8.0	Draft R-1 Report	6			16	8	8		40		20		8	8			8	4	$12,250
9.0	Final R-1 Report	4			4		2		8		4		4					2	$2,830
10.0	Draft City-Wide Report	6			16	8	8		40		16		8	8			8	4	$11,970
11.0	Final City-Wide Report	4			4		4		8		4		4					2	$3,020
																	GRAND TOTAL		**$149,780**

Staff Assigned

The Watershed Company

A. William Way, Professional Wetland Scientist
President

A. William Way has 27 years experience in planning, designing, and implementing stream and wetland assessment and rehabilitation projects. He specializes in the habitat needs of salmonid fishes. He founded The Watershed Company in 1982, building a company with an excellent reputation for technical skills, client service and outstanding relationships with regulators. The firm is known for its science-based approach to design and holistic environmental assessments as well as plans that bridge human needs and environmental imperatives. Mr. Way has been a Professional Wetland Scientist as certified by the Society of Wetland Scientists since 1995.

Selected Project Experience:

- Tibbetts Creek Greenway Plan, Issaquah, WA; project manager
- Narbeck Wetland Sanctuary and Snohomish County Airport Wetland Mitigation Bank, Everett, WA;project manager
- Sammamish River Multi-Objective Management Plan, King County, WA; project manager
- Icicle Creek Restoration Plan and Design, U.S. Fish and Wildlife, Leavenworth, WA; project manager
- Lake Sammamish State Park Stream, Wetland and Shoreline Restoration Plan, Washington State Parks; principal in charge

Gabe Snedeker, AICP—PROJECT MANAGER
Senior Planner

Gabe Snedeker brings proven experience in successfully leading and managing multidisciplinary teams to resolve complex issues. He has more than a decade of experience as a land use and environmental planner with local governments, a federal resource management agency and private sector clients. He brings an in-depth knowledge of legal and regulatory issues in environmental and urban planning. Mr. Snedeker was formerly the Principal Planner at the City of Mercer Island and recently joined The Watershed Company after more than a decade as a planner in local and Federal government. He is a regionally recognized SEPA/NEPA expert with six years experience as the SEPA responsible official with two jurisdictions. Gabe brings award winning citizen involvement experience to The Watershed Company team, having played the lead role in multiple comprehensive plan updates, three critical area ordinance revisions and numerous development code revisions. Mr. Snedeker is experienced in tailoring targeted public participation efforts to specific project needs to enhance agency credibility, incorporate participant input and achieve informed consent.

Selected Project Experience:

- Lake Forest Park Shoreline Master Program; Lake Forest Park, WA; project manager
- Critical Areas Ordinance Inventory and Update, City of Mercer Island, WA; project manager
- Comprehensive Plan Update, City of Mercer Island, WA.; project manager
- Comprehensive Plan and Unified Development Code, City of Shoreline, WA; project manager
- Critical Areas Inventory and Ordinance, City of Shoreline, WA; project manager

Staff Assigned

Gregory P. Johnston, Certified Fisheries Professional
Senior Fisheries Biologist

Greg Johnston has 30 years of experience is fish habitat assessment and fisheries enhancement planning and design. He has a Bachelor of Science degree in Civil Engineering and a Master of Science degree in Fisheries Biology, both from the University of Washington. He is a Certified Fisheries Professional, American Fisheries Society, 2000 and 2005, and also holds an Engineer-in-Training Certificate issued in 1979 by the Washington State Department of Licensing. His dual background in civil engineering and fisheries biology enables him to integrate both the physical and biological components of productive riparian communities. He has performed city-wide fisheries and stream inventory work required for state Growth Management Act updates, outlining resource management tools to protect and enhance natural resources.

Selected Project Experience:

- Monroe Shoreline Master Plan Update, Monroe, WA; fisheries assessment
- Shoreline Stream Inventory for City of Shoreline, WA; project manager
- City of Kirkland Shoreline Master Plan Update, Kirkland, WA; fisheries habitat assessment
- Tulalip Tribes Coho Creek Basin Wetland and Stream Assessment and Restoration Plan; project manager
- Stanwood Stream and Shoreline Inventories for SMP Updates, City of Shoreline; fisheries habitat assessment

Mark Indrebo, Licensed Geologist
Fluvial Geomorphologist

Mark Indrebo specializes in hydrologic and geomorphic analysis. Mr. Indrebo holds a Master's degree in Geology from Western Washington University,1999, and received specialized Rosgen's training in stream and river flow. He has used his knowledge of geomorphology to assess and design stream, wetland, and shoreline projects that provide high quality habitat while maintaining and enhancing the natural function of the wetland, stream, estuary, or lake. His related experience includes historic channel migration studies, stream morphology assessment, various hydrologic studies, water quality planning and construction monitoring. He has assisted with roadway designs that work with natural processes to reduce impact to the environment as well as water quality planning efforts to protect surface water quality.

