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.
- Minard, James P. (1985): Geologic Map of the Bothell Quadrangle, Snohomish and King Counties, Washington: Miscellaneous U.S. Geological Survey Field Studies Map MF-1747.
- Minard, James P. (1983): Geologic Map of the Kirkland Quadrangle, WA; U.S. Geologic Survey Misc. Field Studies Map MF-1543.
- Boundy-Sanders, Susan (2006): Landslide Hazard Areas in Woodinville; Memorandum to Bob Wuotila, city of Woodinville, John Lombard, Steward Associates, Sustainability CAP, and Consultants to the Woodinville sustainability project.
- Snyder, Dale E.; Gale, Phillip S., Pringle, Russell F. (Nov. 1973): Soil Survey of King County, Washington; United States Department of Agriculture, Soil Conservation Service.
- Queries on the King County IMAP (Groundwater Program) website and Washington Department of Ecology Well Log website.

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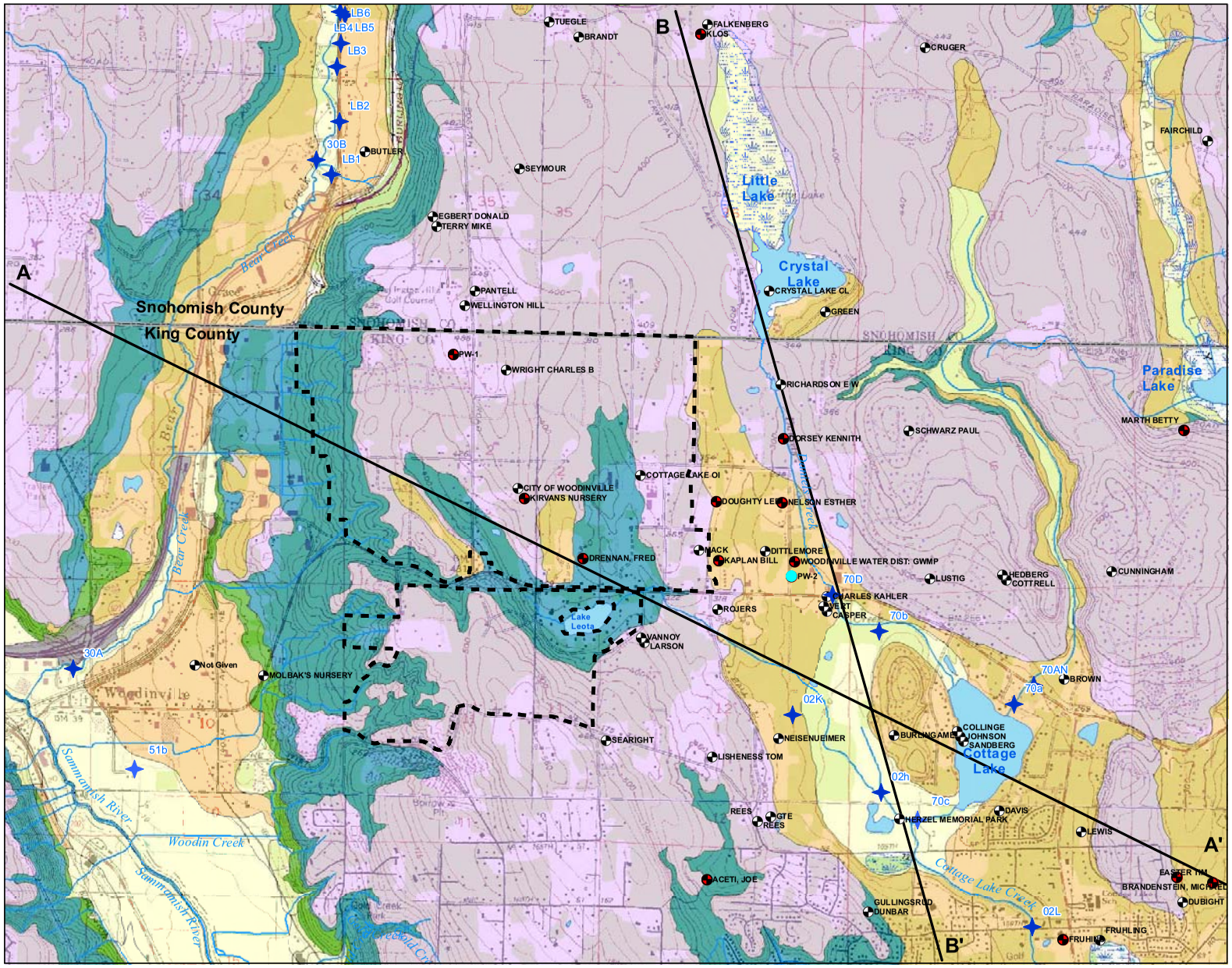
Washington Department of Ecology, 2005. Stormwater Management Manual for Western Washington, Prepared by Ecology Water Quality Program, February 2005. Ecology Publication Numbers 05-10-029 through 05-10-033.

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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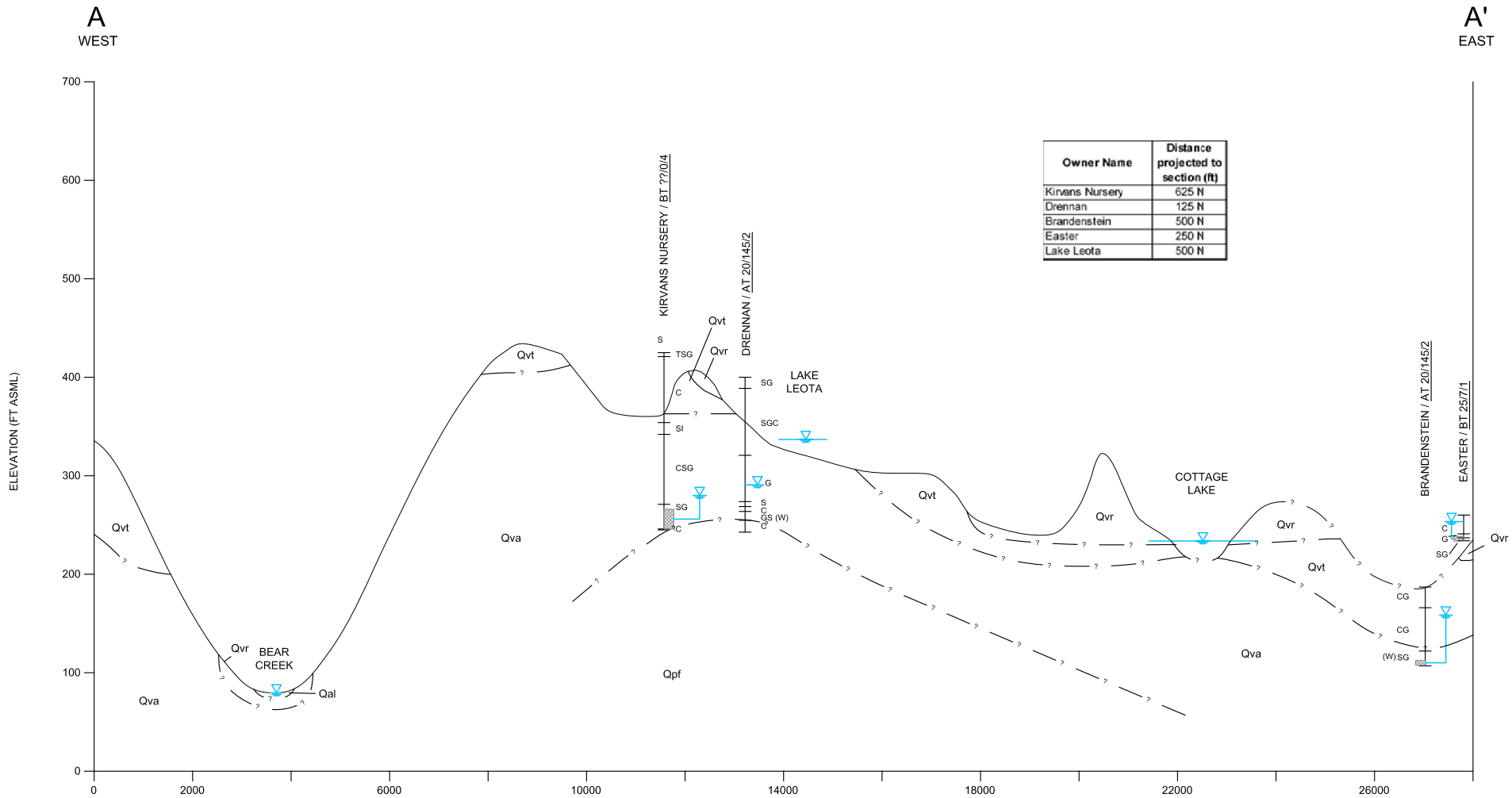
Golder Associates



