OLYMPIC VIEW

WATER & SEWER DISTRICT

DEER CREEK WATER SUPPLY PROTECTION PLAN

Prepared By:

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and
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OLYMPIC VIEW WATER AND SEWER DISTRICT
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DEER CREEK WATER SUPPLY PROTECTION PLAN

1. OVERVIEW

The purpose of this Watershed Protection Plan is to develop and document a program for protection and enhancement of the water supply obtained from Olympic View Water and Sewer District's Deer Creek Water Supply Facility. The Plan has been prepared in accordance with State Department of Health requirements and incorporates elements of source water protection which are outlined in WAC 246-290-135, -668 and -690. This Plan actually represents a hybrid program combining the key elements of both wellhead and watershed protection planning. The reason for taking this approach to water supply protection is that, although the source of supply is considered surface water, the nature of the supply facilities and location within an urbanized area may increase the vulnerability of the source either from surface activities or through aquifer contamination.

1.1 Authorization

The Board of Commissioners of Olympic View Water and Sewer District authorized Penhallegon Associates Consulting Engineers, Inc. and Robinson & Noble, Inc. to complete this study as outlined in the scope of work and cost estimate. Authorization and notice to proceed were received in July, 1999. This Plan has been accomplished in accordance with that scope of work and to meet the specific needs of the District. Penhallegon Associates was responsible for overall coordination of the study and development of a protection program while Robinson & Noble was responsible for hydrogeologic modeling and delineation of wellhead protection zones.

1.2 Objectives and Methodology

In order to develop an effective program for protecting and enhancing the Deer Creek source of supply, the zone of contribution and wellhead protection areas for one-, five-, and ten-year capture zones were first identified by Robinson & Noble, as documented later in this report and in their full report provided in the Appendices. Once the zones of influence were identified, an inventory of land uses and potential contaminants within the area was conducted and coordinated with District billing records. After determining the types of activities and potential threats to water quality from the Deer Creek source, a program for protection of the supply was identified. This program includes recommendations of capital improvements which may be appropriate for protection of the supply as well as precautionary measures which might be implemented by agencies responsible for land use code enforcement in the area of influence. A final step in developing this Plan was to formulate a contingency plan in the event of source water contamination and recommendations regarding continued coordination with the Town of Woodway, City of Edmonds, and Snohomish County for the long term protection and enhancement of the water supply.

2. WATER SYSTEM OVERVIEW

Although a complete inventory of the Olympic View Water and Sewer District water system is provided in the Districts Comprehensive Water System Plan (1996), the following summary is intended to provide the reader with a general understanding of how the water system works and especially, the significance of the Deer Creek source in the District's overall objective of providing high quality, safe and reliable domestic and fire protection service to its customers.

2.1 Service Area

Olympic View Water and Sewer District's water service area includes approximately 2,380 acres of land in the southwestern corner of Snohomish County. Water service is provided to approximately 4,400 connections within the Town of Woodway, a portion of the City of Edmonds and some of unincorporated Snohomish County. The service area is predominantly single family residential in nature with supporting commercial activities and multi-family uses concentrated along major thoroughfares such as Highway 99 and Edmonds Way.

2.2 Water System Demands

Water use in the District is generally consistent with the single family land use and the average day demand over the past five years was approximately 1.43 MGD, while the highest peak day demand over a three day period was approximately 3.61 MGD. Average use per single family residence is approximately 233 gallons per day.

2.3 Water System Facilities

Olympic View's water system consists of four separate pressure zones and the District maintains two separate sources of continuous supply, several emergency intertie connections, three reservoirs, three water booster stations as well as pressure control stations to control pressures and allow for interties between pressure zones. An overview of primary system facilities is provided below and shown on Figure 1.

2.3.1 Source of Supply

Olympic View's water supply has traditionally been obtained from a combination of sources including District owned and operated water source facilities and water purchased from the City of Seattle's regional water supply system. A summary of these facilities is presented below:

Deer Creek Source

The Deer Creek source is a spring fed stream source located in the western portion of the District. Although the source has been active for a number of years, it was upgraded in recent years. A state-of-the-art treatment facility was completed in 1998 and is capable of producing of approximately 1 million gallons per day. Currently, however, the Deer Creek water supply and treatment facility supplies approximately 0.6 MGD on an average day, comprising approximately 40% of the District's total supply. This source typically supplies all of the Woodway Pressure Zone in the western portion of the District. In addition, Deer Creek water is transferred to the District's Low Zone through the Woodway Booster Station.

The Deer Creek Watershed area consists of approximately 20 acres of land located in a ravine near the western edge of the District. The watershed area is owned by the District, is completely fenced for security and District staff are on call 24-hours a day for response to any type of emergency conditions at the water treatment facility or within the watershed. Aside from water supply facilities, the watershed area remains in a natural wooded state for protection.

City of Seattle Source

The District purchases the remainder of its supply from Seattle through two separate metered connections along the southern boundary of the District. Both meters from the Seattle system are from Seattle's 580 Zone, are equipped with flow controllers and flow into Olympic View's Low Zone (540 hydraulic grade line) to supply the District's 1.5 million gallon reservoir by gravity. The City of Seattle source is capable of meeting the needs of the entire District in the event that the Deer Creek source is out of service or unavailable.

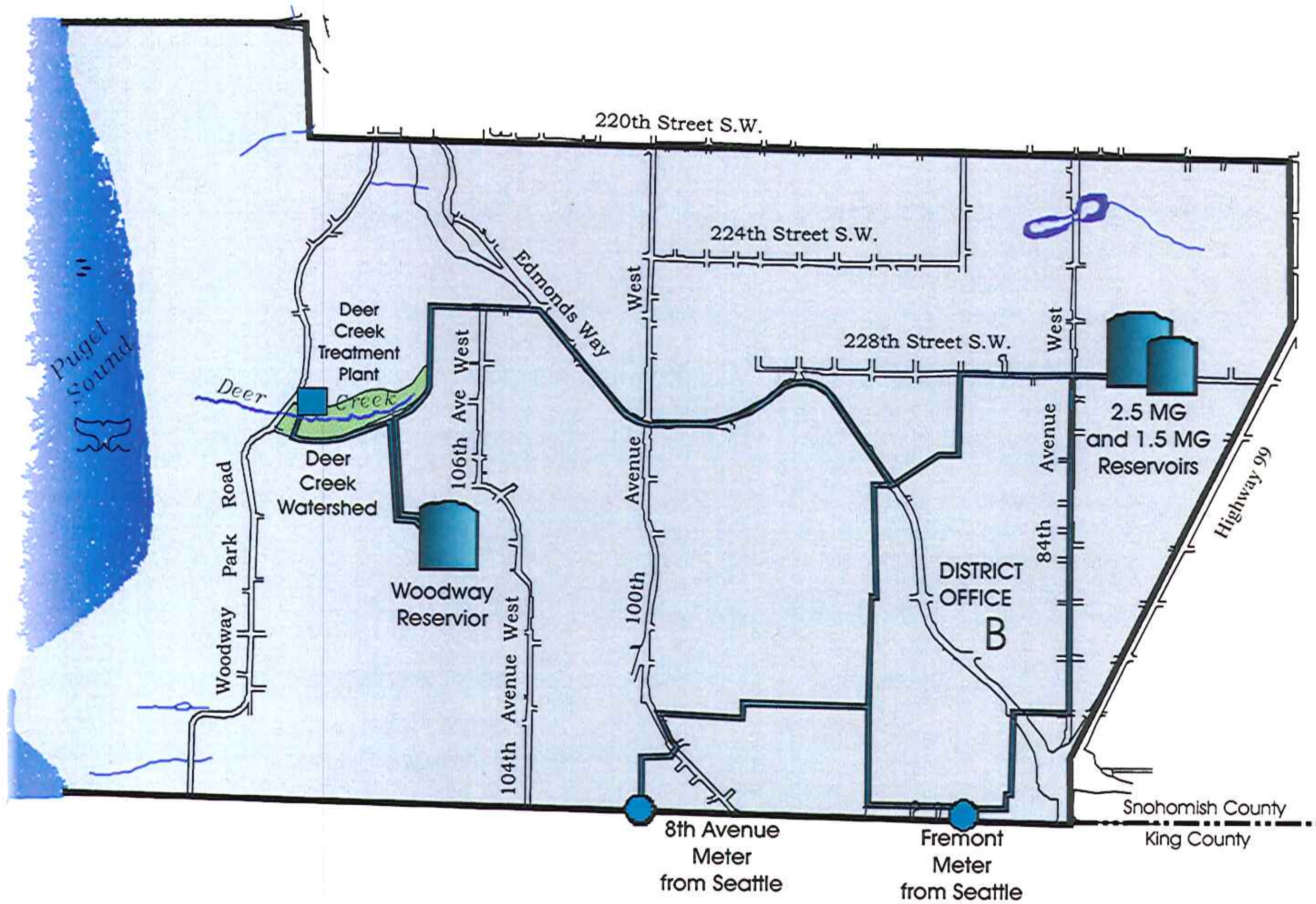


FIGURE 1

WATER SYSTEM FACILITIES MAP

Olympic View Water Supply Protection Plan

Emergency Interties

Three emergency supply interties with the City of Edmonds provide the District with a backup supply in the event of an interruption in the Seattle supply. Two of these interties are directly from Edmonds distribution system, while one is a metered connection which was constructed for the sole purpose of delivering Everett water to Olympic View system via the Alderwood Water District and City of Edmonds systems. Although this facility has served the District in the past, it was not sized or constructed for operation on a continuous basis.

228th Street Well

In 1990 the District constructed a groundwater well. Although this facility is anticipated to yield approximately 550 gpm, difficulty in treating the water has precluded Olympic View from utilizing the source at this time. Any required wellhead protection will be addressed in conjunction with development of the well.

2.3.2 Storage Facilities

There are three storage reservoirs in the Olympic View system: the 0.25 million gallon Woodway Tank which serves the Woodway Zone; the 1.5 million gallon reservoir used to transfer water received to the High and Low Zones; and the 2.5 million gallon reservoir which provides direct service to the Low Zone.

2.3.3 Pump Stations

There are four separate pump stations which serve Olympic View and transfer water between its pressure zones. These facilities are used to transfer water from the Deer Creek source to the Woodway Tank, from the Woodway Tank to the Low Zone, from the 1.5 million gallon reservoir to the 2.5 million gallon tank, and finally, from the 2.5 million gallon tank to the High Zone.

2.3.4 Transmission and Distribution System

The Olympic View system consists of a network of approximately 50 miles of pipe ranging from 2- to 12-inches in diameter within the four separate pressure zones.

3. DEER CREEK SUSCEPTIBILITY ASSESSMENT

In 1996, Olympic View Water & Sewer District completed a Ground Water Susceptibility Assessment form addressing the potential for contamination of the Deer Creek Source. The susceptibility analysis included review of a variety of geologic and land use factors which combine to indicate the vulnerability of and potential severity of certain pollutants entering the water source. The purpose of the assessment was to determine the appropriate level of testing required to insure that the water supply remains free of contaminants.

The State Department of Health reviewed the assessment form, assigned the Deer Creek source a high susceptibility rating and established a testing program appropriate to the source characteristics. Required testing includes periodic analysis for Volatile Organic Compounds (VOC's). Based on the Susceptibility Assessment and regional conditions, the District received a waiver for Synthetic Organic Compound (SOC) monitoring.

4. WELLHEAD PROTECTION AREAS

As documented in Appendix A to this report, Robinson & Noble, Inc. completed a detailed and thorough analysis of the Deer Creek source to identify wellhead protection areas. First, the analysis included collection and analysis of geologic and hydrogeologic data for the region. Based on available information and past studies, the approximate study area for the Deer Creek source was determined to be approximately six square miles centered east of the Deer Creek Springs. Second, Robinson & Noble developed a conceptual model of the hydrogeologic system from which the springs produce water. Third, the data analysis and conceptual model were combined with flow data from the springs and field verification of conditions to develop a numeric model which reflects the recharge and flow characteristics of the shallow groundwater system model. Using the numeric model, wellhead protection zones based on time travel rates of groundwater were developed. A brief summary of each of these steps is provided below while detailed information is provided in the Robinson & Noble Report contained in Appendix A.

4.1 <u>Data Collection and Database Development</u>

In addition to pertinent studies performed for other geologic and hydrogeologic projects in the vicinity of the Deer Creek source, Robinson & Noble researched wells of record within the study area to create a water well database. A total of 23 well records were collected from the State Department of Ecology and of those, 14 were found to have sufficient information to be included in the database. In addition, information from test holes and observation wells in and placed around the watershed area and other information from

Robinson & Noble files was included in the database.