Selected Project Experience:

- Snohomish River Fluvial Assessment at Riverfront Properties, City of Everett, WA; geologist
- Nooksack River Fluvial Assessment, Washington Department of Transportation; geologist
- Blair Water Way Water Quality Planning and Monitoring, Port of Tacoma, WA; project manager

Mark Garff, Landscape Architect/ASLA
Senior Landscape Architect

Broad experience with both public and private clients gives Mr. Garff strong skills to see landscape projects through from conceptual plans to finished product. He combines expertise in landscape structures and landscape design with a thorough knowledge of plants, particularly native Northwest plants and trees. His landscape enhancement and

mitigation work combines aesthetics and biological integrity. Projects at The Watershed Company have ranged from homeowner gardens to mitigation design for highway construction and assessments of landscape potential.

Selected Project Experience:

- Interstate-405 Wetland Mitigation at Thrasher's Corner, Bothell, WA, Washington State Department of Transportation; landscape architect
- Charlottes Way Daylighting, Seattle Public Utilities; landscape architect
- Coho Creek Stream and Wetland Enhancement, Tulalip Tribes, WA; landscape architect

Jennifer Creveling, Professional Wetland Scientist
Senior Wetland Scientist

Jennifer Creveling specializes in wetland and shoreline studies and mitigation designs. She received a Bachelor of Science in Biology from Western Washington University in 1978 and worked primarily for the Washington Department of Wildlife before joining The Watershed Company in 1990. Jenni has been a Professional Wetland Scientist as certified by the Society of Wetland Scientists since 1995. She has worked on many wetland and wildlife projects, such as wetland delineations, inventories of existing conditions, wildlife habitat assessments, impact analyses, mitigation recommendations, and wetland/wildlife restoration projects. She has also prepared and reviewed SEPA and NEPA documents, Corps of Engineers Public Notices, and state agency policies. .

Selected Project Experience:

- Issaquah Creek Stream and Riparian Area Restoration Plan, City of Issaquah, WA; project manager
- City of Kirkland Stream and Wetland Inventory, City of Kirkland, WA; project manager
- Lake Sammamish State Park Stream, Wetland and Shoreline Restoration Plan, Washington State Parks; co-project manager
- I-405 Nickel Project Wetland Mitigation at Thrasher's Corner, Washington State Department of Transportation; project manager

Matt Stevenson
GIS Analyst

Matt Stevenson has a proven track record of applying cutting-edge geospatial technology to complex planning, conservation, and resource management issues. Mr. Stevenson operates at the intersection of planning, policy, and spatial analysis, with a heavy emphasis on Geographic Information Systems (GIS) and information design. Mr. Stevenson has taken the lead on several regional conservation planning projects and devised the methodology for two development risk analyses. Previously, as an analyst at Berk and Associates, he established the firm's GIS capacity and made substantial contributions to economic development and socio-demographic studies conducted for cities and counties throughout Western Washington. He brings the ability to convey complex spatial information with striking cartography and eye-catching graphics. with striking cartography and eye-catching graphics.

Selected Project Experience:

- Sustaining a Livable Lake Forest Park, City of Lake Forest Park, WA; mapping and analytical support.
- Special Study Area Vision, City of Sammamish Town Center, Sammamish, WA; GIS support and analysis

Staff Assigned

- The Greater Skagit Delta Initiative, The Nature Conservancy, Trust for Public Land, Skagitonians to Preserve Farmland, The Skagit Watershed Council; data analyst, geospace data and cartography

Amy Myers
Permit Coordinator/Wetland-Wildlife Biologist

A thorough knowledge of regulatory requirements coupled with wetland and wildlife expertise give Amy Myers skills to bring projects into compliance and smooth permitting so that work can move forward quickly and meet the highest standards. She brings special expertise in Endangered Species Act consultations and Shoreline Master Program Updates.

Selected Project Experience:

- Shoreline Master Program Updates, Monroe, Stanwood, Marysville, Darrington, and Kirkland, WA; inventory, project manager
- Lake Stevens School District, Lake Stevens WA, wetland assessment, mitigation, permitting
- Sammamish State Park Assessment/Enhancement Plan, Washington State Parks. Field assessment
- Biological Evaluations/Assessments for ESA; project manager on over 150

Suzanne Tomassi
Wetland/Wildlife Biologist

Suzanne Tomassi, wildlife and wetland biologist, specializes in wildlife studies and wetland delineation. She received a Master of Science in Wildlife Biology from Michigan State University in 1991 and worked primarily in wildlife research and management for ten years. Before joining The Watershed Company in 2004, she worked for David Evans and Associates, Inc. and Cooke Scientific Services, Inc. She has prepared NEPA, SEPA, ESA, and USFS Roads Analysis documents, conducted many wildlife surveys, habitat assessments, and wetland delineations.