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

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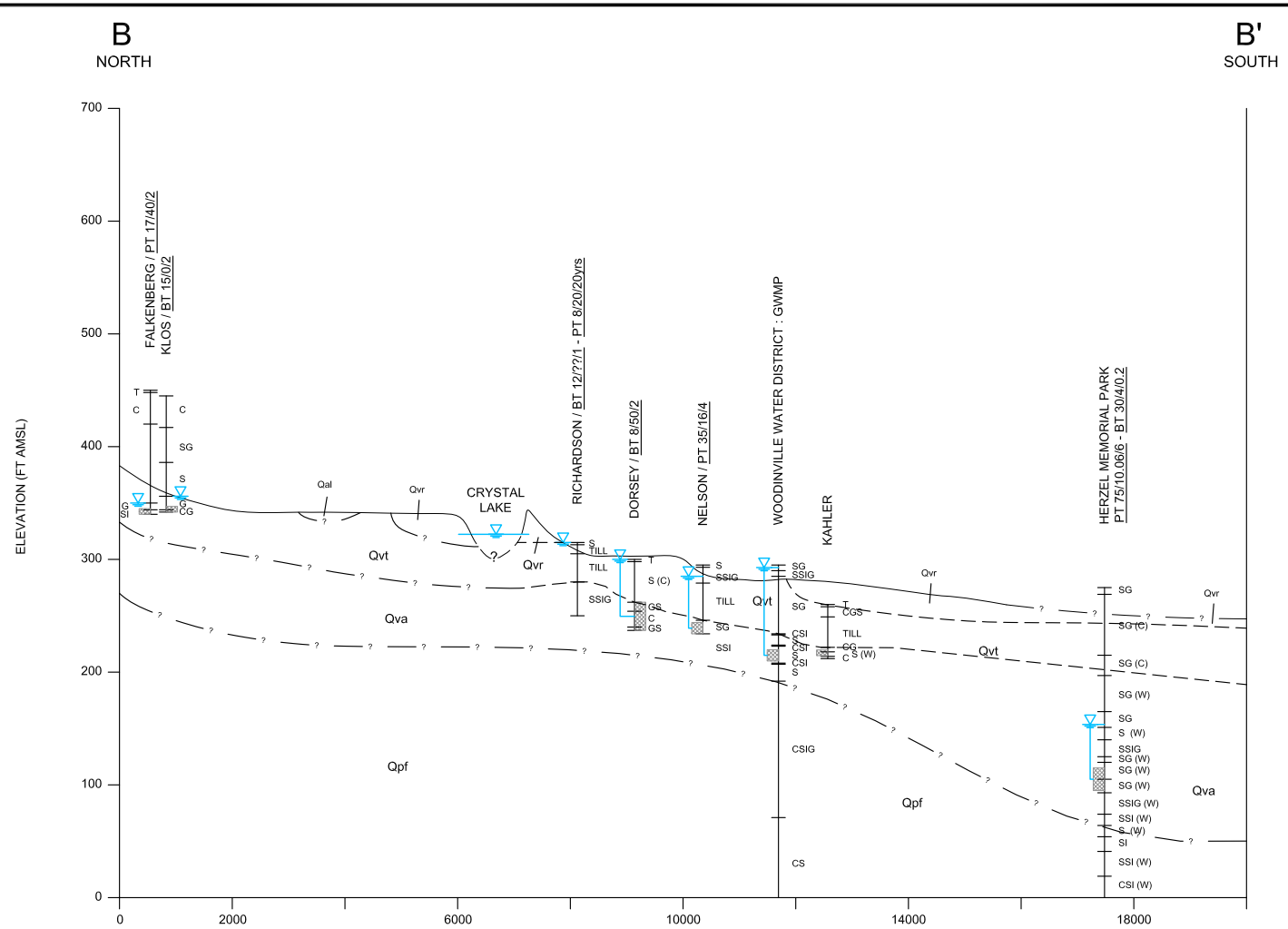
Golder Associates



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
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)

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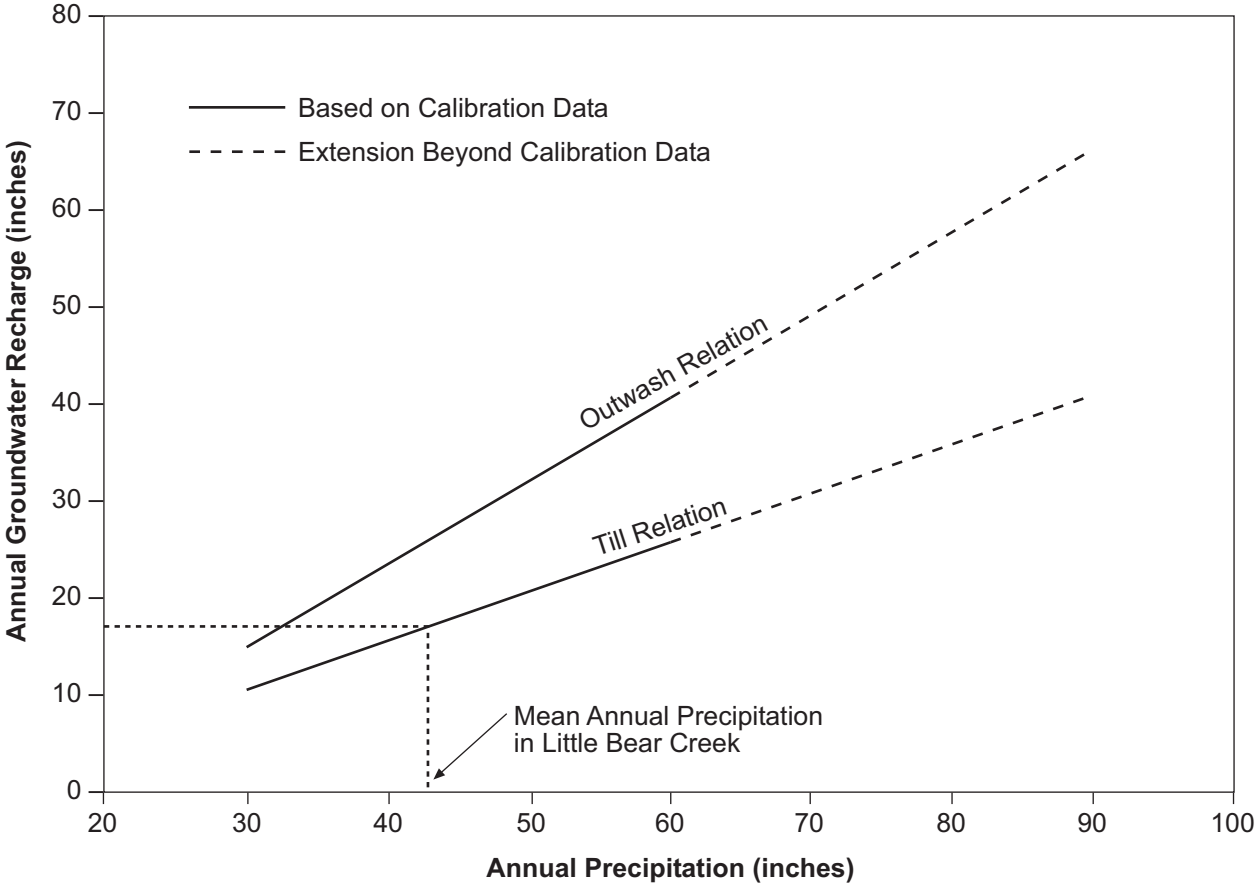
Ovr = VASHON RECESSIONAL OUTWASH
Qvt = VASHON TILL
Qva = VASHON ADVANCE OUTWASH
Qpf = PRE-FRASER UNDIFFERENTIATED DEPOSITS