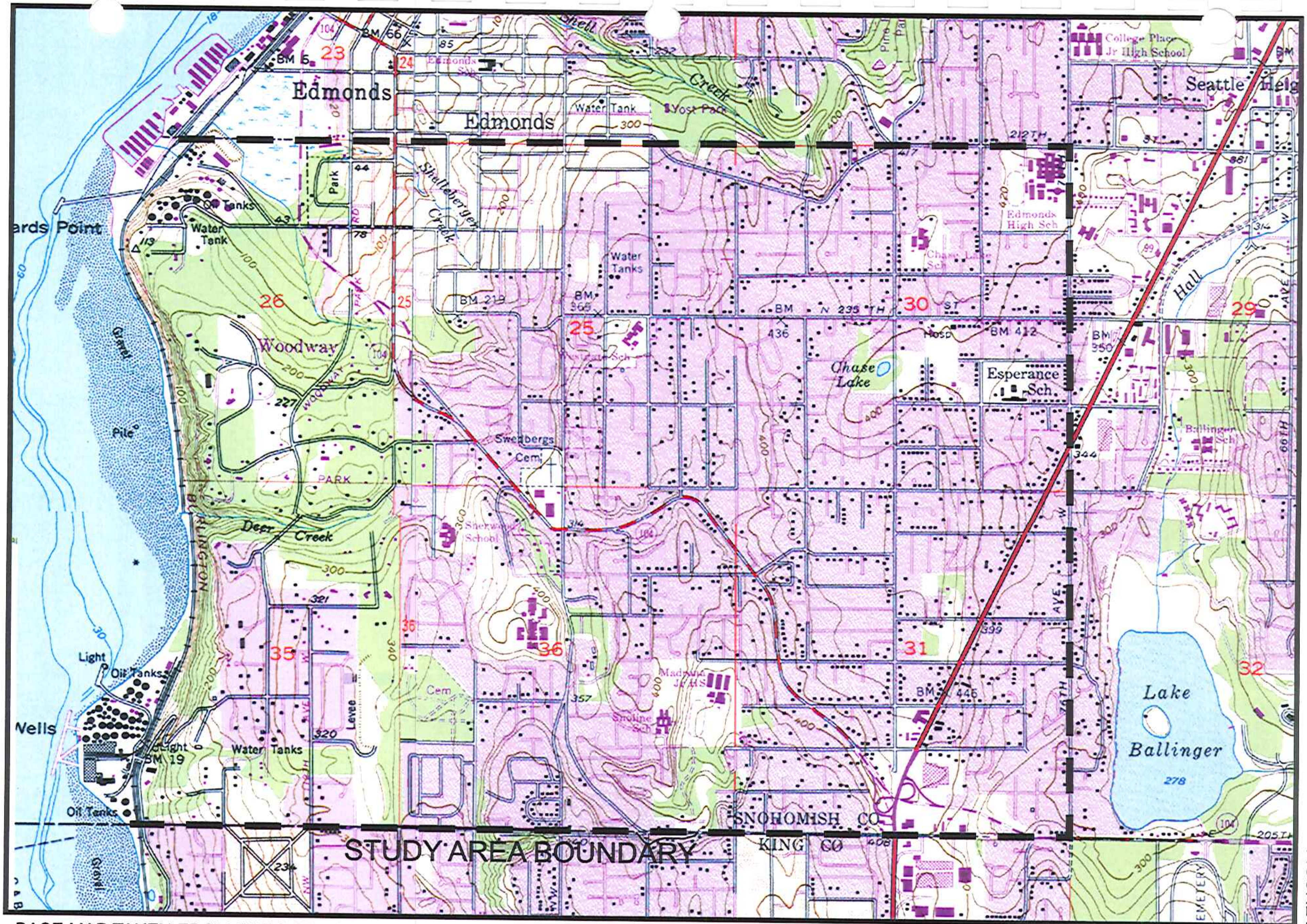
4.2 Conceptual Model

Development of a conceptual model is an important step in developing an overall understanding of groundwater flow in an area and for organizing field data for further analysis. Development of the conceptual model for the Deer Creek source included delineation of boundaries for the model, identification of hydrostratigraphic units within the established boundaries and determination of the general groundwater flow characteristics. The model boundaries are generally limited to physical and hydraulic features which impede the flow of groundwater. The boundaries outlined for this study are the bluff overlooking the Puget Sound on the west and a groundwater divide located approximately ½ mile west of Lake Ballinger, in the eastern portion of the study area (See Figure 2). No groundwater influence is believed to be present from the north or south of the Deer Creek springs.

Definition of hydrostratigraphic units was accomplished in part, by identifying surficial geology, which in the vicinity of the watershed, are in general conformance. A complete discussion of these factors is provided in the Appendices. Primary hydrostratigraphic units in the study area include Vashon Till on the surface, underlain by Vashon Advance Aquifer System and Pre-Vashon transitional beds underlying the advance aquifer system.

The final and most important element of the conceptual model is identifying the general flow system or how groundwater moves through the study area and discharges from the springs. Determination of this requires analysis of a variety of information including precipitation and recharge data, head and hydrograph data, well production data and other pertinent hydrogeologic data. This analysis resulted in the determination that the general flow of groundwater in the area is from east to west and is rapid due to the relative high permeability of Vashon advance outwash sediments and low permeability of the underlying silt and clay transition systems on which the aquifer system rests. The conceptual model indicates that the source of recharge for the groundwater system is direct recharge from precipitation. Discharge from the groundwater system is through the bluff over the Puget Sound but is particularly focused at the ravine in which the Deer Creek Springs are located.

FIGURE 2



BASE MAP TAKEN FROM USGS EDMONDS/EDMONDS EAST QUADS

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WATER SUPPLY PROTECTION AREA MAP

Olympic View Water Supply Protection Plan

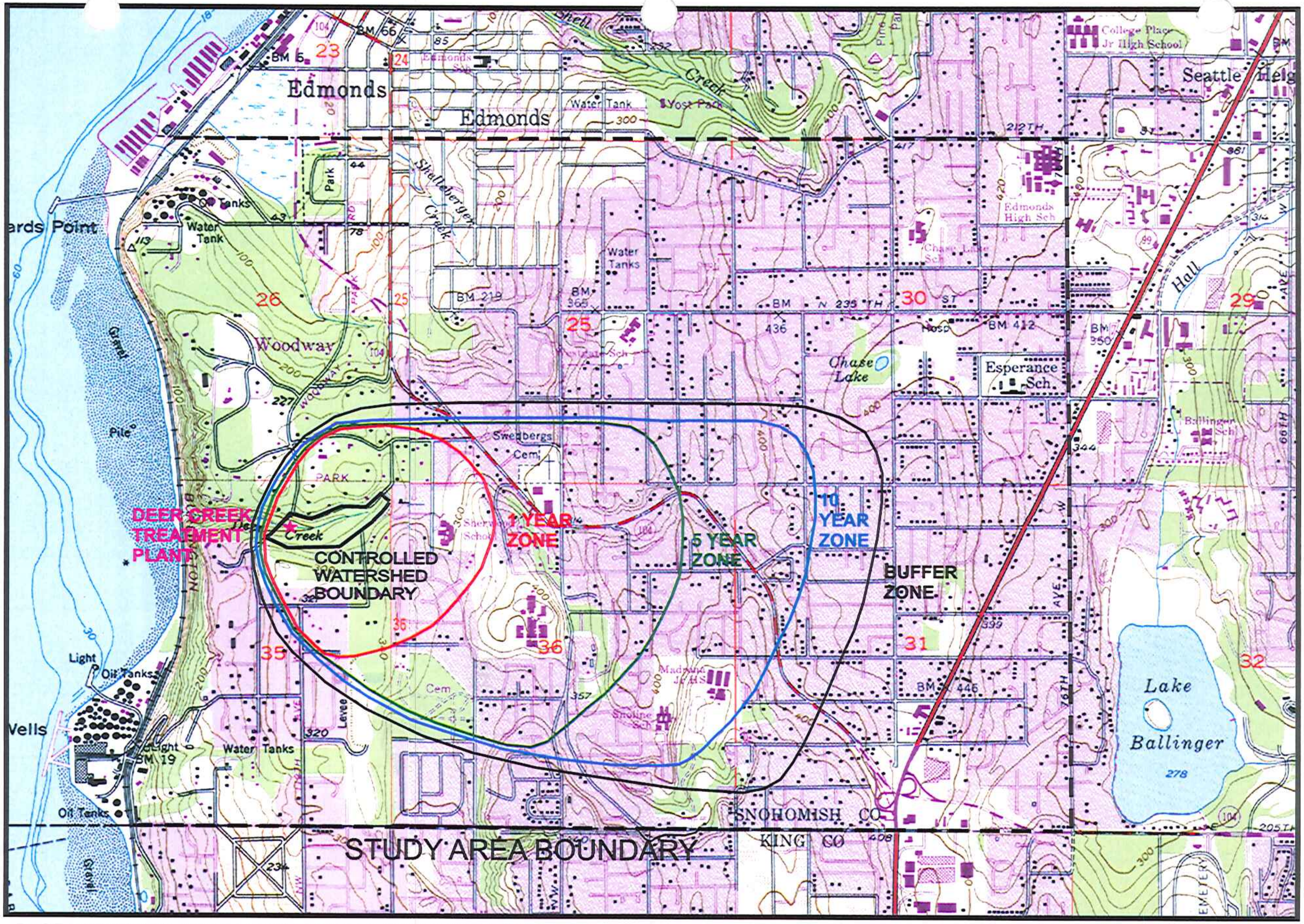
4.3 Capture Zones

Delineation of capture zones is required prior to determination of Wellhead Protection Areas or WHPAs. Two types of capture zones have been identified in the process of developing this Plan, a steady-state capture zone, and time related capture zones. Steady state capture zones are based solely on the location and characteristics of groundwater flow and can be determined by simply tracing flowlines upgradient to the groundwater basin boundary. In the case of the Deer Creek Springs, the zone of contribution reaches approximately 1,000 to 1,500 feet north and south of the springs and east to the groundwater divide located approximately ½ mile west of Lake Ballinger.

Determination of time related capture zones is significantly more difficult and sophisticated, and much more useful in establishing a wellhead protection program. Time related zones are determined by calculating the velocity of water flowing through the groundwater system. As stated in the Robinson & Noble Report contained in the Appendices, the travel time identified for each time related capture zone represents the time it takes for a particle of water to move along the flow paths. It is noted that the time for a particle of contaminant to travel through the same flow path may significantly differ form the estimated time that it takes for a particle of water to travel the same course. Through numeric modeling, Robinson & Noble have identified travel time capture zones for the Deer Creek source, which are reflected in Figure 3.

4.4 Wellhead Protection Areas (WHPAs)

Determination of WHPAs, in accordance with State Department of Health requirements, requires consideration of the following five zones in the development of a wellhead protection zone: Sanitary control area (defined protection radius around a wellhead or spring); Zone 1 (one-year horizontal time of travel zone); Zone 2 (five-year horizontal time of travel zone); Zone 3 (ten-year horizontal time of travel zone); and additional buffer zone. These zones correspond with the time of travel zones established by numeric modeling and outlined in Figure 3, except as they have been modified to account for unknown variability within the groundwater system. An additional buffer zone has been recommended to account for the relatively shallow nature of the groundwater system and includes the entire zone of contribution for the Springs.



BASE MAP TAKEN FROM USGS EDMONDS/EDMONDS EAST QUADS

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WATER SUPPLY PROTECTION AREA MAP

Olympic View Water Supply Protection Plan

5. CONTAMINANT SOURCE INVENTORY

In an attempt to identify the susceptibility of the source to potential contaminants, a survey of land uses in the area of contribution has been accomplished. This effort was coordinated with Emergency Services Coordinating Agency (ESCA) and using District billing records as well as land use maps and other information from the City's of Edmonds and Town of Woodway, within which Olympic View Water and Sewer District serves. This inventory is essential in identifying known potential risks to the watershed area. It is the intent of this Plan that the list of potential contaminants be provided to local regulatory agencies in order to assist in long term protection of the watershed by appropriate environmental protection legislation. Table 1 and Figure 4 outline the identified potential contaminants within the identified Wellhead Protection Areas according to location within each time capture zone.

Figure 4 also provides a general map of known on-site sewage disposal systems in the vicinity of the watershed area, although the names and addresses of individual property owners has not been accomplished as part of this study. The Plan was, however, distributed to local agencies, Woodway, Edmonds, and Snohomish County for use in consideration of future activities related to the existing septic systems. In addition, implementation of this Plan includes notification of all property owners within the capture and buffer zones to inform them of their role and responsibilities in protection of the watershed. Figure 5 indicates general land use within the District to provide an overview of which areas of the District have the potential to support activities which might include hazardous materials.

An additional area of concern in the immediate vicinity of the watershed is the storm drainage system which surrounds the watershed itself. Although adequate storm facilities exist on the east and south sides of the watershed, improvements are needed along the northern edge of the area. Catch basin relocation and installation of curb and gutter are anticipated and will be coordinated the Town of Woodway for protection of the area from runoff from the pavement above the watershed.