Selected Project Experience:

- Jefferson County Comprehensive Plan Habitat Management Project; project manager
- U.S. Forest Service Jarbidge Canyon Roads Analysis Process, project manager
- Washington State Department of Transportation Watershed Coordination Pilot Program; wildlife biologist, team coordinator

Aaron Bosworth
Fisheries Biologist

Experience conducting stream habitat assessments and using numerous fish survey methodologies for natural resource management agencies such as the US Fish and Wildlife Service and the US Forest Service provide Mr. Bosworth with a well-grounded background in fisheries management. Recent education in fish population genetic research, statistical analysis, and environmental policy enable him to apply current theories in fisheries science to any project involving stream habitat restoration or ecosystem management. He brings additional expertise in WRIA 8 protection initiatives and masters degrees in both fisheries and public administration with a focus on environmental policy.

Selected Project Experience:

- Beebe Springs Stream Restoration, Washington Department of Fish and Wildlife; habitat assessment, permitting

Staff Assigned

- Valley Creek Stream Habitat Survey, City of Bellevue; fisheries habitat assessment
- White River Fish Habitat Assessment and Fish Distribution Study, U.S. Forest Service; fish habitat assessment, database mapping

ABHL

Julia Walton, AICP
Associate Principal, Planner

Julia Walton has over 21 years experience of professional urban planning and design experience in the field. She is known for her leadership of large, complex multidisciplinary projects, which implement growth management and develop livable, sustainable communities. Trained as an architect and a planner, Julia uses illustration and example to show "what it might look like" as a template for policy and regulation to successfully lead clients and the public through project discussions. As a certified coach, Julia is the winner of two national awards for public involvement, and also specializes in facilitating "difficult conversations" to build agreements that stick. Recent sustainable projects include the 2004 National APA Award winning Chambers Creek Properties Master Site Plan & Implementation, and the Federal Way Parks Plan.

Selected Project Experience:

- Chambers Creek Properties Master Site Plan & Implementation, WA; principal-in-charge/project manager
- Federal Way Parks, Recreation, & Open Space Plan, Federal Way, WA; principal-in-charge
- Mountlake Terrace Melody Hill Sub-area, City of Mountlake Terrace, WA; principal-in-charge

Len Zickler, AICP, ASLA, LEED AP
Principal, Planner, Landscape Architect

Len Zickler has 30 years of experience as a planner and landscape architect and is a principal at AHBL overseeing the Planning and Landscape Architecture Departments. Len's work has focused on all aspects of current and long range planning including comprehensive and community planning, site feasibility and selection, environmental analysis, entitlements, permit coordination, and site master planning. Len's public sector experience includes comprehensive planning and GMA-related consulting for communities throughout Washington. Len is a recognized expert in the field of sustainable site design and low impact development (LID). He has been an invited speaker throughout the Northwest and nation and has consulted with many Washington communities on the application of LID to their codes and ordinances. He has presented to the US Green Building Council, Master Builders Association, American Institute of Architects, Puget Sound Water Quality Action Team, American Society of Landscape Architects.

Selected Project Experience

- Puget Sound Action Team Low Impact Development Assistance, Cities of Bellingham, Marysville, Redmond, Issaquah, and Poulsbo, and Thurston, Kitsap, Jefferson, Whatcom, Clallam, and Snohomish Counties, WA; principal-in-charge
- Low Impact Development Guidelines, Pierce County Department of Planning and Land Services, Pierce County, WA; principal-in-charge

Staff Assigned

- Low Impact Design Guidelines, City of Olympia Public Works, Olympia WA; principal-in-charge

Wayne Carlson, AICP, LEED AP
Senior Project Manager, Planner

Wayne Carlson is a land use planner and project manager with 14 years of professional experience. Wayne has managed a variety of current and long-range planning projects for public and private-sector clients throughout western Washington. He has considerable GMA and policy planning experience. Wayne managed AHBL's preparation of design standards and guidelines for several Pierce County Communities and managed the preparation of low impact development guidelines for Pierce County. He has also authored environmental reports and assessments for projects under the Washington State Environmental Policy Act (SEPA), the California Environmental Quality Act (CEQA), and the National Environmental Policy Act (NEPA). Wayne worked with Pierce County to write its LID development regulations.