0 2000 4000
SCALE IN FEET
VERTICAL EXAGGERATION = 20x

FIGURE 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



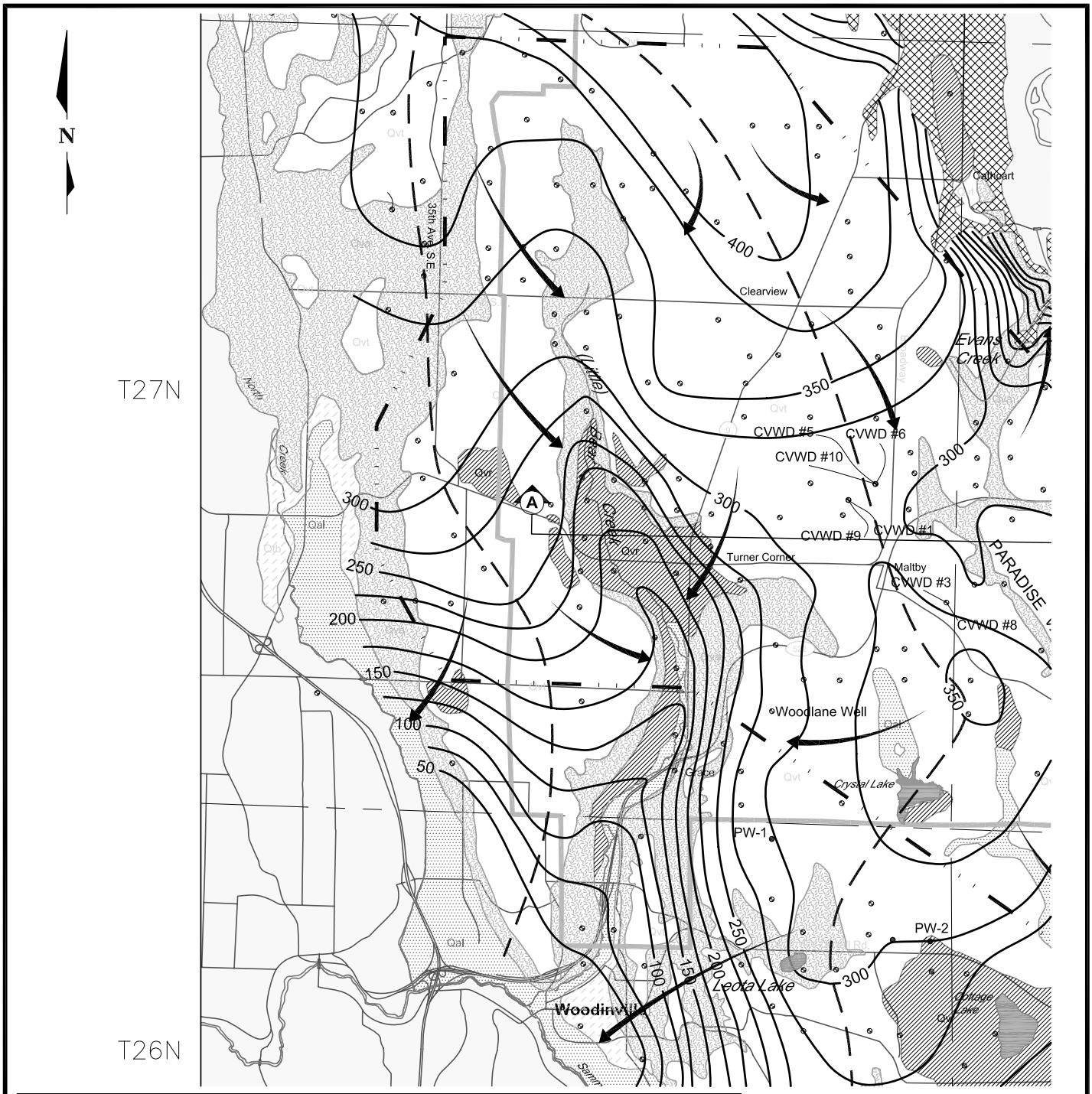
Source

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

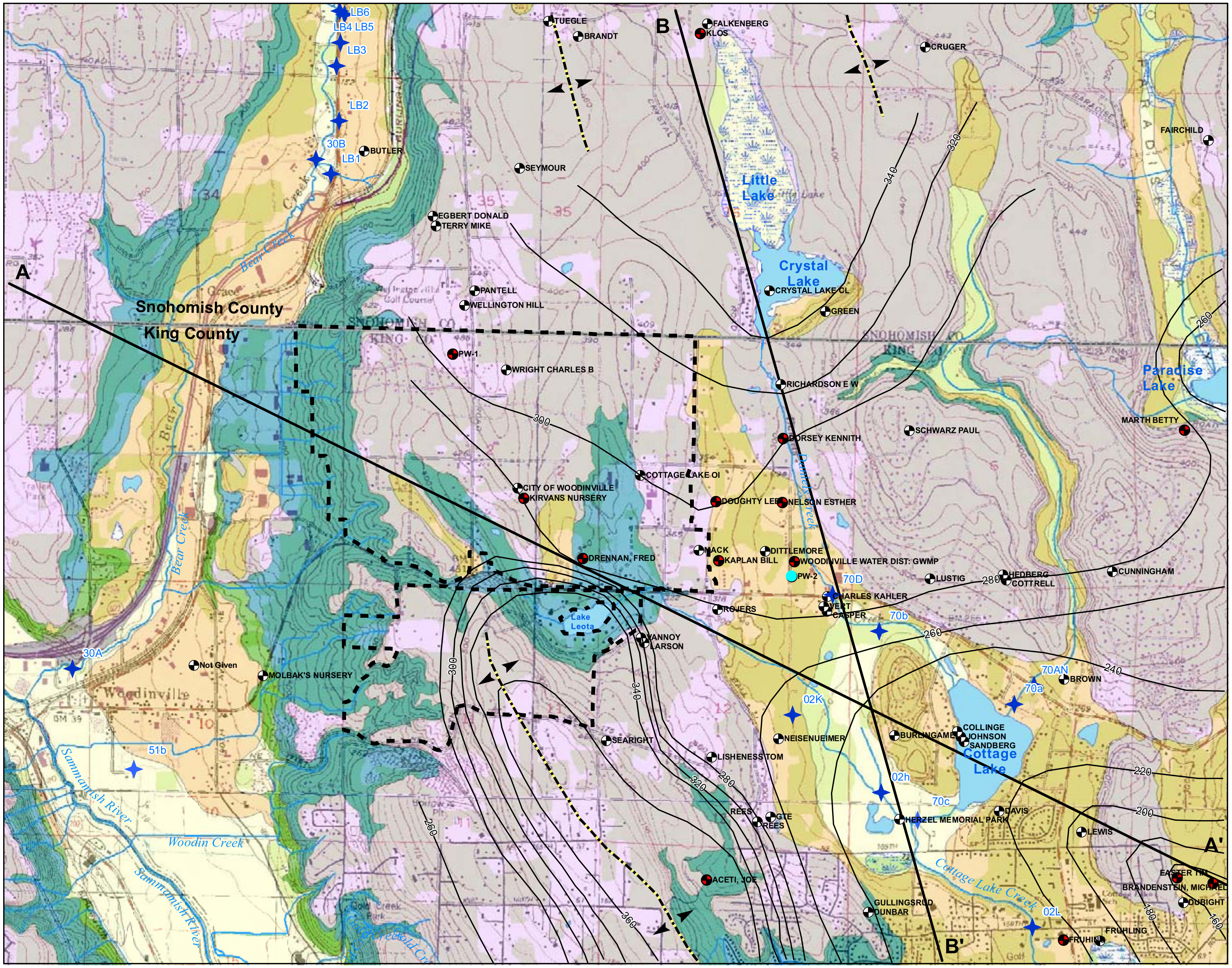
FIGURE **5**

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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- 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