TABLE 1 - POTENTIAL CONTAMINANT INVENTORY

	Facility Name/Address	Type of Use	Priority	Reason	Capture Zone Location	Contact Address/Phone
1	Deer Creek Water Treatment Plant 23003 Woodway Park Rd (In watershed)	Water Treatment Facility	Low Downstream of source	Potassium Permanganate Calcium Hypochlorite Sodium Hypochlorite Aluminum Sulfate	1 Year	Olympic View Water & Sewer District
2	Westgate Lift Station 23005 108th Avenue SW	Sewer Lift Station	High	Wastewater storage	1 Year	Olympic View Water & Sewer District
3	Edmonds Memorial Cemetery	Cemetery	Low	Cemetery	5 Year	City of Edmonds
4	Klayaha Swim and Tennis Club 10307 238th Street SW	Swimming Pool	Low	Chlorine	5 Year	Klayaha Swim and Tennis Club 10307 238th Street SW
5	City Transmission and Auto 23900 Firdale Ave	Auto Repair	Moderate	Gasoline Transmission Fluids	5 Year	City Transmission and Auto 23900 Firdale Ave
6	Texaco Service Station 23726 100th Avenue West	Service Station	Moderate	Gasoline Underground Storage	5 Year	Texaco Service Station 23726 100th Avenue West
7	Westgate Chevron 9930 Edmonds Way	Service Station	Moderate	Gasoline Underground Storage	5 Year	Westgate Chevron 9930 Edmonds Way
8	J&V Cleaners 9804 Edmonds Way	Dry Cleaning	Moderate	Chemical Storage	5 Year	J&V Cleaners 9804 Edmonds Way
9	Kwick & Clean Carwash 9715 Edmonds Way	Service Station	Moderate	Gasoline Underground Storage	5 Year	Kwick & Clean Carwash 9715 Edmonds Way
10	Westgate Vet Hospital 700 Edmonds Way	Veterinary	Low	Storage	5 Year	Westgate Vet Hospital 700 Edmonds Way
11	VIP Cleaners 22810 10th Ave. W	Dry Cleaning	Moderate	Chemical Storage	5 Year	VIP Cleaners 22810 10th Ave. W
12	Woodhaven Vet Clinic 23204 Edmonds Way	Veterinary	Low	Storage	10 Year	Woodhaven Vet Clinic 23204 Edmonds Way
13	District Office 23725 Edmond Way	Utility District Shop	Low	Above Ground Fuel Storage	10 Year	Olympic View Water & Sewer District
14	Olympic Fuel/Laurelhurst Oil 23600 Edmonds Way	Fuel Supply	Moderate	Above Ground Fuel Storage	10 Year	
15	Restlawn Cemetery 10350 237th Place SW	Cemetery	Low	Cemetery	10 year	Restlawn Cemetery 10350 237th Place SW
	Septic Tanks Various Locations	Residential	Low	Wastewater Storage	1 Year 5 Year 10 Year	See Figure 4.

NOTE: Potential Contaminants are indicated on Figure 4 and correlated with numbering shown above.

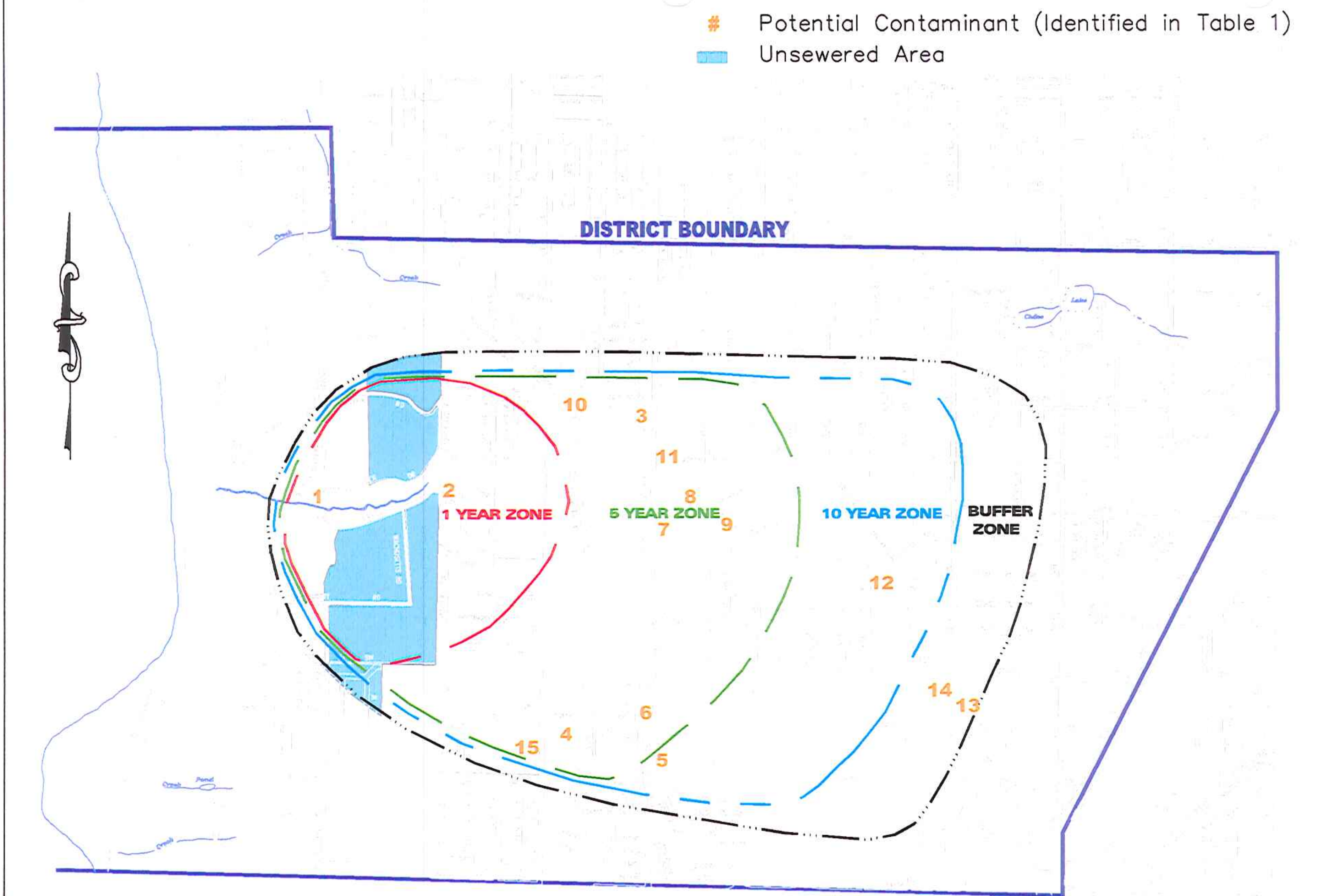

FIGURE 4

OLYMPIC VIEW WATER AND SEWER DISTRICT

UNSEWERED AREAS AND POTENTIAL CONTAMINANTS WITHIN WATER SUPPLY PROTECTION AREAS

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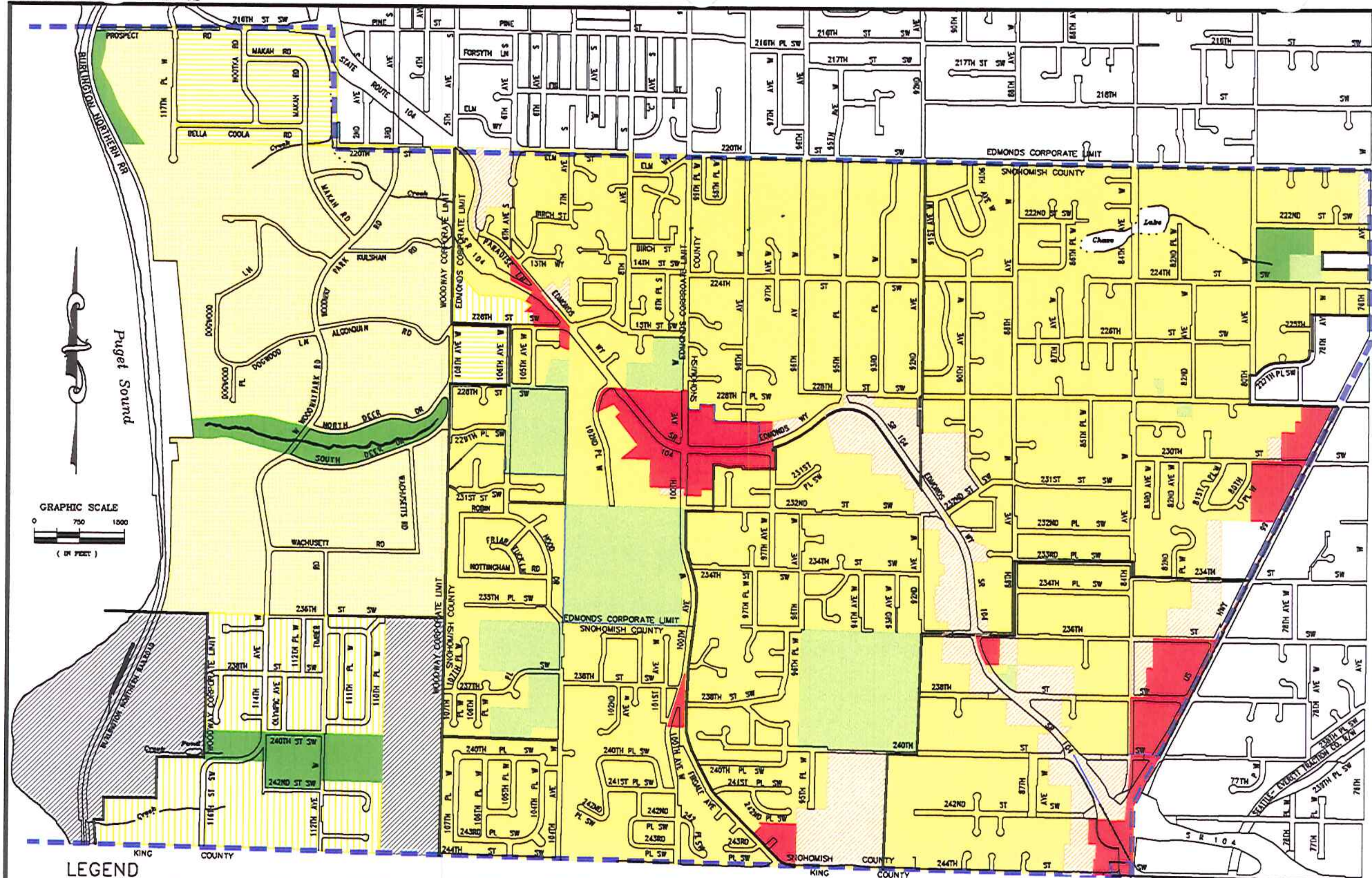

LEGEND

SINGLE FAMILY RESIDENTIAL (87,000 SQ.FT. LOT SIZE)	SINGLE FAMILY RESIDENTIAL (43,000 SQ.FT. LOT SIZE)
SINGLE FAMILY RESIDENTIAL (12-15,000 SQ.FT. LOT SIZE)	SINGLE FAMILY RESIDENTIAL (6-10,000 SQ.FT. LOT SIZE)
MULTI FAMILY	COMMERCIAL
INDUSTRIAL	PARK/ OPEN SPACE
COMMUNITY FACILITY	

Penhallegon Associates Consulting Engineers, Inc.

OLYMPIC VIEW WATER AND SEWER DISTRICT

WATER SUPPLY PROTECTION PLAN

FIGURE 5

ZONING MAP

6. CONCLUSIONS AND IMPLEMENTATION

Based on the hydrogeologic and land use analyses developed as part of this Water Supply Protection Plan, it is concluded that the District's Deer Creek Water Supply is generally well protected from potential contamination and that a very high level of source reliability is provided by the District's multiple sources of water. However, as discussed previously, there are a variety of potential contaminants within the identified capture zones and a specific program for long term protection of the Deer Creek source is required. Olympic View's program should include below listed elements, each of which is discussed in further detail later in this Section.

- Establish Water Supply Protection Guidelines (Appendix B);
- Capital Improvements for increased protection of watershed;
- Coordination with local Emergency Response Teams and Police;
- Coordination with Local Land Use Authorities (Town of Woodway, City of Edmonds, Snohomish County);
- Notification of potential contaminant sources;
- General Public Awareness program;
- Continued monitoring.

6.1 Establish Water Supply Protection Guidelines

Water Supply Protection Guidelines, as presented in Appendix B are key to all other aspects of the Water Supply Protection Plan. They provide the District and other agencies with a summary of the kinds of activities which could have a short or long term impact on the Deer Creek Watershed and subsequently impact how Olympic View maintains high quality drinking water service to its customers.