Selected Project Experience:

- Puget Sound Action Team Low Impact Development Assistance, Cities of Bellingham, Marysville, Redmond, Issaquah, and Poulsbo, and Thurston, Kitsap, Jefferson, Whatcom, Clallam, and Snohomish Counties, WA; project manager
- Low Impact Development Guidelines, Pierce County Department of Planning and Land Services, Pierce County, WA; project manager
- Meadow on the Hylebos Single Family Residential LID Pilot Project, Pierce County Department of Planning and Land Services and Private Developer, Pierce County, WA; project manager

Doreen Gavin, PE, LEED AP
Principal, Civil Engineer

Doreen Gavin is a principal of AHBL and responsible for planning, designing and management of civil engineering projects. In her 26 years of experience, she has completed a variety of project types, from private development to public works. She has successfully performed many roles, from project engineer to principal-in-charge, on significant projects throughout Western Washington and is able to apply this experience to a variety of project types. Doreen's experience includes educational facilities, commercial developments, and health care projects, as well as many public facilities. Her recent LID experience includes the design of Sehmel Homestead Park.

Selected Project Experience:

- Sehmel Homestead Park, Peninsula Metropolitan Park District, Gig Harbor, WA; principal-in-charge
- Chambers Bay Golf Course & Clubhouse Civil Engineering Design, Pierce County Department of Public Works, University Place, WA; principal-in-charge
- Northgate Library, Community Center & Urban Park (LEED Registered), City of Seattle/Seattle Public Libraries, Seattle, WA; principal-in-charge

Laura Grignon, PE
Project Manager, Civil Engineer

Laura Grignon is a civil project engineer and project manager in AHBL's Seattle office with eight years experience. She has expertise in the design of stormwater flow control, water quality and conveyance systems using the KCRTS and KCBW models. Laura has

considerable experience working with various jurisdictional agencies including King County and the Cities of Kenmore, Bothell, Federal Way, Sammamish, Bellevue, Kent, Renton, Mill Creek and Issaquah. Her expertise has been instrumental on the storm drainage design for Seattle School District's Brighton Elementary and Beacon Hill Elementary, as well as North Kitsap School District's Kingston High School, Eastside Catholic High School, and the Christian Faith Center.

Selected Project Experience:

- Puget Sound Action Team - Low-Impact Development Assistance, Puget Sound Action Team, Cities of Bellingham, Marysville, Redmond, Issaquah, and Poulsbo, and Thurston, Kitsap, Jefferson, Whatcom, Clallam, and Snohomish counties; project engineer
- City of Kenmore Plan Review, Kenmore, Washington, project engineer

Pacific Groundwater Group

Charles T. Ellingson, RPG, CGWP
Principal Hydrogeologist

PgG

Charles Ellingson is a co-founder and principal hydrogeologist of Pacific Groundwater Group, bringing to the firm 22 years of consulting experience in groundwater impact predictions, aquifer protection, contaminant hydrogeology, basin hydrology, and water supply. His educational background in groundwater hydraulics complements his experience exploring, testing, and modeling a wide variety of groundwater regimes: single- and multi-aquifer systems, unsaturated soils, fractured aquifers, two-phase flow systems, and shallow groundwater influences on stormwater and wetlands. Mr. Ellingson's areas of expertise include groundwater management, contaminant assessment, design of remedial measures, and modeling the hydrologic effects of land use changes.

Selected Project Experience:

- SeaTac Third Runway Groundwater Impacts, Port of Seattle, WA; project manager
- Salmon Creek Basin Hydrological and Groundwater Study, Thurston County, WA; project manager

Linton Wildrick, RHG
Associate Hydrogeologist

Mr. Wildrick brings 30 years of well-rounded experience, both as a private consultant and as senior hydrogeologist and technical supervisor for Ecology's Water Resources Program, to his projects. Much of this experience is water rights-related and interdisciplinary hydrologic systems analysis, incorporating his knowledge of hydrogeologic processes, watersheds, and stream habitats. At Ecology, he advised managers and permit-writers on hydrologic aspects of water-rights policy and served as the lead scientist on the Technical Committee for Capture of Surface Water by Wells. He testified before legislative committees on proposed changes to water law and administrative rules, and he is current on court decisions and policy changes affecting water management in Washington. Mr. Wildrick also served as the lead research liaison with the U.S. Geological Survey (USGS) and published over 40 groundwater-related technical reports.