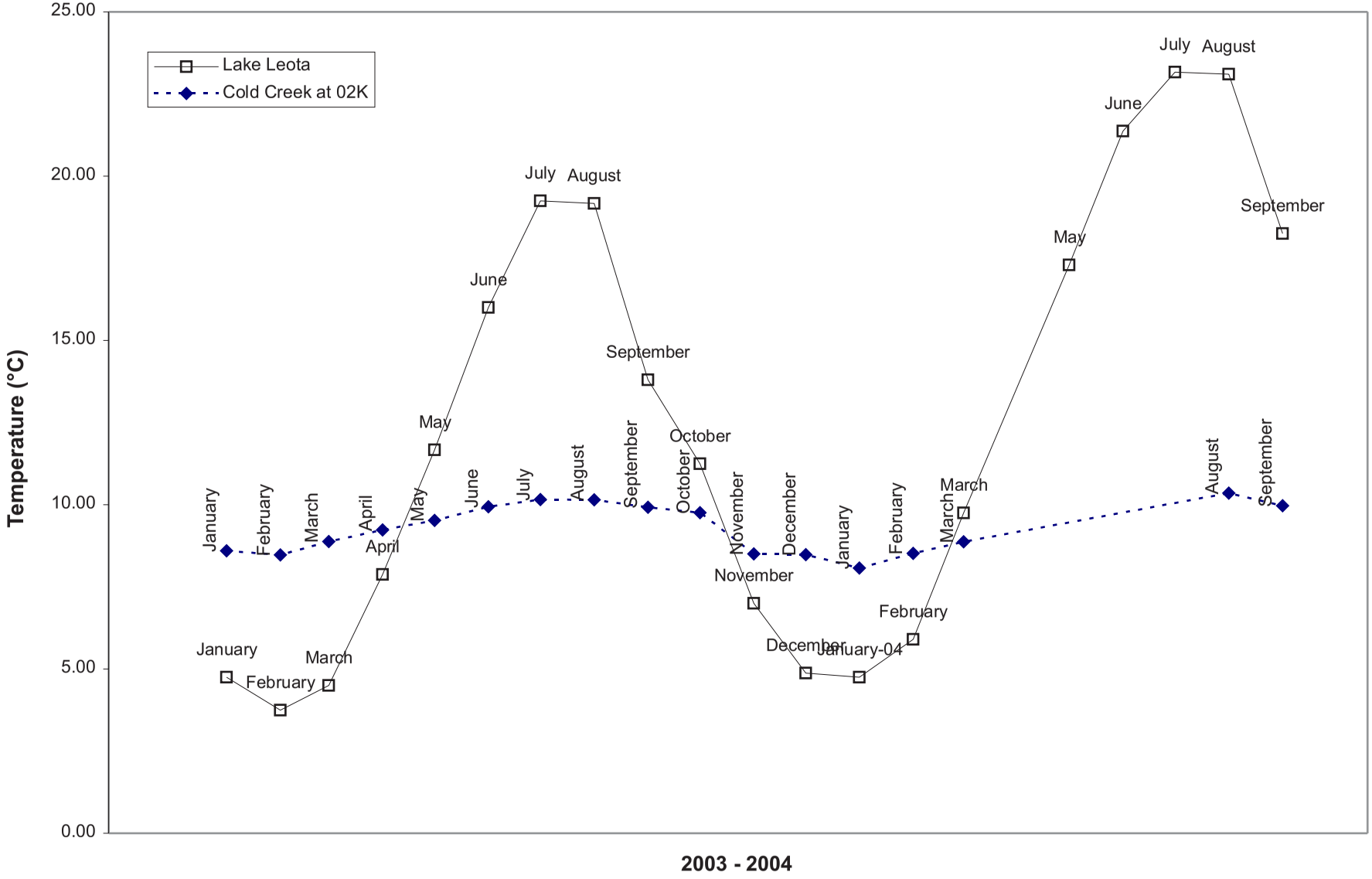

FIGURE 7

LAKE LEOTA & COLD CREEK HYDROGRAPH

S&A/WOODINVILLE HYDROGEO SVCS/WA

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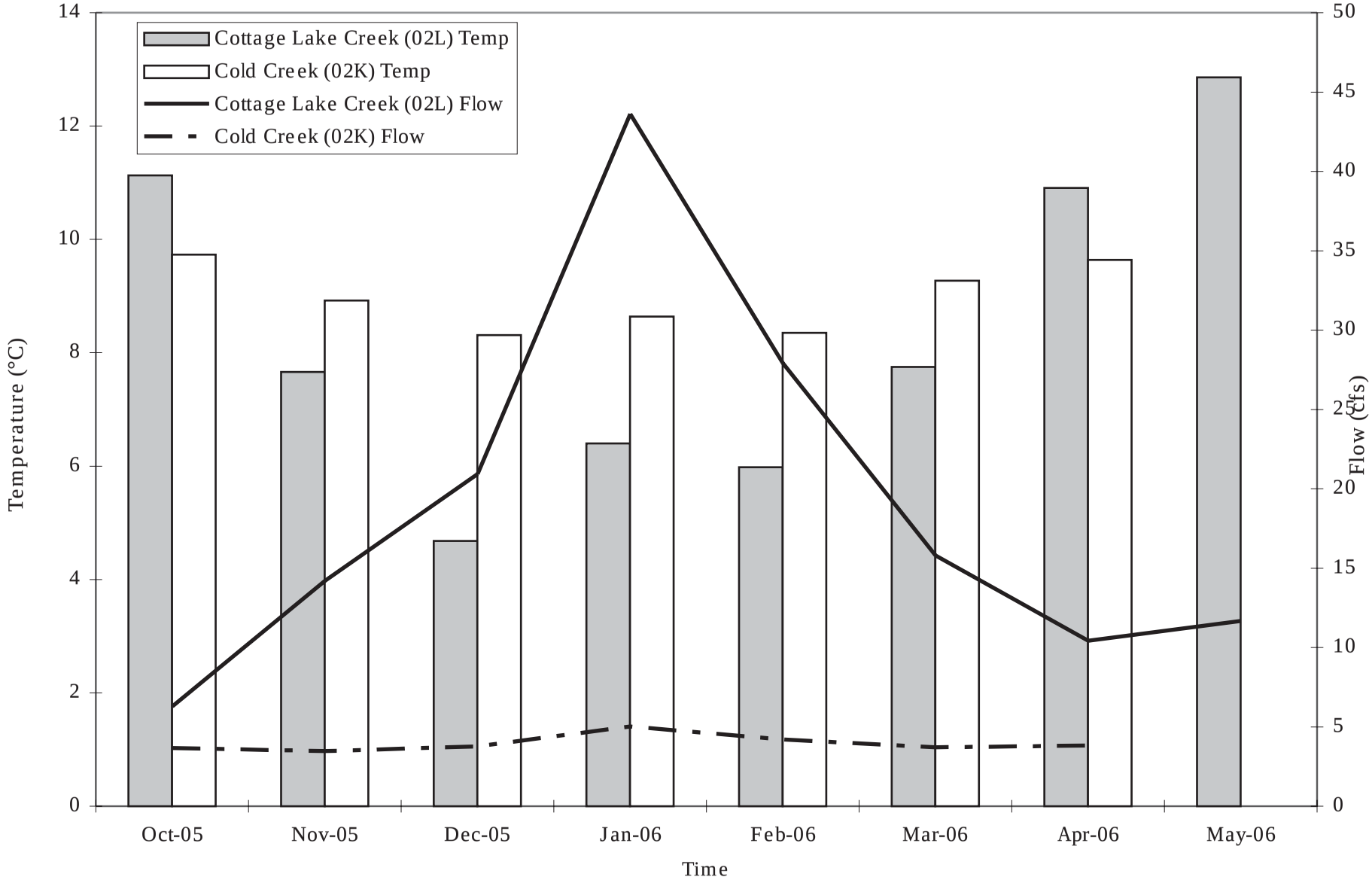