6.2 Capital Improvements

Certain capital improvements are or may be required for continued protection of the watershed. At this time, modification of stormwater facilities on the north side of the watershed will be included as a 2002 Capital Improvements project to insure that stormwater flows are properly intercepted and are not allowed to flow into the watershed area. It is recommended that the District proceed with a design of storm water system improvements. Additional capital improvements projects which may be required for watershed protection will be identified and accomplished as required and included in the District's periodic water system planning efforts.

6.3 Other Emergency Response Programs

Olympic View Water & Sewer District operates within the limits of Edmonds, Woodway, and Snohomish County. As such, any of these agencies may become aware of activities or situations which could impact the watershed prior to Olympic View. Continued coordination with these agencies and maintenance of notification procedures is required and will be accomplished by District representatives remaining in close contact with these agencies.

6.4 Cooperation with Local Land Use Authorities

Implementation of the Supply Source Protection Plan requires cooperation with other agencies as well as notification of the owners and operators of facilities or operations which pose a potential threat to the integrity of the watershed. Initial coordination with the Town of Woodway, the City of Edmonds, and Snohomish County has been accomplished by providing a copy of this Plan and the District's Water Supply Protection Guidelines for comment and review (See Appendix B).

Continued cooperation with land use agencies (Town of Woodway, City of Edmonds and Snohomish County) will be required for the long term protection of the watershed. Copies of this document and maps indicating Capture Zones were provided to land use authorities and for incorporation into environmental protection legislation as appropriate.

Additional long term protection of the water supply can be obtained by the District by being included in the permitting process for applications indicating association with activities which might involve use of potential contaminants. Appropriate forums for regulating activities which may impact the watershed include Building Codes, Design Standards, Site Plan Review Procedures which include input from the District, and Subdivision and Zoning Regulations. The District has requested that each of the aforementioned agencies maintain a watershed protection area overlay indicating capture zone locations and current copy of its Water Supply Protection Plan on file for consideration in determining the suitability of development applications. Additional cooperative efforts are discussed in further detail in Appendix B.

Periodic meetings with appropriate agencies is recommended as a means of ongoing coordination with those agencies. Topics for consideration might include minimum design standard within the identified Capture Zones, Emergency Response Coordination, and public notification programs which might be implemented to raise public awareness of the importance of watershed protection.

6.5 Notification of Potential Contaminant Sources

Notification of businesses within the watershed protection Capture Zones identified in this Plan is imperative to public awareness and long term protection. Initial contact as well as periodic data and information distribution is recommended. Identified potential sources of contaminants identified in Table 1 have been notified by letter. Sample letters are included in Plan Appendix C.

All Property owners within the Capture and Buffer zones surrounding the watershed area have been notified by direct mailing to indicate the importance of taking care to protect the environment in this close proximity to Deer Creek. As documented in Appendix C, general information regarding use of chemicals, fertilizers and potential contaminants will be provided. Additional information regarding the importance of proper septic tank operation and maintenance will be accomplished through District newsletters and in cooperation with other agencies.

6.6 General Public Awareness Program

In addition to coordinating with appropriate regulatory agencies and notifying potential point source contaminant property owners, the District maintains a pro-active approach to encouraging all of its customers to participate in watershed protection. Those customers within the identified Capture Zones will receive periodic mailings regarding their direct and indirect roles in protecting the watershed. These notices will include statements regarding the importance of maintaining a safe water supply as well as specific information pertaining to the use of potential contaminants and proper maintenance of on-site sewage disposal systems.

In addition, the District will continue to include information the Deer Creek source protection in its annual Water Quality Report, periodic newsletters and utilize other public forums for educating the public about this important subject. Preprinted brochures and other educational information from national organizations such as the American Water Works Association, as well as information from the Environmental Protection Agency and State Departments of Health and Ecology should be made available to the District's customers as appropriate.

6.7 Continued Monitoring

Continued groundwater monitoring is required as a means of maintaining a long term water quality history within the watershed and identifying any potential changes in water quality and required changes in treatment of the water obtained from the source.

7. CONTINGENCY PLAN

As indicated earlier in this Plan, Olympic View Water and Sewer District has three separate sources of supply available to it: the Deer Creek Source which is the subject of this Plan, as well as supply from the City of Seattle to the south and emergency interties with the City of Edmonds which could provide Everett regional supply water from the north. In accordance with the District's established emergency response program, any compromise or interruption of the Deer Creek supply would most likely be compensated for by increasing the amount of water obtained from the regular Seattle supply. This could readily be accomplished by opening and closing valves within the system and no capital improvements would be required. The interties with Edmonds could also be activated if additional supply was needed to augment the Seattle source for any reason.

Appendix A

ROBINSON & NOBLE, INC.
GROUND WATER & ENVIRONMENTAL GEOLOGISTS
ESTABLISHED 1947

OLYMPIC VIEW WATER DISTRICT
WELLHEAD PROTECTION AREAS DELINEATION
DEER CREEK SPRINGS SOURCE AREA

November 1999

by

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Introduction

In July of 1999, Robinson & Noble was retained to delineate the wellhead protection areas for the Olympic View Water District's Deer Creek Spring source. This report presents the methods and findings of the investigation, and provides maps defining the zone of contribution and wellhead protection areas for the one-, five-, and ten-year capture zones of the spring source.

Several steps are necessary to accurately delineate wellhead protection areas (WHPAs). First, geologic and hydrogeologic data for the general region must be collected and analyzed. The appropriate study region for this project was determined to be an area that encompasses approximately six square miles centered east of Deer Creek Spring (Figure 1). Second, a conceptual model of the hydrogeologic system from which the springs produce water needs to be developed from the hydrogeologic data. Third, by using the data analysis and conceptual model, a capture zone delineation method can be chosen and the zones defined. Finally, using the defined capture zones as a base, the wellhead protection areas can be delineated. The Washington State Department of Health (DOH) requires that each well or other groundwater source have three designated WHPAs, labeled Zone 1, Zone 2, and Zone 3, based upon the one-, five-, and ten-year capture zones. DOH also recommends that there be an additional WHPA outside of Zone 3, termed the Buffer Zone, which may be used to protect additional aquifer or recharge areas.

In this case, the capture zones for the one-, five-, and ten-year conditions were delineated using a numerical model that reflected the recharge and flow characteristics of the shallow groundwater system discharging at the Deer Creek Springs. Before developing the model, the known information regarding the geology and hydrology of the area was collected and reviewed. Additionally, the flow data for the springs themselves was researched. This preliminary data collection and system description phase included reviewing previous work performed in the area. In this study area, pertinent geologic and hydrogeologic investigations have been performed by Robinson & Noble, other consultants, the US Geological Survey, and the Washington Department of Ecology.

After the collection and review of existing published and unpublished information was completed, certain geologic and hydrogeologic conditions in the study area were field-verified. The resultant understanding of the area was used to form a conceptual model of the hydrogeologic system associated with the springs. Using this conceptual understanding, the numerical model of the Deer Creek Spring system was developed and calibrated.

Previous Studies

The portion of Snohomish County that was analyzed for this study has been the subject of a number of different studies and projects dealing with the geology and hydrogeology. The area was mapped and studied in 1952 by R. C. Newcomb for the preparation of the US Geological Survey's Water Supply Paper 1135, *Ground Water Resources of Snohomish County, Washington.* Detailed geologic mapping of the area was performed in 1983 by James Minard for the US Geological Survey. Recently, western Snohomish County was studied by the US Geological Survey and the Washington Department of Ecology to prepare Water-Resources Investigations Report 96-4312, *The Ground-Water System and Ground-Water Quality in Western Snohomish County, Washington.* Additionally, Robinson & Noble personnel have worked closely with the District since 1981 in an effort to define and protect the spring resource, as well as to search for additional groundwater sources within the District's service area. Our firm has also recently performed a regional study of the Intercity Aquifer for the City of Everett that extended south to the Olympic View service area.

Database

The first step of the present study was to construct a water well database (appended) for the study area. The database includes those wells of record within the study area for which a quarter-quarter section location, or finer, was available. Well records with insufficient location information were not included in the database. A total of 23 well records were collected from the Washington State Department of Ecology. Of these, 14 were found to have sufficient information to be included in the database. In addition to the wells recorded at Department of Ecology, information available from test holes and observation wells placed around and within the District's watershed protection area were included in the data set, as was well information found in published studies and Robinson & Noble files for the area. The locations of wells in the database are plotted on Figure 2. Well locations were cross-checked between the information sources when possible.

Information in the database is considered to be generally accurate. However, errors may exist for individual wells because field verification for each well was not possible. Well logs were collected for an area of six square miles. Database coverage throughout the study area is rather limited (Figure 2). Well densities are low, probably because this area has been served by public water for a long time.

Conceptual Model

A hydrogeologic conceptual model is a pictorial representation of a groundwater flow system used to simplify and organize field data so that the system can more readily be analyzed (Anderson and Woessner, 1992). Ideally, a conceptual model should be as simple as possible, yet contain every important hydrologic component necessary to recreate system behavior. Essentially, the conceptual model synthesizes information from field mapping and verification, geologic logs, cross sections, potentiometric maps, hydrographs, and other geologic and hydrologic information into a generalized representation of the geology as it affects the groundwater flow system. Once constructed, the conceptual model serves as a guide for the scientific analysis of groundwater systems of an area.

Figure 3 presents the conceptual model for the study drawn as a schematic block diagram. The diagram contains three major components: boundaries, hydrostratigraphic units, and general flow system inflow and outflow information. These components are described below.

Boundary Identification

Identifying the model boundaries is typically the first step in constructing a conceptual model. Ideally, model boundaries should be natural hydrologic boundaries such as groundwater divides and large bodies of water. Two general types of hydrologic boundaries exist: physical boundaries, and hydraulic boundaries. Physical boundaries are formed by the presence of a physical impediment to groundwater flow or the absence of the aquifer. Hydraulic boundaries may be described as groundwater conditions that impede groundwater movement, such as a large body of water or a groundwater divide.

The bluff overlooking Puget Sound forms the western boundary to the Deer Creek Springs aquifer system. This bluff forms a physical boundary because, of course, the aquifer system is not present west of the bluff. A groundwater divide located in the eastern portion of the study area defines a hydraulic boundary to the east. The northern and southern boundaries to the aquifer system are not present within the study area. However, since the general groundwater flow direction is from east to west, the flow lines tend to preclude any significant transfer of water from the north or south into the domain of this particular flow problem. Therefore, groundwater is not believed to flow into or out of the study area from the north or south, and the lack of defined northern and southern aquifer boundaries is not critical to the model. In this case arbitrary boundaries parallel to the direction of flow are both mathematically and conceptually valid.

Hydrostratigraphic Units

Following boundary identification, the next step in conceptual model formation is the definition of hydrostratigraphic units. Hydrostratigraphic units are groupings of sediments that exhibit similar hydrogeologic properties. The units may or may not conform with stratigraphic units. Typically, hydrostratigraphic units divide sediments into aquifers and confining units.

In this area, the hydrostratigraphic units generally conform with established stratigraphic units. The surficial geology of the area is presented on Figure 4. Sediments have been divided into three hydrostratigraphic units within the study area: the Vashon till and the minor amounts of Vashon recessional outwash that overly it, the Vashon advance outwash, and the pre-Vashon transitional beds. These units are briefly described in Table 1.

Table 1: Descriptions of Hydrostratigraphic Units

Hydrostratigraphic Unit	Unit Description
Vashon Till	Includes Vashon till, overlying Vashon recessional outwash, and lower permeability ice-contact deposits. Locally covers the Vashon advance outwash deposits. Is regionally discontinuous in the study area.
Vashon Advance Aquifer System	Includes Vashon advance outwash and other high permeability deposits immediately below the Vashon till.
Pre-Vashon Transitional Beds	Includes low permeability lacustrine sediments below the advance aquifer system.

General Flow System

Defining the general flow system is the final element in the construction of a conceptual model. An analysis of precipitation and recharge data, head and hydrograph data, well production data, and other hydrologic information is used to define the flow system. Recharge enters the aquifer system directly from infiltration of precipitation and from infiltration of surface runoff from till-covered areas. Within the groundwater basin supplying the springs, water flows generally westward through the Vashon advance outwash sediments. The flow is rapid due to the relatively high permeability of these deposits and the low permeability of the silt and clay transitional beds on which the aquifer system rests.

At its westernmost point, the basin discharges through a notch in the surface of the transition beds at Deer Creek Springs. This notch creates the concentrated discharge point, as opposed to a spread-out discharge line that would be expected were there no notch. However, all discharge from the aquifer does not occur at the springs; elsewhere, a portion of ground water seeps from small springs formed where the advance outwash-transition bed contact is exposed. Water also discharges by evapotranspiration in areas where the advance outwash is exposed.

The conceptual model shows that the source of recharge for the groundwater system is direct recharge from precipitation. The precipitation quickly infiltrates into the permeable Vashon advance outwash deposits where these are exposed at land surface. Downward movement beyond the outwash sediments is impeded by the low-permeability pre-Vashon transitional deposits, which are predominantly silt and clay units. These underlying low permeability materials create saturation in the sand that, in essence, is the reason for the shallow groundwater system.