Selected Project Experience:

Staff Assigned

- Groundwater Protection Strategy for the Puyallup Tribal Jurisdiction; Puyallup Tribe of Indians., Puyallup, WA
- Salmon Creek Watershed Assessment, Clark Public Utilities, Clark County, WA; hydrogeologist
- Study Design and Initial Watershed Assessments; Washington Dept. of Ecology, State-wide; hydrogeologist
- Watershed Assessment Methodology Development and Assessment of Snohomish River Basin; Washington Dept. of Ecology, King and Snohomish Counties, WA; hydrogeologist

SUPPLEMENTAL FINDINGS IN SUPPORT OF DEVELOPMENT MORATORIUM

The Woodinville City Council reaffirms the findings contained in Ordinance No. 419. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council additionally enters the supplemental findings below in support of the temporary development moratorium imposed under that ordinance. The City has duly considered the Growth Management Act (GMA) planning goals enumerated in RCW 36.70A.020. The moratorium imposed under Ordinance No. 419 will assist the City in reviewing and amending its Comprehensive Plan and development regulations in a manner that appropriately balances these policy interests for the Woodinville community and physical environment. Specifically, the City has considered the following GMA goals:

1. Urban Growth - *Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.* (RCW 36.70A.020(1)).

The City is committed to accommodating and encouraging appropriate levels of urban development in accordance with applicable GMA directives. The comprehensive Sustainable Development study that will be conducted during the moratorium period will help the City to identify which public facilities and services are needed in order to accommodate such future growth within the R-1 zoning district, an area that is — and historically has been — under-served with respect to utility service and other public facilities.

Moreover, the Sustainable Development study will help determine the appropriate phasing and installation timeframe regarding public facilities within the R-1 zone. This in turn will assist the City's capital planning and budgeting efforts. Other plans and studies, including but not limited to the Downtown/Little Bear Creek Corridor Master Plan (DT/LBC) and the Economic Development Study, are currently being reviewed by the City Council and will likewise assist the City in influencing the location and timing of urban development where adequate public facilities and services are provided.

2. Reduce Sprawl - *Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development*. (RCW 36.70A.020(2)).

The Sustainable Development study conducted during the moratorium period will help determine the measures necessary to encourage the conversion of undeveloped land at appropriate levels of urban density. The study is intended in part to help the City balance the need to accommodate growth while simultaneously ensuring appropriate protection of the local environment and natural resources. Innovative land use management techniques aimed at reducing sprawl and protecting the environment will be evaluated as part of this process. It is anticipated that the City's development regulations may be

amended at the conclusion of the Sustainable Development study process to specifically encourage and provide incentives for the use of such innovative techniques.

3. Transportation – *Encourage efficient multimodal transportation systems that are based on regional priorities and coordinated with county and city comprehensive plans.* (RCW 36.70A.020(3)).

During the Sustainable Development study period, the City will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services consistent with local and regional transportation plans.

4. Housing - *Encourage the availability of affordable housing to all economic segments of the population of this State, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock.* (RCW 36.70A.020(4)).

As the largest contiguous residential area in the City, the R-1 zone contains a substantial percentage of the City's existing housing stock. Although single family homes are predominant in the R-1 zone, the development pattern in this zoning district has traditionally provided for a variety in age, style and size of houses. The Sustainable Development study conducted during the moratorium will help to determine appropriate development techniques — potentially including, but not limited to, low impact development standards — to protect the environment and natural resources while simultaneously accommodating growth and preserving existing housing stock.

5. Economic Development - *Encourage economic development throughout the State that is consistent with adopted comprehensive plans, promote economic opportunity for all citizens of this state, especially for unemployed and disadvantaged persons, promote the retention and expansion of existing business and recruitment of new business, experiencing insufficient economic growth, all within the capacities of the state's natural resources, public services, and public facilities.* (RCW 36.70A.020(5)).

A critical goal of the City's long-range planning efforts is to enhance the economic vitality of the Woodinville community. However, this policy must be carefully balanced and viewed holistically with the City's other planning goals to ensure an appropriate balance of economic development, housing, and environmental protection. The results and recommendations of the City's

Sustainable Development study will be considered together with the City's economic development efforts to foster a complementary and coherent pattern of housing and business growth.

Furthermore, the State's fisheries are recognized as a significant element of the Pacific Northwest economy. Different portions of the City's R-1 zone drain into the headwaters of Bear Creek, and towards Little Bear Creek and Woodin Creek, all known to contain salmonids — including Chinook salmon. The Sustainable Development study will likely recommend methods of protecting this valuable economic resource through the adoption and implementation of careful and well-balanced land use planning and zoning measures. The City's Economic Study also identifies the livability of the City's residential neighborhoods and the protection of the natural environment as keys to the local economy's vitality. The Sustainable Development and Concurrency studies will serve to identify the need for public facilities and services which support economic development.

6. Property Rights - *Private property shall not be taken for public use without just compensation having been made*. *The property rights of landowners shall be protected from arbitrary and discriminatory actions.* (RCW 36.70A.020(6)).