FIGURE 8
STREAM TEMPERATURE VS. FLOW
S&A/WOODINVILLE HYDROGEO SVCS/WA

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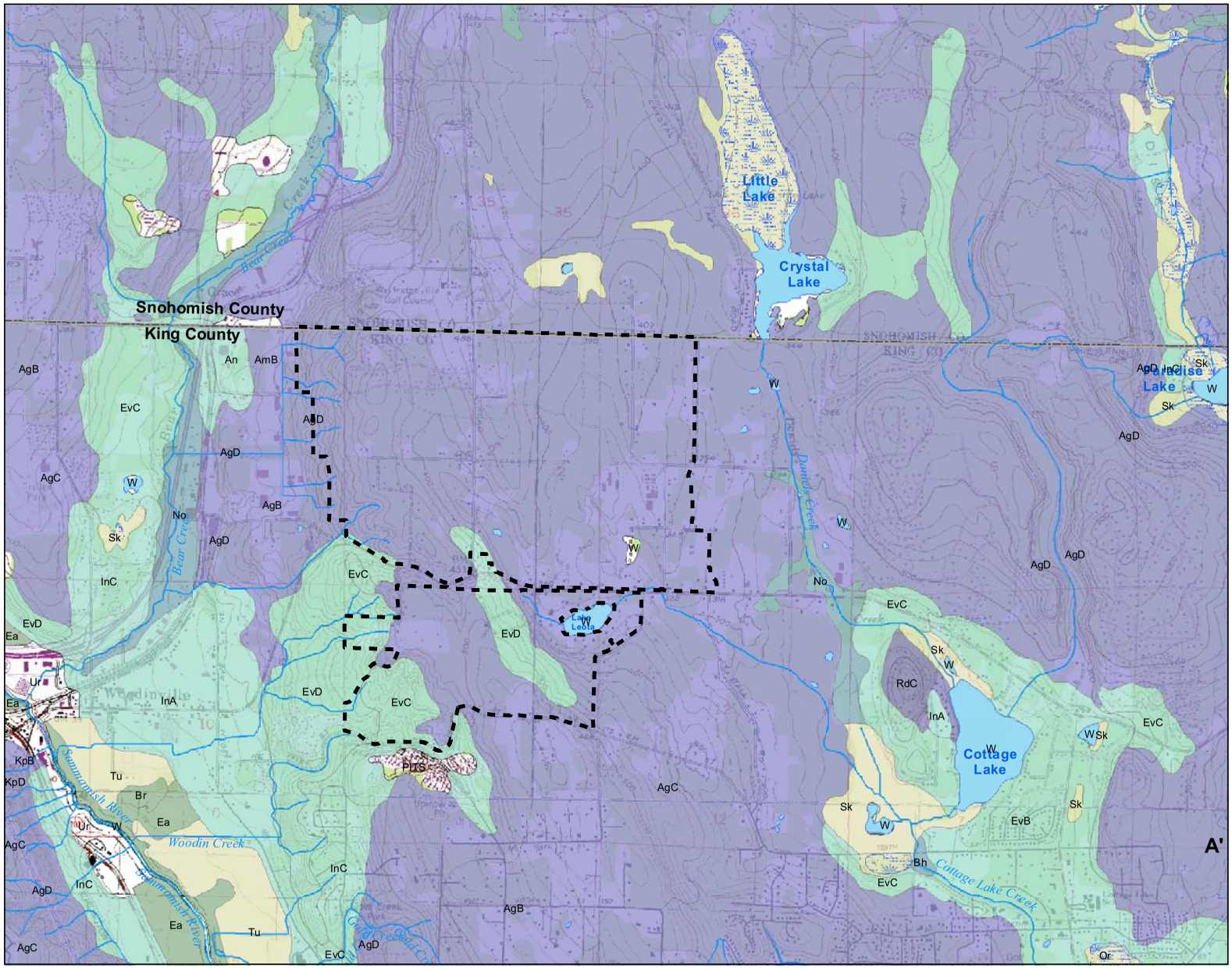
Golder Associates



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*.

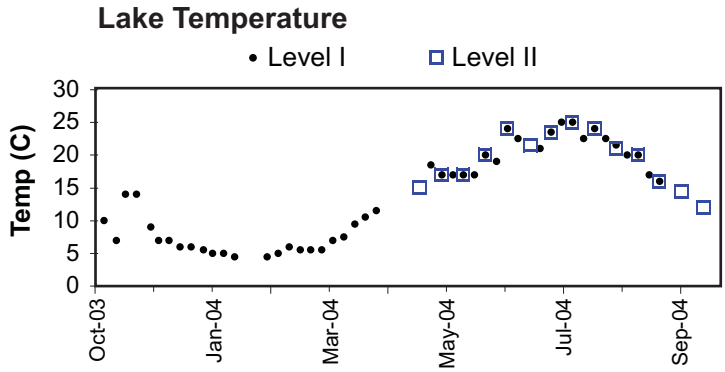
Physical Parameters

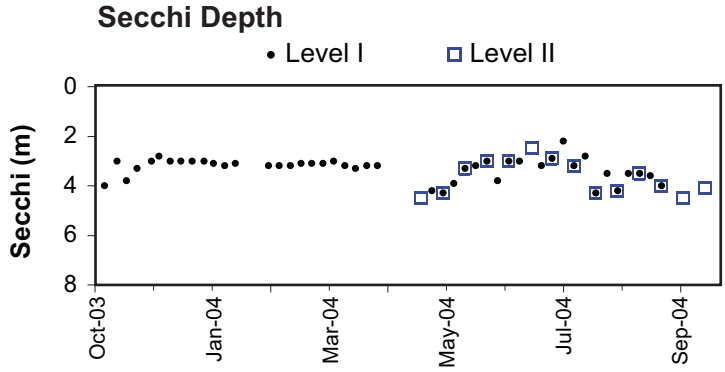
Secchi transparency ranged between 2.2 and 4.5 m through the year. The summer average was 3.6 m, which was in the upper middle range for all the small lakes monitored in 2004. Annual water temperatures ranged from 4.5 to 25.0 degrees Celsius. The maximum recorded was in the mid range for the lakes that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

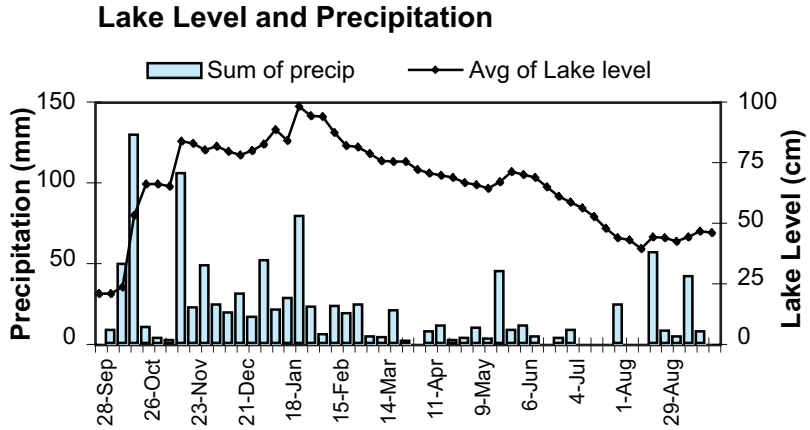
Excellent precipitation and water level records were compiled for the year. Water levels were consistent with the regional pattern of winter-high levels, dropping slowly through the summer to a low stand in early fall.

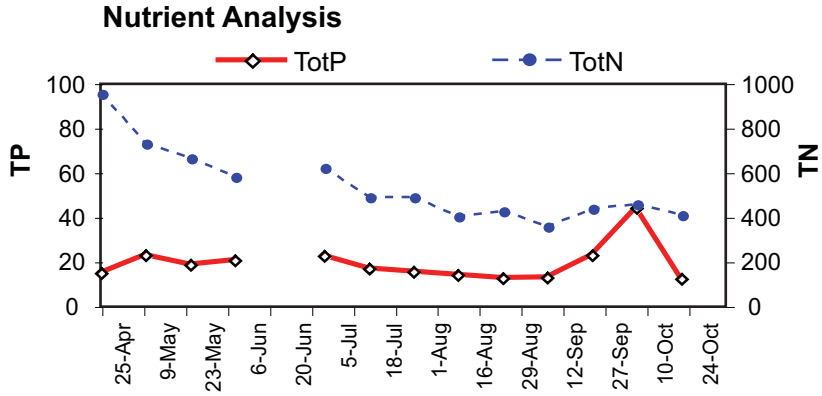
Nutrient Analysis and TSI Ratings

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.

