WELLHEAD PROTECTION PLAN

City of Yelm, Washington

REPORT

Submitted To: Stephanie Ray
City of Yelm
105 Yelm Ave. West
Yelm, WA 98597

Submitted By: Golder Associates Inc.
9 Monroe Parkway, Suite 270
Lake Oswego, OR 97035 USA

Distribution: City of Yelm, WA – 5
Golder Associates Inc., Lake Oswego, OR – 2

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EXECUTIVE SUMMARY

This report updates the 2010 Wellhead Protection Plan (WHPP) for the City of Yelm (City). The report documents the delineation of the wellhead protection areas (WHPAs) for the City. The City currently obtains its drinking water supply from two existing wells (Wells 1A and 2), and is planning to expand their source capacity and seek approval to include a new additional groundwater supply source (SW Well 1A). The two existing wells are screened in the glacial advance outwash aquifer (Qva), while the new well is screened in a deeper unconsolidated aquifer (TQu). Both aquifers are confined by overlying low-permeability sediments.

A WHPP for the existing wells was last updated in 2010 as part of the City's Water System Plan Update (Brown and Caldwell 2010). Since that time, the City has planned upgrades to their water system, which have necessitated the following updates to their existing WHPP:

- Expanded knowledge of the hydrogeologic characteristics of the area now that a deeper supply source aquifer (TQu) has been identified.
- Revised WHPA delineations for existing Wells 1A and 2 using a numerical groundwater flow model and planned pumping capacity expansions.
- New WHPA delineation for the planned SW Well 1A supply source using the numerical groundwater flow model.
- A new contaminant source inventory generated within the updated and newly defined WHPAs.
- Susceptibility assessment for the planned SW Well 1A source supply.

Contaminant sources having the potential to adversely impact groundwater quality were identified within the WHPAs through an environmental database search of potential contaminant source sites and an evaluation of typical land use practices. A total of 120 known or suspected soil and groundwater contamination sites were identified within a 2.5 mile search radius encompassing the WHPAs. Of the 120 potential contaminant source sites identified, 23 sites coincide with the 6-month and 1-year capture zones for Wells 1A and 2. No known or potential contaminant sites were identified in the 5- or 10-year capture zones for Wells 1A and 2, and none were identified within any of the WHPA capture zones delineated for SW Well 1A.

To prevent and protect against contamination of the City's drinking water supply sources, the City currently employs the following management strategies:

- Controlling future development in WHPA capture zones through land use regulations.
- Enforcement and regulation of activities within the WHPAs through the City's Municipal Codes.
- Notification to owners and operators of potential sources of contamination that are located within the City's WHPA boundaries as well as the local agencies or jurisdictions that regulate them.

- Spill prevention measures to prevent the accidental release of pollutants, and spill treatment and response actions to be taken to minimize potential damages in case a spill does occur.
- Contingency measures to implement in the event that a natural disaster or contamination event results in the temporary or permanent loss of the City's water supply source.

The following pollution prevention and risk reduction measures are recommended to compliment the City's current commitment to protect its groundwater sources and maintain a safe and reliable community water supply:

- Adopt new WHPAs – To continue to protect the valuable groundwater resource, the City should adopt the newly-defined WHPAs to enforce land use restrictions on certain high-risk activities and work with Thurston County to integrate WHPAs into their Critical Areas Ordinance (CAO).
- Public Outreach/Education – Increase public awareness and ownership of the wellhead protection (WHP) program through outreach efforts focused on groundwater protection.
- Water Quality Monitoring – Install groundwater monitoring wells designed to improve the coverage for groundwater quality from known or suspected contaminant sites, and evaluate groundwater quality test results.
- Spill Response Plan Update – The Spill Response Plan should be reevaluated and updated as needed to address any site-specific conditions pertaining to SW Well 1A after the wellhouse facility is constructed.

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1.0 INTRODUCTION

The potable water supply for the City of Yelm (City) is from groundwater sources. The City currently relies on two approved groundwater supply wells (Wells 1A and 2), and is currently expanding their source capacity and seeking approval to include an additional supply well (SW Well 1A). The City is committed to protecting its groundwater sources through a proactive wellhead protection (WHP) program to help prevent groundwater contamination and maintain a safe and reliable community water supply.

Robinson and Noble (2001) prepared a Wellhead Protection Plan (WHPP) for existing Wells 1A and 2 in 2001. The City last updated its WHPP in 2010 as part of the City's Water System Plan update (Brown and Caldwell 2010). Since 2010, a few upgrades by the City have necessitated a subsequent WHPP update (this report), including: (1) an increase in pumping capacity at Wells 1A and 2, (2) a planned new supply source (SW Well 1A), and (3) the ability to improve the previously mapped wellhead protection areas (WHPAs) using a numerical groundwater flow model (a more complex delineation method than used for past updates). This report updates the City's existing WHPP in the following ways:

- An updated discussion of the hydrogeologic characteristics of the area now that a deeper supply source aquifer (TQu) has been identified.
- Updated WHPA delineations for Wells 1A and 2 using a numerical groundwater flow model and the planned pumping capacities.
- New WHPA delineations for the planned SW Well 1A supply source using the numerical groundwater flow model and planned pumping capacity.
- Susceptibility assessment for the planned SW Well 1A source supply.
- A contaminant source inventory within the updated and newly defined WHPAs.