The moratorium process is a legally-sanctioned development control mechanism, and the City has enacted its R-1 moratorium ordinance in conformance with applicable state law. By its terms, the moratorium is of a limited, temporary duration, and will not be construed to violate any previous permit applicant's vested development rights as defined by state and local regulations. Moreover, the limited exceptions contained in Section 3 of Ordinance No. 419 authorize modification, remodeling and expansion of existing structures notwithstanding the moratorium, ensuring that landowners may continue to alter their existing residences during the pendency of the City's Sustainable Development study.

7. Permits - *Applications for both state and local government permits should be processed in a timely and fair manner to ensure predictability*. (RCW 36.70A.020(7)).

The receipt and processing of new land use permits under the moratorium will be suspended only for the limited time necessary to conduct the Sustainable Development study. Upon the expiration of the moratorium, the City will process development applications involving the R-1 zoning district in a fair and timely manner consistent with applicable state and local regulations.

The separate Development Services study initiated earlier this year is intended to make the City's permit process more efficient. The recommendations resulting from this study are expected to be implemented over the next few months. The Sustainable Development study will address current uncertainties regarding the R-1 zone. Having these questions answered, particularly with regard to

appropriate environmental protections, will enhance the certainty of the City's permit application and approval process. Individual property owners will know in advance what mitigation, construction techniques, and infrastructure is required for the proposed development of their property. This in turn will provide for more timely permit processing and the need for fewer individual environmental studies by permit applicants. The Development Services study will thus serve as a valuable resource for both the City and development applicants, and will increase the predictability of the development process within the R-1 zone.

8. Natural Resources - *Maintain and enhance natural resource-based industries, including productive timber, agricultural, and fisheries industries. Encourage the conservation of productive forest lands and productive agricultural lands, and discourage incompatible uses*. (RCW 36.70A.020(8)).

The Bear Creek Basin drainage area encompasses a significant portion of the eastern Woodinville City limits within the R-1 Zoning District. The basin drains southeasterly into the Cold Creek Natural Area wetland system, a complex network of wetlands and groundwater springs feeding the headwaters of Cold Creek and an important cold water source for the Bear Creek system. The Bear/Cottage Lake/Cold Creek system is formally rated as a Tier I subarea under the draft WRIA 8 Chinook Salmon Conservation Plan, and the action start list for the North Lake Washington Chinook population is to identify and protect headwater areas, wetlands, groundwater sources, natural hydrologic processes and temperatures that support Chinook salmon within this area. The Sustainable Development study conducted during the moratorium period will provide policy recommendations concerning the protection of these valuable resources.

9. Open Space and Recreation - *Retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities*. (RCW 36.70A.020(9)).

The Sustainable Development studies will assist in identifying potential park and recreation (i.e, trail) opportunities in concert with habitat conservation areas.

10. Environment - *Protect the environment and enhance the state's high quality of life, including air and water quality, and the availability of water.* (RCW 36.70A.020(10)).

A primary purpose of the Sustainable Development study is to address the protection of the environment, quality of life, air and water quality, and the availability of water resources. The City's R-1 zoning district contains coarse, permeable geologic materials that allow infiltration to mapped critical aquifer recharge areas (CARAs), many of which have been characterized as possessing a "high" or "medium" potential for ground water contamination. The R-1 Zoning District also contains Lake Leota, a natural water body, with known water quality

impacts. The shallow ground water surrounding Lake Leota is believed to be hydrologically connected to local CARAs.

Regions within the R-1 Zoning District hydrologically drain toward areas characterized by "high" or "medium" potential for ground water contamination. Said areas are known or suspected of being hydrologically connected to Bear Creek, a significant and biologically productive salmonid-bearing stream. Other areas within the R-1 zone drain variously toward Lake Leota, Little Bear Creek, and Woodin Creek, the latter two of which are known to contain salmonids.

11. Citizen Participation and Coordination - *Encourage the involvement of citizens in the planning process and ensure coordination between communities and jurisdictions to reconcile conflicts.* (RCW 36.70A.020(11)).

The City is committed to providing opportunities for citizen involvement in the public process. The City Council's adoption of Ordinance No. 419 occurred at a public meeting on March 20, 2006, and substantial public comment was received at that meeting. Pursuant to RCW 35A.63.220 and RCW 36.70A.390, the City Council also held a public hearing on May 1, 2006 to receive and consider public testimony regarding the R-1 moratorium.

The City Council has also proposed the formation of a Citizen Advisory Panel to assist the Sustainable Development study consultants and the Planning Commission in reviewing information and the promulgation of land use management policies and tools to address environmental protection and development issues within the R-1 zone. Any amendments to the City's Comprehensive Plan and/or development regulations recommended by the Sustainable Development study will undergo significant public scrutiny and commentary before both the Planning Commission and the City Council. It is contemplated and encouraged that residents, property owners, businesses and all other interested parties will participate in this process. Because the R-1 zone area is adjacent to unincorporated areas of both King County and Snohomish County, these counties will also be asked to participate in the review of the studies and potential outcomes.