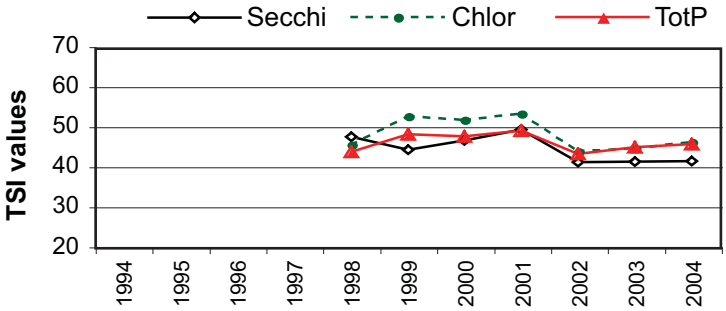
The 2004 TSI values were fairly close to each other in the mesotrophic range, with TSI-Secchi somewhat lower than the other two indicators, similar to 2003.

Chlorophyll Concentrations and Algae

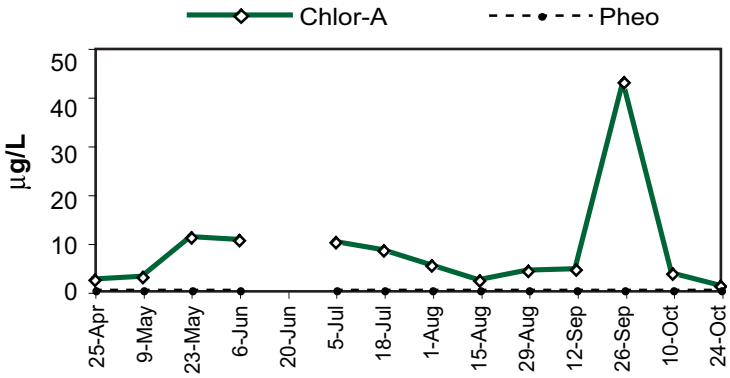
Chlorophyll remained fairly low through the sampling period until mid October when it spiked in late September, two weeks before the high phosphorus value. Commonly found algae in spring and summer included an unidentified chrysophyte species, *Synura*, and *Dinobryon*. The high peak in late September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

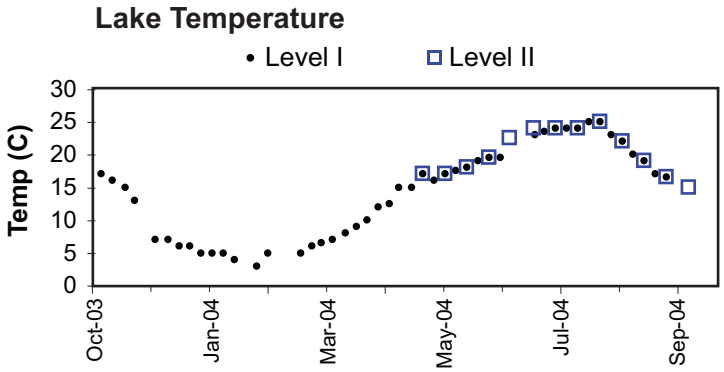
Physical Parameters

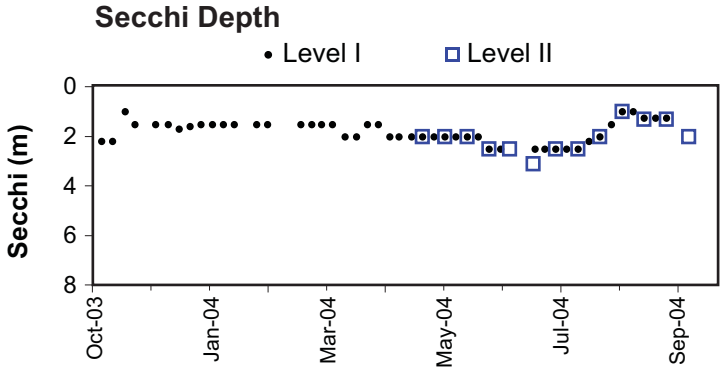
Secchi transparency ranged between 1.0 and 3.1 m during the year. The summer average was 2.1 m which placed it in the lower end of small lakes monitored in 2004. Surface water temperatures ranged from 3.0 to 25.0 degrees Celsius, putting it in the mid range for the group.

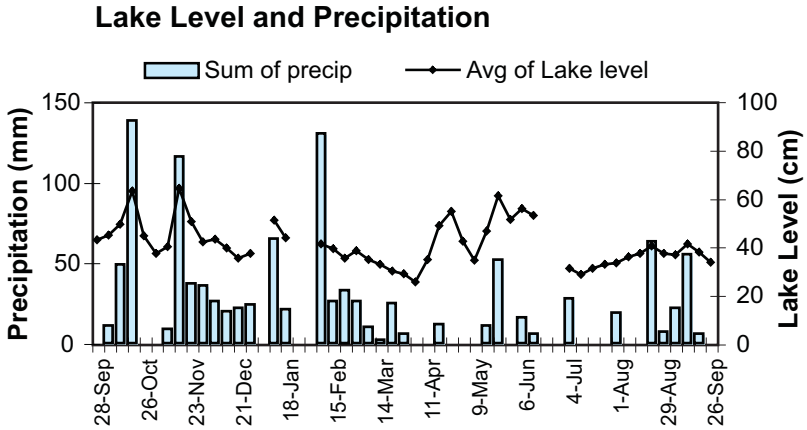
Excellent local precipitation and water level records were available for the year, showing that the lake level varied erratically through most of the year, relating to rainfall events in winter, but also remaining at high levels in summer, likely affected by both beaver and human activities.

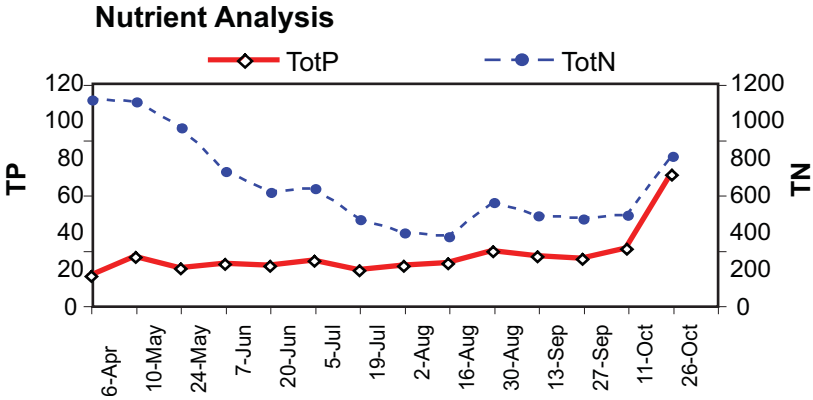
Nutrient Analysis and TSI Ratings

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.

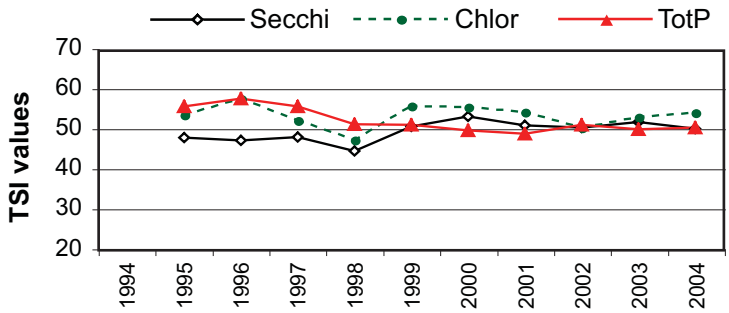
In 2004 TSI values for the three indicators were close to each other, above the threshold for eutrophic conditions, similar to recent years.

Chlorophyll Concentrations and Algae

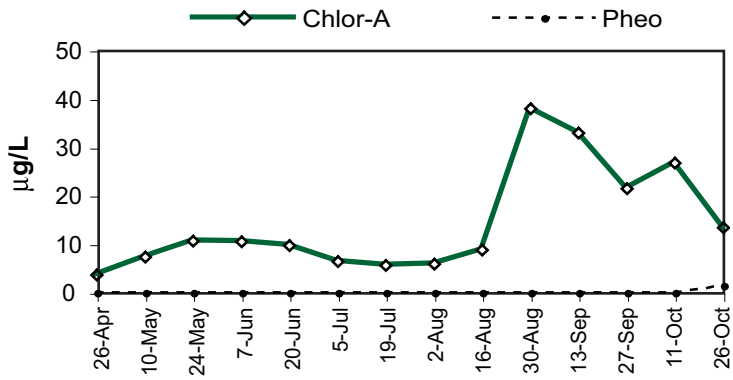
Chlorophyll content decreased from a minor increase in late May to low values that remained steady through summer and then increased greatly in late August, shortly after the drop in N:P ratios. For most of the sample season, the phytoplankton was dominated by the bluegreen *Aphanizomenon flos-aquae.* 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.