The groundwater system consists of water that mounds upon the low permeability transitional beds and then drains away from the mound. The center of the mound is represented by a groundwater divide situated approximately ½ mile west of Lake Ballinger. This divide is oriented roughly north-south and forms the eastern boundary for the Deer Creek Springs System. Recharge that enters the system west of that divide flows generally westward to discharge along the bluffs of Puget Sound as springs and seeps, with a particular focus at the Deer Creek Springs. Recharge that enters east of the divide flows southeastward towards Lake Washington, and therefore, has little bearing on the springs. There is, undoubtedly, some leakage of water out of the Vashon Advance aquifer system to deeper aquifers. The amount of this downward leakage has not been quantified in the scope of this investigation, but is considered small compared to the horizontal flow in the aquifer system towards the springs.

As discussed previously, the horizontal flow through the aquifer system discharges along the western bluffs, but the discharge is particularly focused at the Deer Creek ravine. This may be a reflection of the ravine's presence, but more likely is a reflection of minor undulations in the surface of the underlying basal silt and clay unit that causes both the spring flow and the Deer Creek valley itself, which has been cut by the spring's flow during the post-Vashon period.

Hydrostratigraphic Unit Descriptions

As described earlier, the materials beneath the study area have been divided into hydrostratigraphic units based upon their hydrologic characteristics. The thickness and distribution of the units are based largely upon a cross-sectional analysis of the study area. For this study, a cross section was constructed using geologic logs, maps and other information such as topography and geomorphology. Section A-A' (Figure 5) transects the spring's recharge area and includes the District's exploration wells. Each unit is described below.

Vashon Till

The Vashon till hydrostratigraphic unit includes both till and the small amount of overlying Vashon recessional outwash deposits. Geologic mapping of the area shows the highly permeable Vashon recessional outwash is limited in both thickness and lateral extent in the study area. The Vashon recessional outwash, where present, consists of coarse grained sand and gravel. As it is relatively thin and generally discontinuous, this unit is not significant as an aquifer in the study area. There are no wells of record in the study area completed in the Vashon recessional outwash. The outwash does locally enhance the infiltration of storm water; however, the low permeability of the underlying till limits the benefit of this characteristic to the point where it is only significant at an extremely local level.

The Vashon till consists of a compact mixture of silt, clay, sand and gravel. The low permeability sediments of the till, where present, locally provide a protective cover over the more permeable advance outwash, but because the till is discontinuous over the study area, it does not serve as a confining unit within the contribution zone for the Deer Creek springs. The fine-grained materials within the till impede downward movement of ground water and limit surface water infiltration. Although this unit has relatively low permeability, leakage through it does occur. Local and generally thin permeable zones with sufficient water for small domestic supplies are occasionally present within the till.

Vashon Advance Aquifer System

Vashon advance outwash deposits are located beneath the till. These deposits, which locally consist of clean, compacted, medium-grained sands with occasional gravel, form a moderately productive aquifer system. The Vashon advance deposits are the flow medium of the aquifer discharging at Deer Creek Springs, and are a major source of ground water for domestic supply wells. Within the study area, many of the well logs on file with Ecology are for wells completed in this aquifer. Locally, this unit has an average thickness of approximately 100 feet.

Pre-Vashon Transitional Beds

Below the Vashon advance outwash aquifer system is a moderate to thick sequence of fine-grained, low permeability sediments, typically consisting of silt and clay. The average thickness of this unit is estimated to be approximately 130 feet within the study area. This sequence of sediments comprises a fairly extensive confining unit both in and around the study area, and provides a major impediment to the vertical movement of water between the Vashon deposits and underlying deposits. Well logs indicate that, in some areas, more permeable interbeds do exist in the unit. These interbeds supply water to a few wells in the area.

WHPA Delineation

Before delineating the WHPAs, the one-, five-, and ten-year capture zones for the Deer Creek Springs had to be defined. Capture zones (more specifically called travel time-related capture zones) are the area around a point of withdrawal that contributes flow during a specified period of time. Capture zones are necessarily sub-areas of the zone of contribution, which is the entire area contributing ground water to a source. The zone of contribution is also described as a steady-state capture zone.

Typically, a steady-state capture zone can be estimated solely on the location of groundwater divides and knowledge of groundwater flow. Travel time is not a consideration in such estimation. The potentiometric map is the main tool used for delineation of these zones. They can often be determined simply by tracing flowlines upgradient to the boundary of the groundwater basin. In this case, the zone of contribution spreads approximately 1,000 to 1,500 feet to the north and south of the springs, and extends eastward to the groundwater divide described earlier.

Travel time-related capture zones are more difficult to define because of the time consideration. Instead of simply tracing a flow path upgradient, the velocity of water traveling the path must be determined so that the travel time can be calculated. The travel time represents the time necessary for a particle of water to move along the flow paths. Assuming that particles of contamination move at the same velocity as water particles, travel time particle paths predict the rate at which contamination, entering the aquifer at a given distance from a groundwater source, will reach that source. However, it must be remembered that particles of contamination may move slower, at the same rate, or more quickly than water particles, depending on a number of factors including contamination type. Consequently, actual capture zones for specific contaminants may be larger or smaller than the general zones delineated here.

The travel time is based on the flow velocity of the water, making it a function of the gradient, hydraulic conductivity, and porosity of an aquifer. Because these three factors vary throughout the aquifer system studied, and the exact nature of those variabilities cannot be known, the determination of travel times arrived at through numerical modeling cannot be considered absolute. The size and shape of capture zones are also dependent, to some degree, on the water level within the aquifer which dictates discharge rates at the springs. These water levels typically vary with time, adding another uncertainty factor into capture zone definitions.

Modeling Procedures

Several general methods exist for delineating capture zones. From generally least to generally most accurate, they are: the calculated fixed-radius method, analytical modeling, hydrogeologic mapping and analysis, analytic element modeling, and numerical modeling. Accuracy, however, is dependent on more than the delineation method; it is also dependent on data availability and the skill with which the appropriate methodology is selected and applied. For this project, the calculated fixed radius method was not considered.[1] For the Deer Creek Spring, analytical modeling was determined to be insufficient for describing the hydrologic conditions observed, since it requires a homogeneous aquifer and uniform recharge conditions throughout the modeling domain. A numerical model was chosen over an analytical model because a numerical model better allows the modeling of boundaries and springs and allows a more accurate representation of the variability in the hydrogeologic units and the effective recharge. The numerical groundwater flow model developed for this project is described below.

The Department of Defense Groundwater Modeling System (GMS) was utilized for the modeling. GMS is a comprehensive graphical user environment that serves as a pre- and post-processing interface for a number of analysis packages. For this project, GMS was used to interface with MODFLOW for model generation followed by MODPATH for particle tracking, once a calibrated model was achieved.

Initially, GMS was utilized to convert the conceptual model to a MODFLOW format. The conceptual model, described earlier, can generally be described as an unconfined sand aquifer overlying a much less permeable aquitard. Springs form where the water table intersects the land surface. At the springs, ground water becomes surface water and is efficiently escorted from the system. Using GMS, a model grid was configured to cover the entire zone of contribution for Deer Creek Springs. No-flow boundaries were established north, south, and east of the basin. Model calibration was achieved by adjusting the hydraulic conductivity values and recharge within appropriate limits until head values approximately matched observed levels near Deer Creek Springs and an appropriate discharge was simulated at the springs.

The modeling grid had small cell sizes near the springs (100 feet square) where more resolution was desired, and telescoped outward to larger cell sizes (maximum 1,000 feet square). Because the northern and southern aquifer system boundaries are outside the study area, no-flow cells representing these boundaries were placed at distance from the area of

[1] This method assumes equal amounts of water flow to a well from all directions. For most hydrogeologic settings in western Washington, this is a very poor assumption.

interest. Because these no-flow boundaries coincide with the flow lines of the aquifer and by definition, no flow occurs across flow lines, these boundaries are mathematically and conceptually valid for the simulation. The exact location of the groundwater divide that defines the eastern boundary of the system likely varies seasonally. However, since the model was run under steady-state conditions and there is no field data by which to define the variability of the position, a fixed divide location was chosen and simulated with no-flow cells.

The western boundary of the aquifer system occurs at the bluffs overlooking Puget Sound where the geologic maps indicate the contact between the sand and the underlying clay beds are exposed. Discharge from the model occurs along the bluff as seeps where the water table in the aquifer intersects the land surface, as was confirmed during the field mapping of the surficial geology. Therefore, the western model boundary is represented by drain cells, simulating seeps and springs both along the bluff and in the Deer Creek valley.

The area was modeled as a single layer of uniform aquifer material overlying an impermeable basal confining unit. The hydraulic conductivity of the basal confining unit was considered to be sufficiently low as to negate any vertical leakage. Hydraulic conductivity of the aquifer was determined through an evaluation of the available well logs of record in the area that appeared to be completed in the aquifer of interest. Estimated values ranged from 4 to 333 feet per day, and a value of 150 feet per day was determined appropriate for the material. This value is well within the range presented by the U.S.G.S. (Thomas, et al. 1997) for Vashon advance outwash sediments found in Snohomish County. A single value of conductivity was used for the modeled aquifer because observations of the material in the field indicated a relatively uniform composition and texture. The aquifer bottom was set to an elevation of 195 feet, based on observations of the test drilling in the immediate area of the spring.

On average, the discharge at the springs is estimated to be approximately 690 gpm with an historical range of between 300 and 1,000 gpm. As the discharge of the springs is dependent only on the amount of water available in the aquifer, these variabilities in discharge reflect the fact that heads in the Vashon advance outwash aquifer vary through time. These variations in head are principally the result of variations in recharge to the aquifer through time. In addition to the temporal variation, the amount of recharge reaching the aquifer is highly variable within the study area. Four different recharge zones were used in the model. The spatial recharge distribution was taken directly from the recharge maps presented by Thomas, et al. (1997). The recharge amounts applied in the model range from 10 to 22 inches per year, and are within the ranges suggested by Thomas, et al. (1997).

The geology and topography of the area control the amount and distribution of recharge. Recharge is lowest on the steeply sloped areas where the surficial geology has a low permeability, such as till, and highest on the flat-lying, high permeability materials, such as the advance outwash sand deposits.

Calibration of the numerical model was checked by comparing water levels at points measured in the field with the simulated water levels at the same locations in the model. Additionally, the discharge of the modeled Deer Creek Springs was compared to the actual measured discharge at the weir at the downstream end of the spring works. The model was considered calibrated when the water level and discharge values simulated by the model were in general agreement with the observed conditions.

Travel Time-Related Capture Zones

The capture zones for the Deer Creek Springs were determined using MODPATH (through the GMS interface) in the calibrated numerical model of the aquifer. The porosity of the aquifer material was set at 25%, which is a median to low value for a sand aquifer such as the Vashon advance aquifer. Particles were mathematically introduced into the model around the upper portion of the spring, then tracked upgradient for one, five, and ten year periods. The area encompassing the paths of a large suite of such particle tracks represents the capture zone for that period of capture. These capture zones were then modified to accommodate the uncertainties of the modeled conditions and used as the basis for the delineation of the wellhead protection areas surrounding the spring.

Summary

The Washington State Department of Health requires the definition of wellhead protection zones based on travel time rates of ground water (DOH, 1995). They define five zones for which wellhead protection strategies should be considered:

- The *sanitary control area*: typically the 100-foot radius of control around a wellhead or a spring(as defined in WAC 246-290-135)
- *Zone 1*: the one-year, horizontal time of travel boundary
- *Zone 2*: the five-year, horizontal time of travel boundary
- *Zone 3*: the ten-year, horizontal time of travel boundary
- The *Buffer Zone*, which extends up gradient of Zone 3 and may include the entire zone of contribution

The first four of these zones are required components of WHP plans and define areas requiring differing levels of response to a contamination event based on the expected time of travel to the given groundwater source. The Buffer Zone is optional, but is considered useful in planning for comprehensive protection of the source or response to contamination events. As such, the buffer zone can be an important planning tool for providing information on monitoring the presence of potential contaminant sources outside Zone 3, which ultimately may have the potential for contaminating the WHPA (DOH, 1995).

Recommendations

In the case of the Deer Creek Springs, recommended wellhead protection area Zones 1, 2, and 3 (Figure 6) correspond to the one-, five-, and ten-year capture zones as delineated by the numerical modeling effort, modified slightly to account for the unknown variability within the system. As this groundwater system is shallow and, therefore, more susceptible to infiltration of surface contamination, an additional Buffer Zone is recommended. The recommended Buffer Zone includes the entire zone of contribution for the springs.