12. Public Facilities and Services - *Ensure that those public facilities and services necessary to support development shall be adequate to serve the development at the time the development is available for occupancy and use without decreasing current service levels below locally established minimum standards.* (RCW 36.70A.020(12)).

As explained with respect to subsection 3 above, the Sustainable Development study will examine the City's transportation infrastructure needs and the opportunity to accommodate multi-modal forms of transportation within the R-1 zoning district. The City intends to review the findings and recommendations from this study in conjunction with the transportation concurrency program

separately being considered by the City. This analysis is needed in order to determine how appropriate growth — particularly within the R-1 zoning district — may be accommodated concurrently with necessary transportation facilities and services and consistent with local and regional transportation plans.

13. Historic Preservation - *Identify and encourage the preservation of lands, sites, and structures, that have historical or archaeological significance*. (RCW 36.70A.020(13)).

At this time, there are no lands, sites, or structures within the R-1 zone area known to have historical or archaeological significance.

Staff Report

TO: CITY COUNCIL

THRU: RICHARD LEAHY, CITY MANAGER

FROM: CINDY BAKER, INTERIM DEVELOPMENT SERVICES DIRECTOR

SUBJECT: APPROVAL OF PRELIMINARY WORK PLAN AND SCHEDULE FOR ADDITIONAL WORK ON THE SUSTAINABLE DEVELOPMENT STUDY

MEETING OF: April 9, 2007

ISSUE: Shall the City Council approve a schedule and preliminary scope for additional work on the Sustainable Development Report for Low Density Residential Zones?

STAFF RECOMMENDATION: To approve a schedule and preliminary scope for additional work on the Sustainable Development Report; and request that staff work with the Citizen Advisory Panel (CAP), consultants, and attorney to refine the scope of work, prioritize tasks, and return with a proposed budget for City Council approval.

POLICY DECISIONS: On March 12, 2007, the City Council adopted Ordinance 431, an interim ordinance to temporarily remove restrictions on development with densities less than four dwelling units per acre in Low Density Residential Zones. Under State Law, the Interim Ordinance may only be in effect for 6 months (it will expire on September 11, 2007). At that time the Council will need to adopt a permanent ordinance; or it may extend the interim regulations for an additional six months.

BACKGROUND: The City's Low Density Residential Zone has been subject to a building moratorium for the past year (March 20, 2006 through March 20, 2007), and is now subject to interim regulations that expire on September 11, 2007.

Adopting interim regulations for this zone allows additional time to thoroughly review the recommendations of the Planning Commission and to conduct further analysis regarding appropriate permanent changes to the City's existing development regulations.

During the moratorium period, city staff, consultants and the CAP conducted studies and prepared reports that identified and evaluated transportation, environmental, neighborhood character, capital facilities, and policy impacts related to different housing densities in the Study Area (Low Density Residential R-1 Zone). These studies are referred to as the Sustainable Development Report (SDR). The SDR was reviewed by the Planning Commission and City Council prior to either board taking action on the topic.

<u>Additional Analysis Needed</u>
When the City Council adopted the interim regulations on March 12, 2007, it determined that additional information and analysis was needed beyond the SDR before a permanent decision about zoning and environmental protection in the R-1 zone could be made.

With assistance of the CAP, we have identified six possible areas for further analysis: 1) Transportation (including impacts of local and regional traffic and necessary improvements to retain Level of Service); 2) Hydrology (including surface water and groundwater); 3) Geotechnical (including soil conditions, landslides, and earthquake faults); 4) Other Critical

Areas (including wetlands and wildlife corridors); 5) Neighborhood Character (including CC&Rs and buildable lands); and 6) Other.

We are still developing costs estimates for these tasks, however, they initially appear to be very substantial. We intend to continue working with the consultants, our Attorney, and the CAP to better refine these costs and prioritize them for your future consideration.

Schedule

To comply with the September 11, 2007 deadline of the interim R-1 regulations, we must pursue an aggressive work schedule, which is summarized below.

Date	Task
April 2007	Work with CAP, consultants, and attorney to finalize scope of work and prioritize elements. Begin work on well defined issues/topics.
May 7, 2007	Public Hearing by City Council on Interim R-1 Regulations. Seek Council approval on full scope or work and project budget.
June 18, 2007	Initial draft of report complete.
June 2007 (to be determined)	Possible joint meeting of City Council and Planning Commission to review preliminary report findings.
July 3, 2007	Finalize report.
July 6, 2007	Submit possible code revisions (if any) to CTED for 60-day Review and Comment Period
July 18, 2007	Planning Commission Public Hearing
Aug. 1, 2007	Planning Commission Public Hearing – Recommendations to City Council
Aug. 20, 2007	City Council – 1st Reading of Planning Commission Recommendations
Sep. 4, 2007	City Council – 2nd Reading and Adoption
Sep. 10, 2007	Back-up Date for City Council Action
Sep. 11, 2007	Interim R-1 Development Regulations Expire

This schedule provides little room for delay and tries to balance the time needed to develop the information with the time needed to give the City Council adequate time to decide the matter.