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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

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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

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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

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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

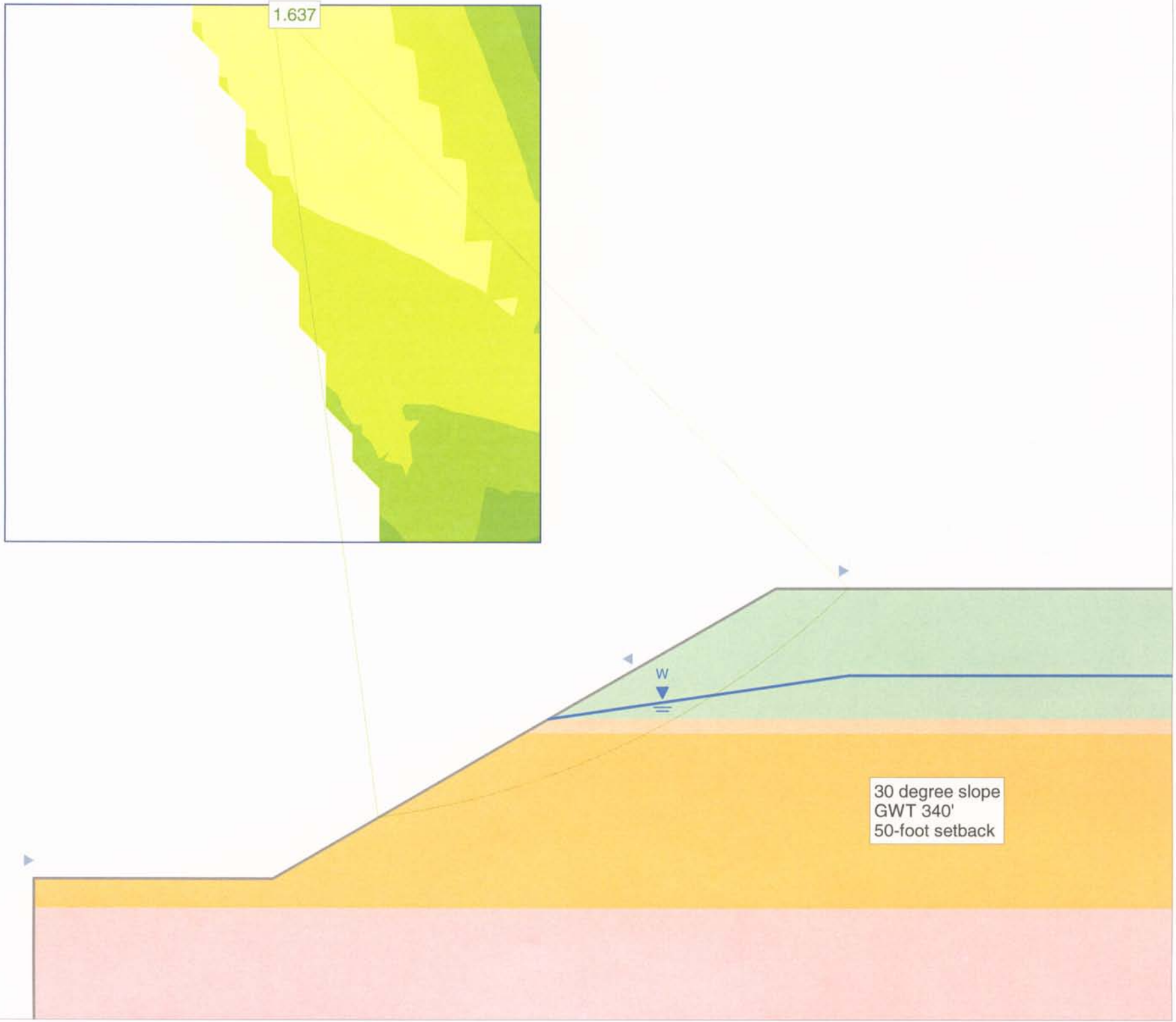
Estimated Seepage Pressure Changes

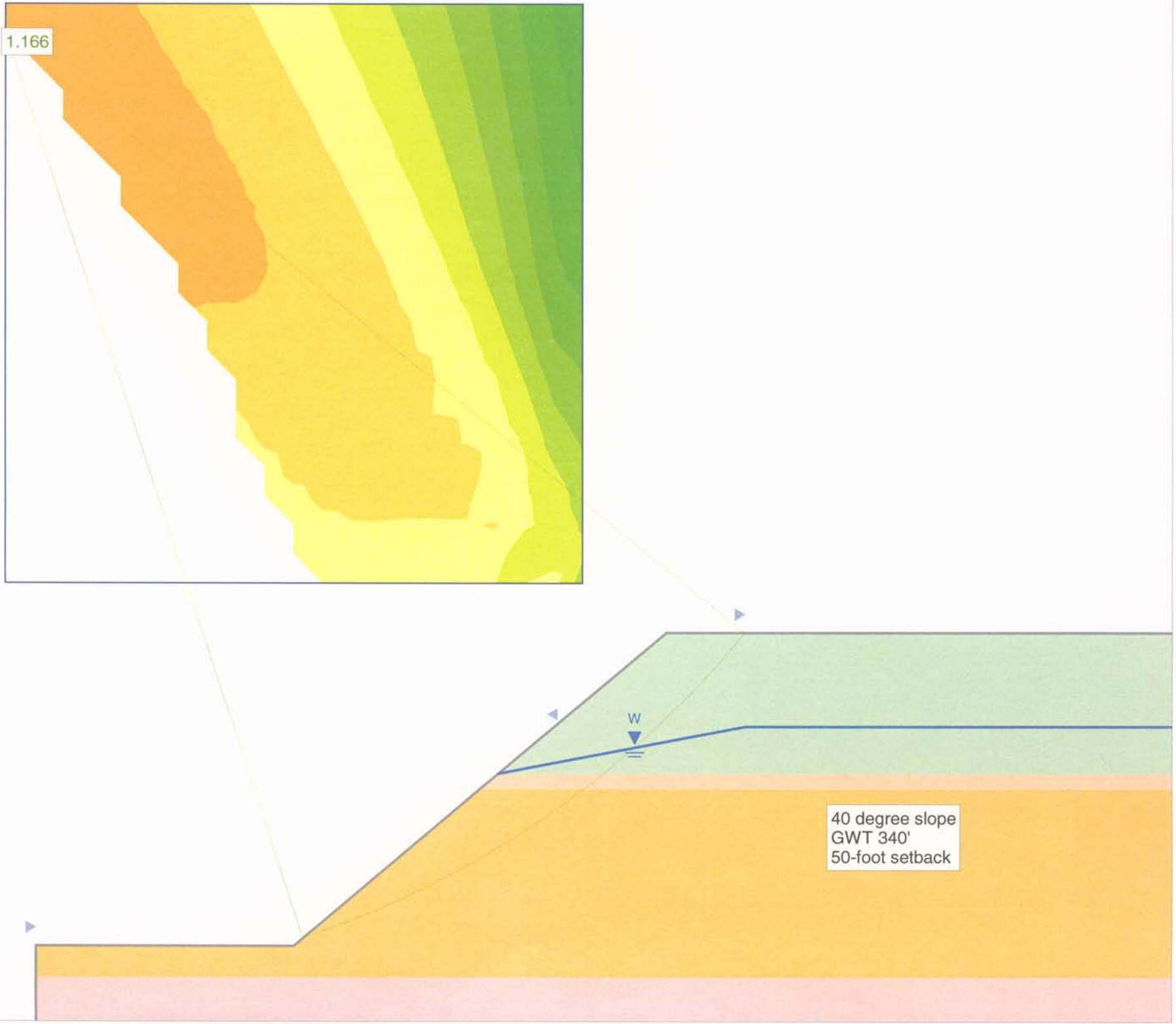
Pond Geometry[1]		Groundwater Level Change[2]		Stability Change[3]			
Aquifer Hydraulic Conductivity	Distance from Crest of Slope	at Pond	at slope crest	30-degree slope[4]	Percent change	40-degree slope[4]	Percent change
(ft/day)	(ft)	(ft)	(ft)	(FOS)	%	(FOS)	%
50	50	15	15	-0.10	-6%	-0.04	-3%
50	100	15	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%