Within the recommended wellhead protection areas, there is cause for additional concern the areas where Vashon advance outwash deposits are mapped as the surficial geology. The aquifer serving the springs has no natural geologic protection in these locations, and is extremely vulnerable to impact from surface activities. The till-covered areas are less vulnerable due to the protective nature of the relatively low permeability till overlying the aquifer. However, the discontinuous nature of the till makes this protection less reliable where large volumes of contamination are introduced. A composite map of the surface geology and the wellhead protection area zones is presented as Figure 7. The higher vulnerability region (where the aquifer is not covered by till) is the area within the wellhead protection area zones that is mapped as Vashon advance outwash.

References

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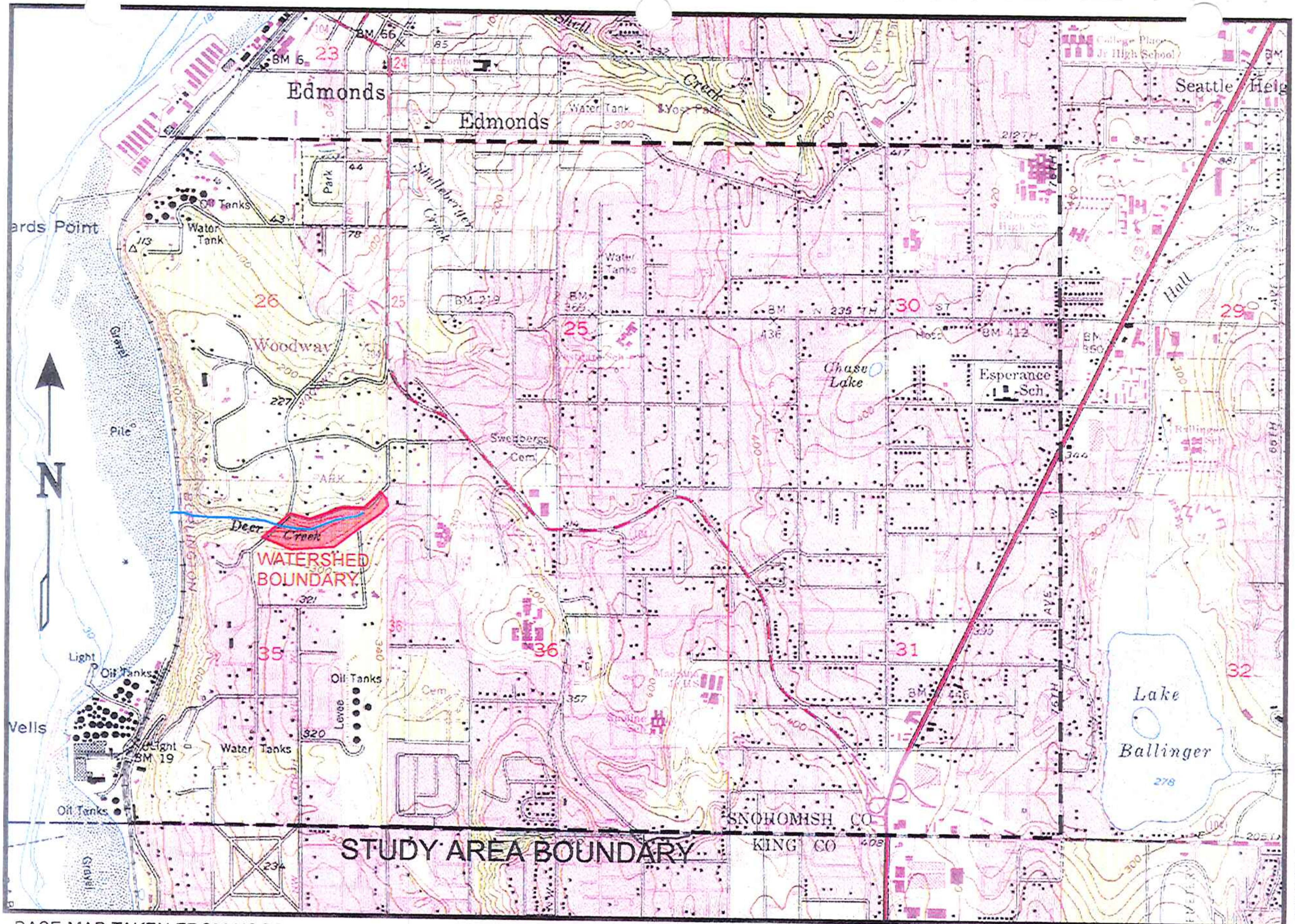
Washington State Department of Health, 1995, *Washington State wellhead protection program*: Washington State Department of Health, Environmental Health Programs, 78 p.

Thomas, B.E., J.M Wilkenson, and S.S. Embrey, 1997, *The Ground-Water System and Ground-Water Quality in Western Snohomish County, Washington*, U.S.G.S. Water-Resources Investigations Report 96-4312, 218 p.

Minard, J.M. 1983, Geologic map of Edmonds East and part of Edmonds West quadrangles, Snohomish County, Washington, USGS Miscellaneous Field Studies MF 1541, Scale 1:24,000, 1 sheet.

Newcomb, R.C., 1952, *Ground Water Resources of Snohomish County, Washington*, U.S. Geological Survey Water Supply Paper 1135, 133 p.

FIGURES



BASE MAP TAKEN FROM USGS EDMONDS/EDMONDS EAST QUADS

SCALE = 1: 24,000
T 27 N/R 3 E • SNOHOMISH COUNTY

FIGURE 1

ROBINSON & NOBLE, INC.

STUDY AREA LOCATION MAP

Olympic View Wellhead Protection Plan

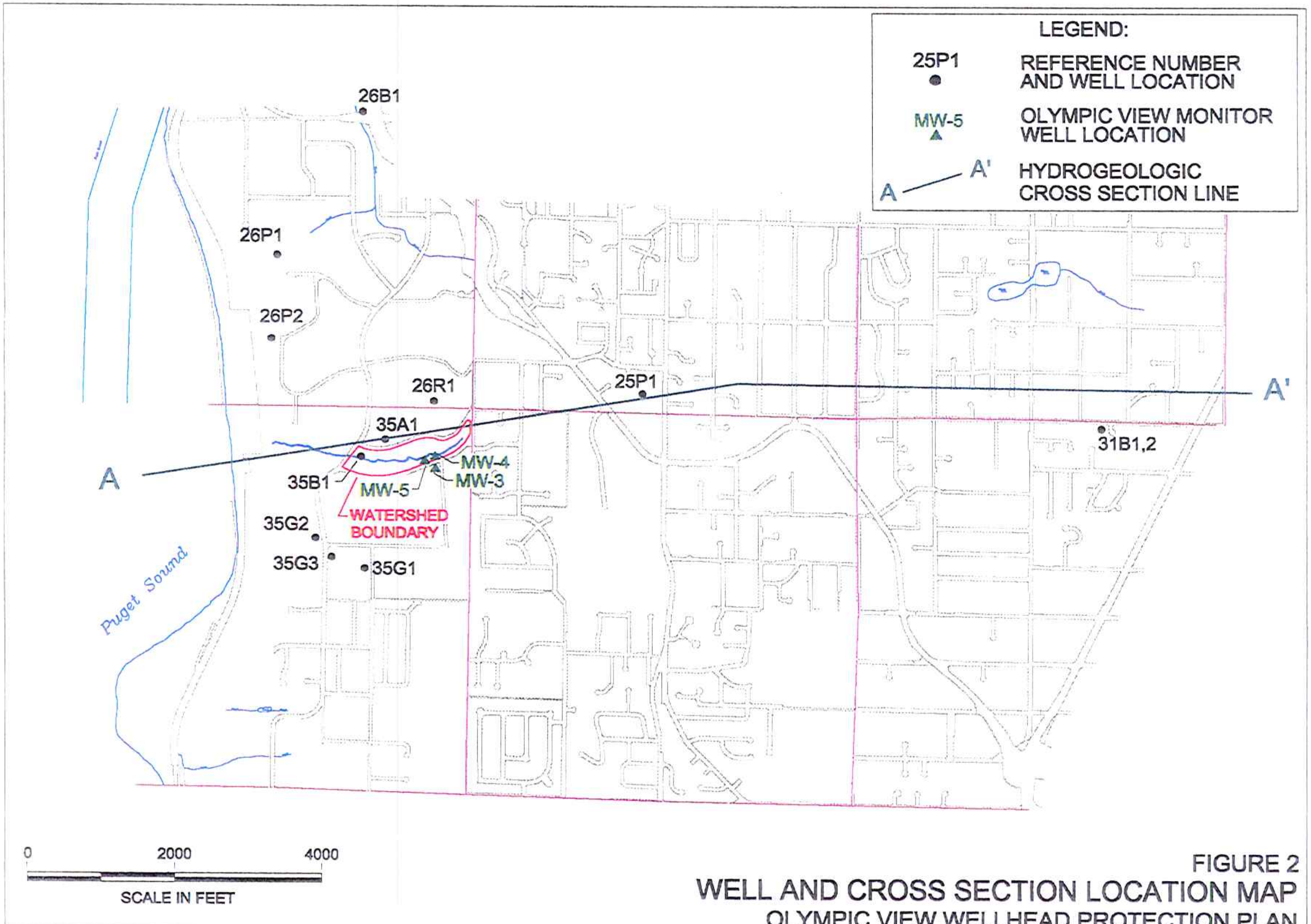
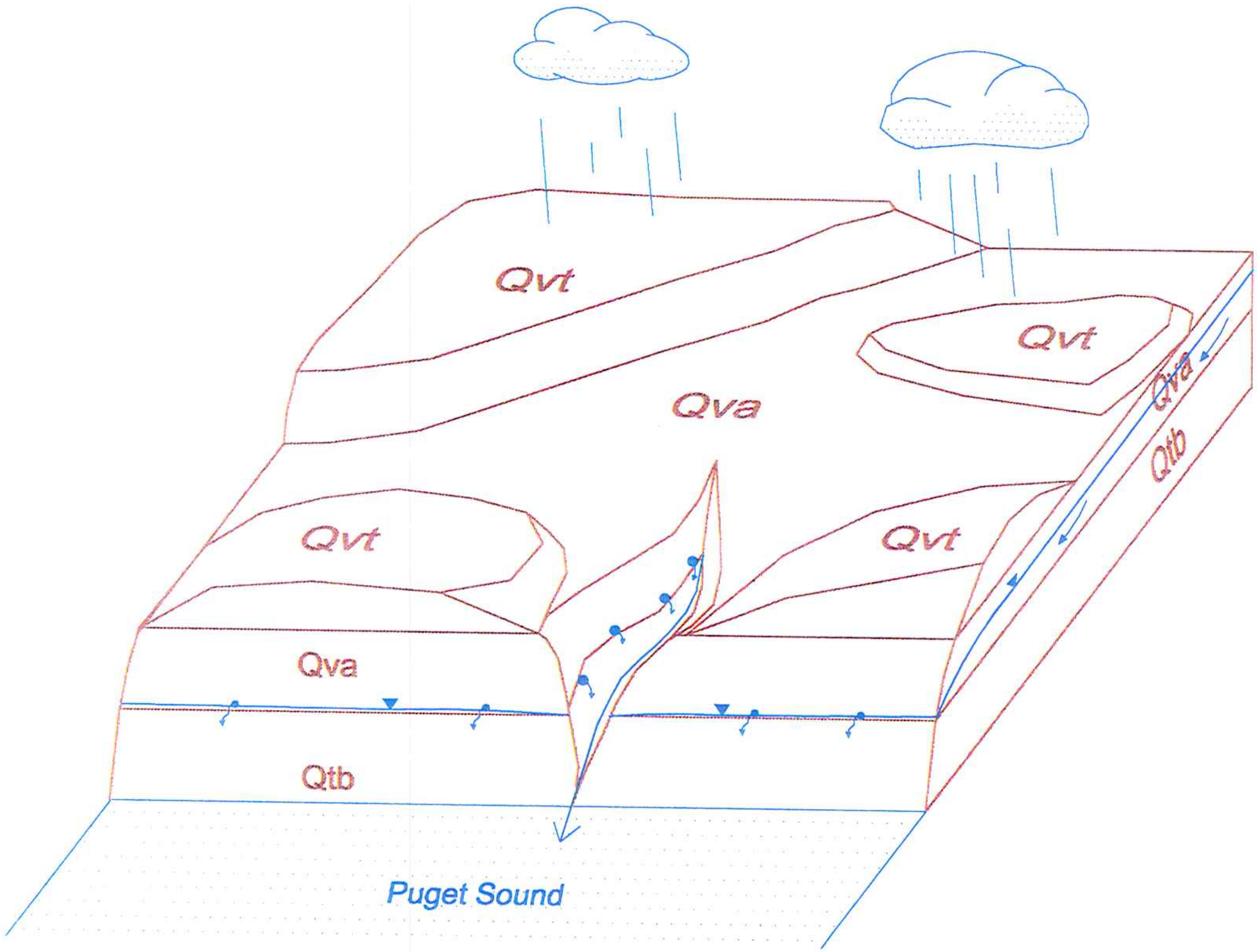


FIGURE 2
WELL AND CROSS SECTION LOCATION MAP
OLYMPIC VIEW WELLHEAD PROTECTION PLAN
ROBINSON & NOBLE, INC.