ALTERNATIVES:

1. Approve the preliminary work plan and schedule; or
2. Identify desired changes in the work plan and schedule; or
3. Not approve the request and accept the February 20, 2007 Sustainable Development Study as is.

RECOMMENDED MOTION:

I MOVE THAT THE CITY COUNCIL APPROVE THE PRELIMINARY WORK PLAN AND SCHEDULE FOR ADDITIONAL WORK ON THE SUSTAINABLE DEVELOPMENT STUDY, SUBSTANTIALLY AS PRESENTED, AND ASK THE STAFF TO WORK WITH THE CAP, CONSULTANTS, AND ATTORNEY TO REFINE THE SCOPE OF WORK AND PROJECT BUDGET FOR FUTURE CITY COUNCIL CONSIDERATION AND APPROVAL

ATTACHMENT:

Attachment A: Summary of Work Plan Scope for additional work on the Sustainable Development Study

Summary - Work Plan for Additional Work on Sustainable Development Study

Goals to Complete Sustainable Development Study ***(see attachments for detailed tasks)***	***Estimated Costs***	***Consultants/ Comments***
1. Transportation		**Perteet**
Goal 1 Identify transportation needs that would support Maximum (R-4) development	To be provided.	
Goal 2 Identify non-motorized improvements	To be provided.	
Goal 3 Identify transportation system costs for needed roadway systems improvements	To be provided.	
Goal 4 Assist in Low Impacts Development Standards	To be provided.	
Goal 5 Assist in Development Standards	To be provided.	
Goal 6 Evaluate Safety	To be provided.	
Goal 7 Develop a Transportation Report	To be provided.	
2. Hydrology		
Surface Water		**Perteet**
Goal 1 Identify storm system needs to support development alternatives **Goal 2.** Develop storm system improvement development plan with costs; evaluate **Goal 3.** Develop water quality protection plan (The above includes Review Basin areas around Lake Leota; coordinate with surface water management plan (under separate contract); further evaluate Low Impact Development –look at other jurisdictions' codes; evaluate if flows to Bear Creek could meet a refined "Litowitz" test; Review Bob Harmon data)	To be provided.	
Groundwater **Goal 1** Update & Improve groundwater flow map in R-1 zone	To be provided.	Options for cost savings Right-of-Entry possible problem
City time meetings, coordination, review, etc	To be provided.	
3. Geotechnical		**Golder**
Goal 1 Review and update landslide hazard areas in R-1 **Goal 2** Evaluate active faults in R-1 **Goal 3** Prepared Stratigraphic Study in R-1 **Goal 4** Coordinate with CAP	To be provided	Right-of-Entry possible problem

4. Other Critical Areas Information		**Jones & Stokes**
Goal 1 Identify additional wetlands **Goal 2** Identify any wildlife corridors in R-1 **Goal 3** Reassess Bear Creek systems for Litowitz”	To be provided	J&S (review by Steward & Assoc.) Right-of-Entry possible problem
5. Neighborhood Character & Land Use		**Jones & Stokes**
Goal 1 Identify and evaluate CC&R’s **Goal 2** Review & strengthen Neighborhood Character report **Goal 3** Re-evaluate residential zones in WMC **Goal 4** Evaluate Density Transfer **Goal 5** Prepare Documents, assist staff and CAP **Goal 6** Prepare Buildable Lands Data and Report	To be provided	Right-of-Entry possible problem
6. Other		
Goal 1 Request Health Department assist city with knowledge about alternative septic systems	To be provided	

CITY OF WOODINVILLE
17301 NE 133rd Avenue NE
WOODINVILLE, WA 98072
(425) 489-2757

PUBLIC OPEN HOUSE

The City of Woodinville will host an Open House on the Sustainable Development Study and associated Comprehensive Plan and Zoning Code Amendment strategies for the R-1 planning area of the City. You are invited to review the results of the study and proposed amendments at the open house on:

Wednesday, January 10, 2007
4:00 – 6:30 p.m.
Council Chambers
City of Woodinville City Hall
17301 133rd Avenue NE
Woodinville, WA 98072

For more information, please contact Bob Wuotila, Senior Planner, (425) 489-2754, extension 2283.