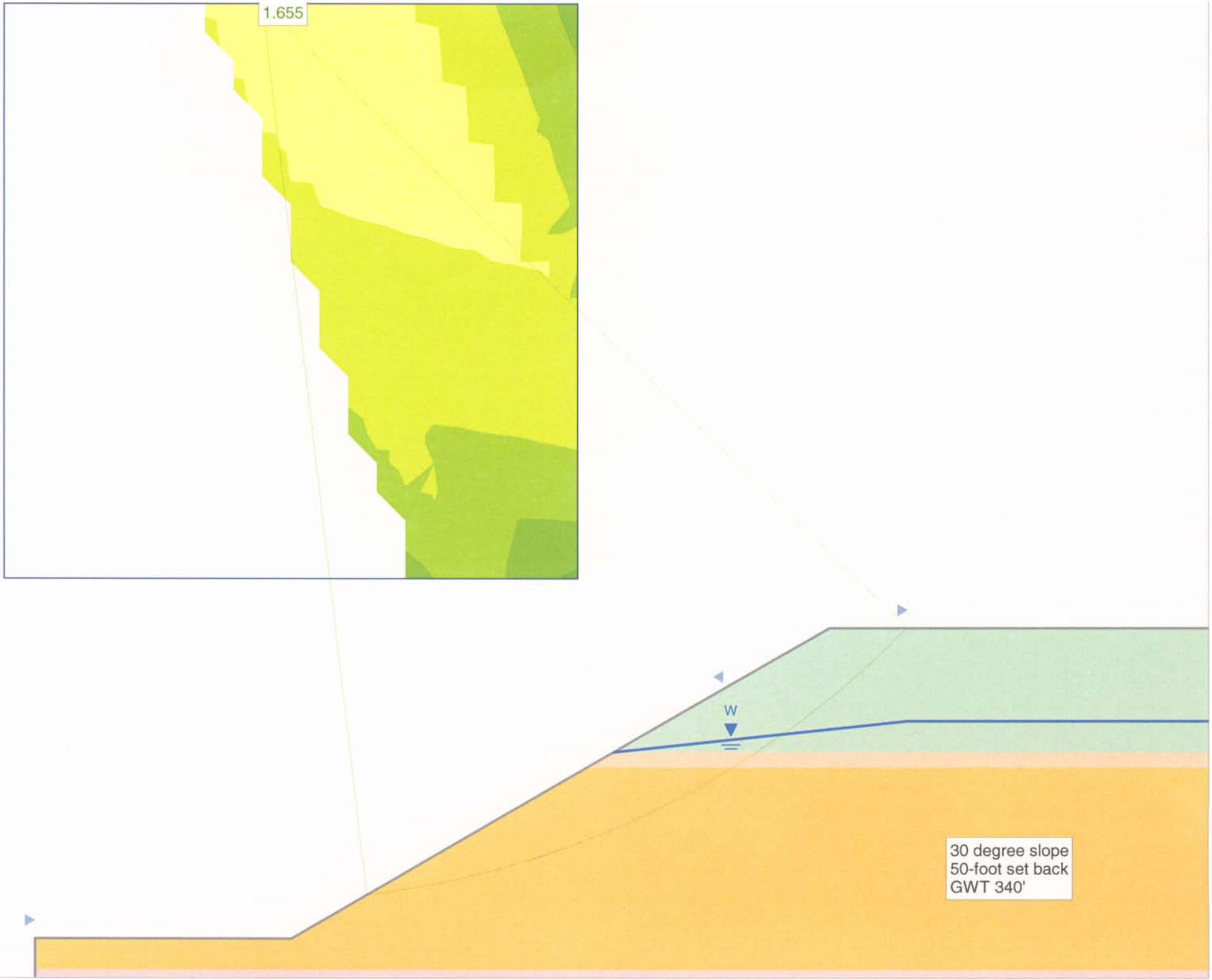
1 Assumes 100'x200' pond, with a 20-foot aquifer saturated thickness, and 0.1 storage coefficient
2 Calculated based on Finnemore (1995)
3 Calculated based on SLIDE calculations (see attachment)
4 Initial FOS = 1.66
5 Initial FOS = 1.18

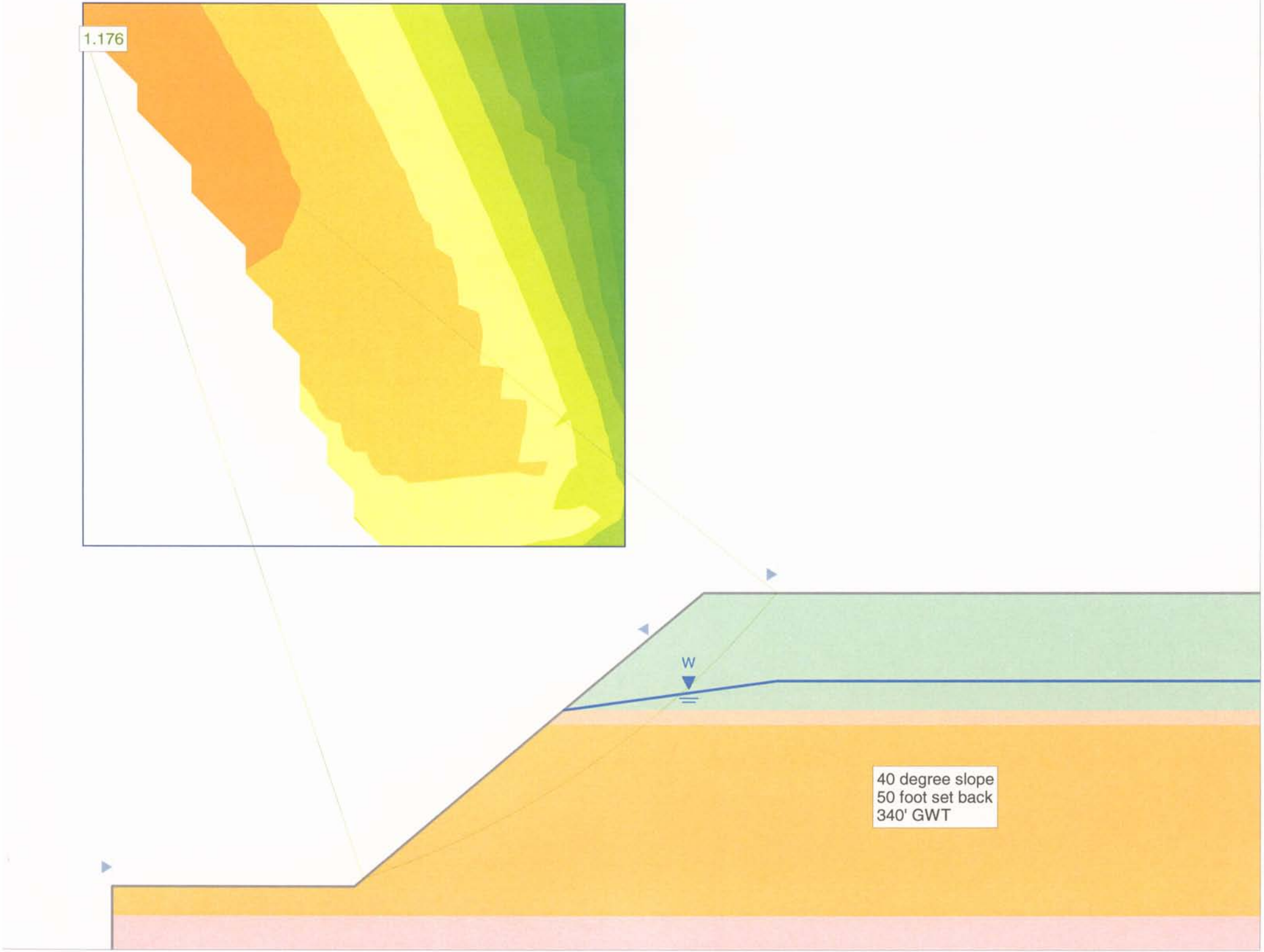
CONCLUSION

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


1.655
W
30 degree slope
50-foot set back
GWT 340'


1.176
W
40 degree slope
50 foot set back
340' GWT