OCTOBER 1999, JOB NO. 81-32WH



NOT TO SCALE

FIGURE 3
SCHEMATIC OF DEER CREEK SPRING SYSTEM
OLYMPIC VIEW WELLHEAD PROTECTION PLAN
ROBINSON & NOBLE, INC.

OCTOBER 1999, JOB NO. 81-32WH

LEGEND:

HYDROGEOLOGIC UNITS

ml	Modified Land
Qyal	Younger Alluvium
Qls	Landslide Deposits
Qvr	Vashon Recessional Outwash
Qvt	Vashon Till
Qva	Vashon Advance Outwash
Qtb	Pre-Vashon Transitional Beds
Qw	Whidbey Formation

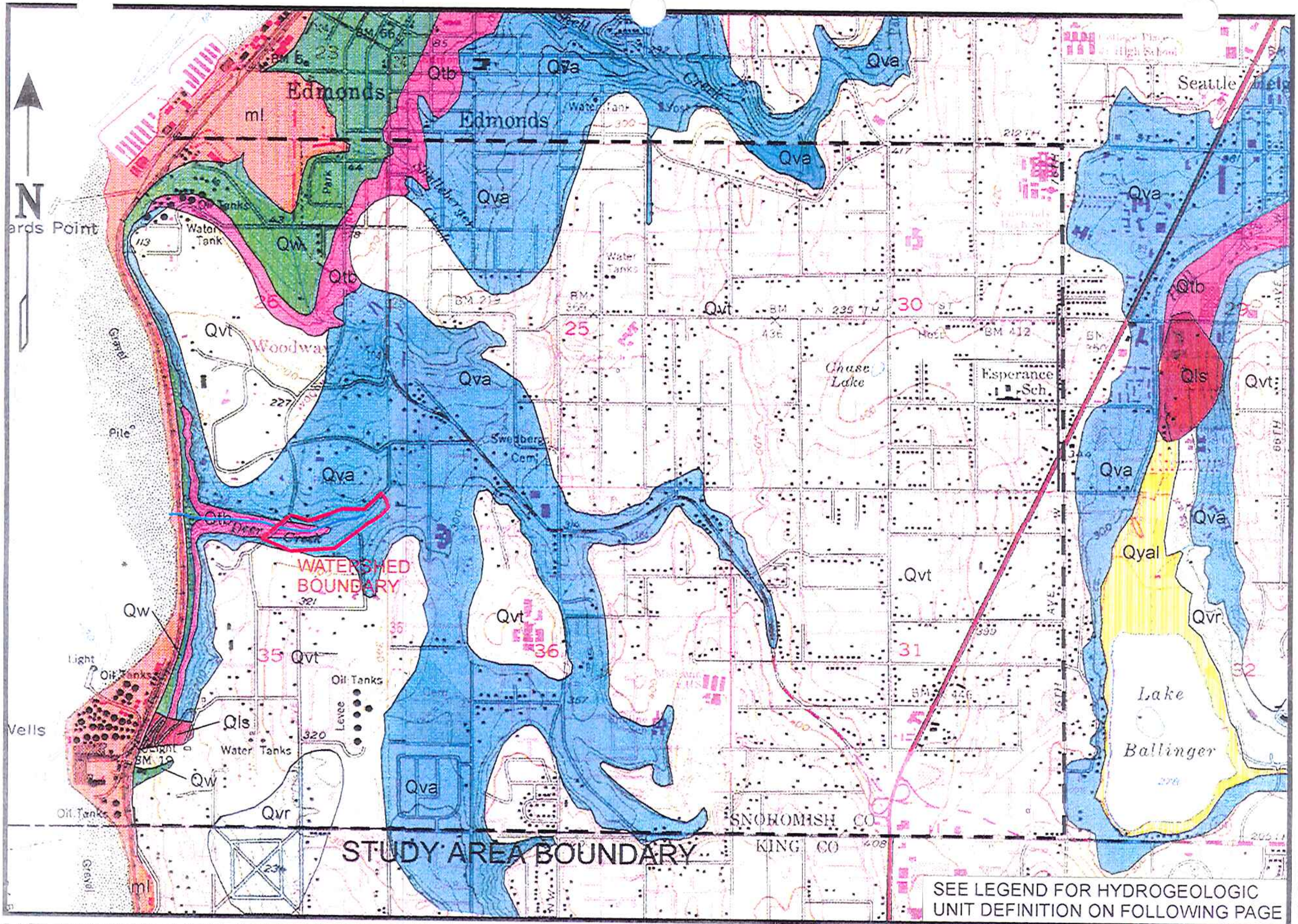


FIGURE 4

BASE MAP TAKEN FROM USGS EDMONDS/EDMONDS EAST QUADS

SCALE = 1: 24,000
T 27 N/R 3 E • SNOHOMISH COUNTY
INFO TAKEN & MODIFIED FROM MINARD, 1983, USGS MF-1541

ROBINSON & NOBLE, INC.

HYDROGEOLOGIC UNIT SURFACE MAP

Olympic View Wellhead Protection Plan

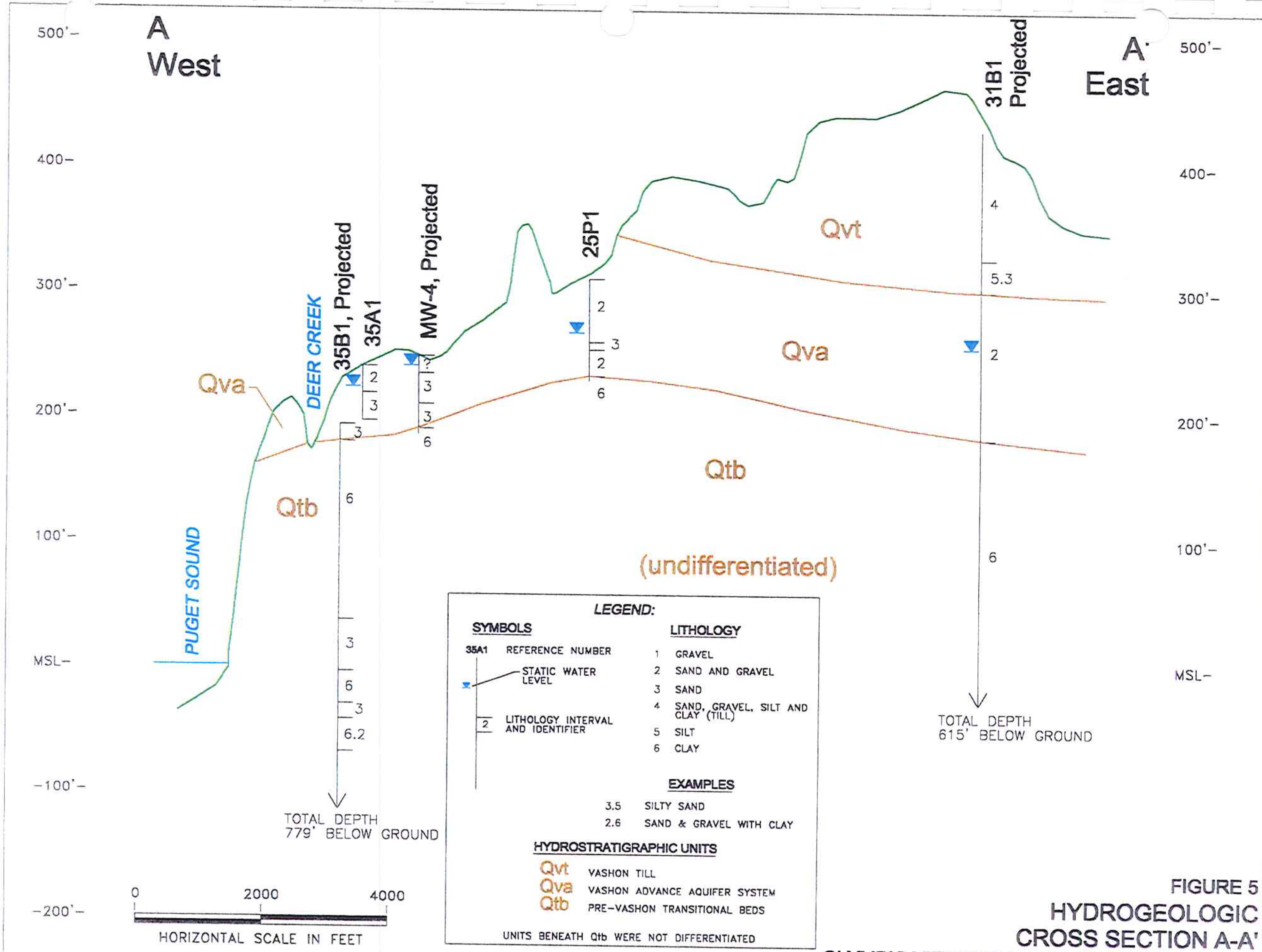


FIGURE 5
HYDROGEOLOGIC CROSS SECTION A-A'
OLYMPIC VIEW WELLHEAD PROTECTION PLAN
ROBINSON & NOBLE, INC.

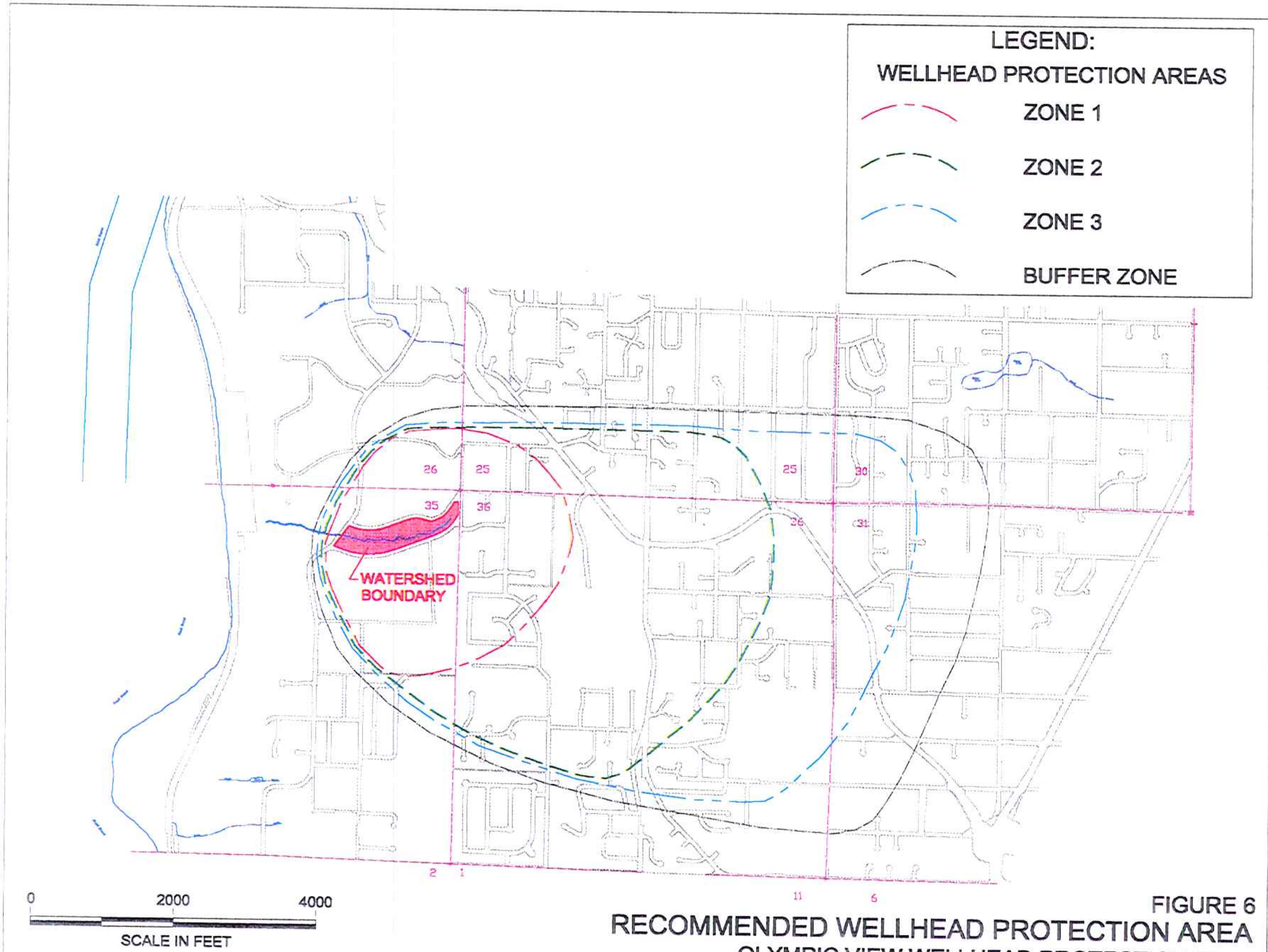
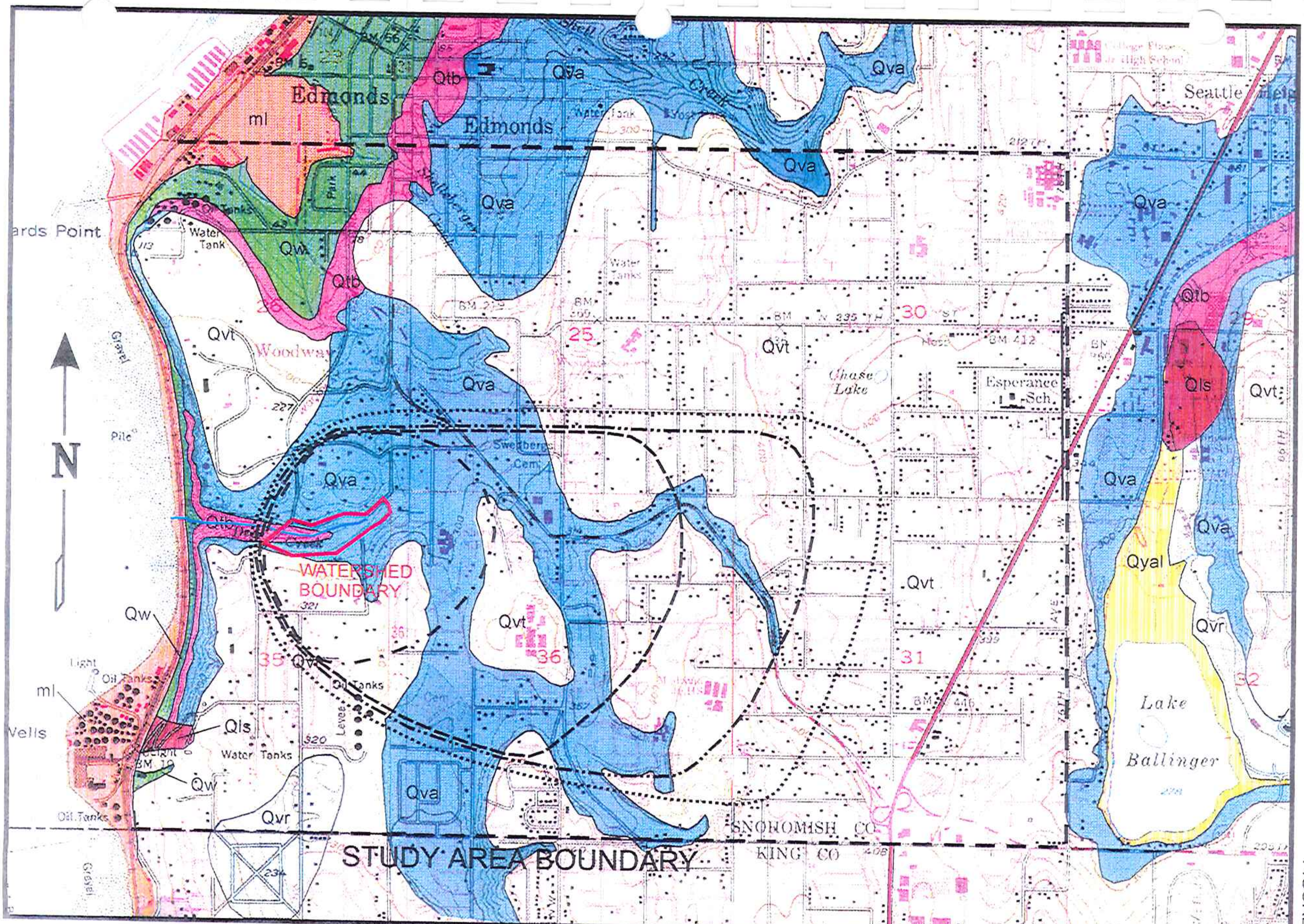


FIGURE 6
RECOMMENDED WELLHEAD PROTECTION AREA
OLYMPIC VIEW WELLHEAD PROTECTION PLAN
ROBINSON & NOBLE, INC.

OCTOBER 1999, JOB NO. 81-32WH



BASE MAP TAKEN FROM USGS EDMONDS/EDMONDS EAST QUADS

SCALE = 1: 24,000
T 27 N/R 3 E • SNOHOMISH COUNTY
INFO TAKEN & MODIFIED FROM MINARD, 1983, USGS MF-1541

FIGURE 7

ROBINSON & NOBLE, INC.

COMPOSITE WHPA/GEOLOGIC MAP

Olympic View Wellhead Protection Plan

APPENDIX

Reference #	Local #	Owner Name	Well Elevation	Water Level Elevation	Depth to water (ft).	Depth drilled (ft.)	Top completion	Bottom Completion	Q	dd	Q/dd	Hydraulic conductivity (K)	Calculated T
01F1	26N/3E-1	Arthur Kruokeberg	430	360	70	90	85	90	10	2	5.0	204	7,617
25P1	27N/3E-25	City of Edmonds	305	260.9	44.1	79	68.7	78.7	130	22.2	5.9	123	9,205
26B1	27N/3E-26	Lae Bugten Salmon Hatchery	20	10	10	60	50	55					
26P1	27N/3E-26	H. & M.A. James	210	-16	226	279	261	278	15	1	15.0	186	23,600
26P2	27N/3E-26	Dan Lyon	225	33	192	269	253	268	15	1	15.0	211	23,600
26R1	27N/3E-26	Randy Clark	285	260	25	55	45	55	15	1	15.0	333	24,879
31B1	27N/4E-31	Olympic View Water District	450	-6.1	456	615	540	604	570	53	10.8	52	16,932
31B2	27N/4E-31	Olympic View Water District	450	1	449	963	540	590	155	33	4.7	21	7,920
35A1	27N/3E-35	George Stead	240	220	20	42	32	42	25	10	2.5	48	3,594
35B1	27N/3E-35	Olympic View Water District	188	15	173	986			260	17	15.3		
35G1	27N/3E-35	Jack Bode	320	236	84	141	127	137	45	108	0.4	6	469
35G2	27N/3E-35	George Barber	260	202	58	90	65	90	11	18	0.6	4	717
35G3	27N/3E-35	George Galpin	280	259	21	92	70	85	33	20	1.7	19	2,143
35P1	27N/3E-35	Bill Sprague	275	198	77	135	117	129	42	3	14.0	258	23,102

Appendix B

OLYMPIC VIEW WATER AND SEWER DISTRICT
WATER SUPPLY PROTECTION GUIDELINES

It is the intent of this document to provide guidelines for use by the Olympic View Water and Sewer District staff, the agencies having jurisdiction over land use within the District, and the general public as appropriate, for the long term protection of the District's Deer Creek Watershed and public water supply facilities. The following key elements have been identified as critical features of a successful Water Supply Protection Plan.

Regulatory Control

Although Olympic View does not maintain any authority over land use regulations and requirements, it may be able to assist agencies with authority through participation in development of land use regulations. The following regulatory measures by land use agencies should be consideration as a means of minimizing the potential for contamination of, and participation in the long term protection of, the community water supply:

1. Identify the watershed area, as well as the identified 1, 5 and 10-year capture zones in all appropriate sensitive area regulations and mapping.
2. Restrict new on-site sewage disposal systems within the one-year capture zone.
3. Restrict potential high impact pollutants from the 1 and 5-year capture zones.
4. Require that oil based and detergent based waste materials are treated by the sanitary sewer system.
5. Require adequate storm drainage facilities within the 1 year capture zone to provide adequate protection of the watershed area from runoff.

Protection Activities

Long term cooperation with the various land use and emergency response agencies has been identified as another key element in the protection of the water supply. This will likely include the following activities:

1. Consideration of the potential impacts on the watershed should be made in reviewing development proposals. The District may be able to assist in this determination if necessary to evaluate unique or questionable proposals.

2. Notification of any potential threat to the water supply system is also a critical element of the long term success of this program. Cooperation between all emergency response participants is required to insure that proper notifications of spills, septic tank failures, or other threats to the water supply are made.

3. Remedial activities associated with the watershed should be coordinated with the District.

Program Promotion:

Protection of the water supply is a community responsibility that should be shared by both public agencies and private citizens and businesses. Program promotion through public education is critical to the overall effectiveness of protecting the water supply. The following general activities should be considered as a means of promoting protection of the watershed and water supply.

1. Septic Tank Maintenance program promotion. The District is to be notified in the event of septic tank failure.

2. Use of chemical fertilizers by parks departments, businesses and residences in the capture zones is discouraged.

3. Protection of surface water bodies and groundwater wells through public awareness, etc. will assist in the water supply protection efforts of the District.

4. Oil based and detergent based waste materials are to be treated by the sanitary sewer system.

Appendix C

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OLYMPIC VIEW WATER & SEWER DISTRICT

23725 Edmonds Way
Edmonds WA 98026-8981

Phone (425) 774-7769
Fax (425) 670-1856

November 30, 2001

Dear Business Owner:

Olympic View Water and Sewer District has recently completed a Watershed Protection Plan in accordance with the requirements of the State of Washington Department of Health. The Plan has been prepared as a means of protecting the community drinking water supply from contamination and insure that the high quality of water from the District's Deer Creek water source is maintained. Although this is not the District's only source of water, it does supply many customers of the District and helps offset higher cost wholesale sources of supply.

The Deer Creek source is located west of 108th Avenue West, between North and South Deer Drives. It is a surface water supply, which is fed by springs from the ravine in the watershed area.

A primary goal of the District's watershed protection planning is to raise public awareness regarding the potential human activities which increase the vulnerability of the source of supply. Although the source is considered well protected and secure, there are certain activities which could result in contamination of the source.

To assist in protection of the watershed, the District's consultants have identified a specific area where special precautions are warranted and completed an inventory of potentially hazardous activities based on business types and land use designations. The purpose of this letter is to inform you that the nature of your business indicates that activities which you may be engaged in or materials which you may have stored on site could present a threat to the watershed if proper care and disposal techniques are not employed. Any hazardous material, which is spilled onto the ground in this area could eventually reach the watershed area. Some specific sources of contamination which your should be aware of are:

- Accidental spilling of fuel or oil or other chemical products.
- Improper use of septic systems (i.e. paints, cleaners, and/or solvents in the septic system).
- Lack of septic tank maintenance (i.e. periodic pumping).
- Draining of motor oil, gasoline, antifreeze or other similar materials on the ground or into the stormwater system.
- Leaking fuel or chemical storage tanks and/or distribution lines.

Please be aware that Olympic View Water and Sewer District maintains a rigorous water quality testing program to insure the high quality of all drinking water delivered to you. We do, however, appreciate your assistance in the long term protection of our source of supply. Please contact the District at (425) 774-7769 if you have questions regarding the Watershed Protection Plan.

Sincerely,

Roger Eberhart, P.E.
District Manager

\1951

OLYMPIC VIEW WATER & SEWER DISTRICT

23725 Edmonds Way
Edmonds WA 98026-8981

Phone (425) 774-7769
Fax (425) 670-1856

November 30, 2001

Dear Property Owner:

Olympic View Water and Sewer District has recently completed a Watershed Protection Plan in accordance with the requirements of the State of Washington Department of Health. The Plan has been prepared as a means of protecting your drinking water supply from contamination and insure that the high quality of water from the District's Deer Creek water source is maintained. Although this is not the District's only source of water, it does supply many customers of the District and helps offset higher cost wholesale sources of supply.

The Deer Creek source is located west of 108th Avenue West, between North and South Deer Drives. It is a surface water supply, which is fed by springs from the ravine in the watershed area.

A primary goal of the District's watershed protection planning is to raise public awareness regarding the potential human activities which increase the vulnerability of the source of supply. Although the source is considered well protected and secure, there are certain activities which could result in contamination of the source.

To assist in protection of the watershed, the District's consultants have identified a specific area where special precautions are warranted. The purpose of this letter is to inform you of the proximity of your property, home or business to the watershed protection area. Although any hazardous material which is spilled onto the ground in this area could eventually reach the watershed area, some specific sources of contamination that you should be aware of are:

- Accidental spilling of fuel or oil.
- Improper use of septic systems (i.e. paints, cleaners, and/or solvents in the septic system).
- Lack of septic tank maintenance (i.e. periodic pumping).
- Draining of motor oil, gasoline, antifreeze or other similar materials on the ground or into the stormwater system.
- Leaking fuel or chemical storage tanks and/or distribution lines.

Please be aware that Olympic View Water and Sewer District maintains a rigorous water quality testing program to insure the high quality of all drinking water delivered to you. We do, however, appreciate your assistance in the long term protection of our source of supply. Please contact the District at (425) 774-7769 if you have questions regarding the Watershed Protection Plan.

Sincerely,

Roger Eberhart, P.E.
District Manager