1.1 Regulatory Background and Purpose

The 1986 amendments to the Safe Drinking Water Act (SDWA) authorized two provisions for groundwater protection, one of which was the WHP program. The WHP program was developed to protect and prevent potential groundwater contamination of public drinking water supplies.

The SDWA allows each state to design its own WHP program in order to maximize effectiveness at the local level. The State of Washington requires that all Group A water systems develop WHPPs as stated in Washington Administrative Code (WAC 246-290). The Washington State Department of Health (WDOH) has established requirements, guidelines, and materials to assist water systems in developing WHPPs. For a groundwater supplied system, the following elements are required:

- Discussion of the hydrogeologic characteristics of the area
- Susceptibility assessment of the source supplies
- Delineation of the WHPAs
- Contaminant source inventory within the defined WHPAs

- Contingency plan
- Notification to owners/operators of potential contamination sources
- Notification to regulatory agencies and local governments of WHPA boundaries and contaminant source inventory findings
- Notification to local emergency responders of WHPA boundaries, results of the susceptibility assessment and contaminant source inventory, and contingency plan

1.2 City Production Wells

Wells 1A and 2 are the City's sole drinking water supply sources. The wells are located on Second Avenue SE between Washington and McKenzie Streets in SW¼, SW¼, Section 19, T17N, R2E W.M. in Thurston County (Figure 1). Well 1A was drilled in 2005 as a replacement for Well 1, which was installed in the 1950s and currently functions as a monitoring well. Well 2 was constructed in 1958 and was equipped with new pumping equipment in 2002. Well 1A is located approximately 65 feet southwest of Well 2. Table 1 summarizes the construction details for Wells 1A and 2. Water well reports and borehole logs for the existing water supply wells are provided in Appendix A. Both Wells 1A and 2 were recently inspected, cleaned, and upgraded with new pumping equipment to increase their capacities.

At the time the 2001 WHPP (Robinson and Noble 2001) was prepared, Wells 1A and 2 were in operation and two additional wells were identified as potential future sources (Wells 3 and 3A). Since 2001, Wells 3 and 3A have been physically disconnected from the City's distribution system. Well 3A is maintained for emergency use and Well 3 is maintained as a monitoring well. Both wells have an intact surface seal and are located within a well house.

In 2010, the City commenced a deep groundwater resource exploration project in the Tahoma Terra area west of downtown. The project was designed to explore the potential of developing a new groundwater source from a portion of the aquifer system that would lessen the effects of pumping on local surface water features and existing groundwater users. Based on the findings from this exploration project, the City has constructed a new groundwater supply well (SW Well 1A). The well is located in Thurston County in SE¼, SE¼, Section 23, T17N, R1E W.M. (Figure 1). Construction details of SW Well 1A are provided in Table 1. A water well report and borehole log is provided in Appendix A. The City has applied for a water right for this well and further development will occur once water rights are obtained.

1.3 Plan Overview

This WHPP update includes the following elements:

- Section 2.0: Hydrogeologic Conditions – Presents the current understanding and characterization of hydrogeologic conditions in the Yelm area.
- Section 3.0: Wellhead Protection Area Delineation – Identifies the 6-month and 1-, 5-, and 10-year WHPAs for the City's existing (Wells 1A and 2) wells and planned future well (SW Well 1A).

- Section 4.0: Susceptibility and Contaminant Source Inventory – Presents an inventory of known and potential contaminant sources, identifies and discusses land use activities in the Yelm area and within the WHPAs, and assesses the potential risk these land use activities and associated contaminants may have to the supply sources.
- Section 5.0: Management Strategy – Presents an overview of the City's efforts to manage groundwater protection and coordinate activities among state agencies, local governments, emergency responders, and owner/operators of potential contaminant sources, and others. This section also provides general considerations for new monitoring wells.
- Section 6.0: Summary – Summarizes key aspects of the WHPP.
- Section 7.0: Recommendations – Provides a list of recommendations for further consideration based on findings from this WHPP update.

2.0 HYDROGEOLOGIC CONDITIONS

This section provides background information on the physical setting and hydrogeology of the Yelm area based on previous investigations and findings from the 2010 deep groundwater exploration project. The primary sources of data for the characterization of the local hydrogeologic system include:

- Conceptual Model and Numerical Simulation of the Groundwater Flow System in the Unconsolidated Sediments of Thurston County (Drost et. al 1999)
- City of Yelm Wellhead Protection Plan (Robinson and Noble 2001)
- Thompson Creek Conceptual Hydrogeologic Model (Golder 2009)
- City of Yelm 2010 Water System Plan update (Brown and Caldwell 2010)
- The City of Yelm Southwest Well 1A Development Report (Golder 2010)

2.1 General Physical Setting

The City of Yelm is located along the western margin of Yelm Prairie approximately 15 miles southeast of the City of Olympia in northeastern Thurston County, Washington.

2.2 Climate and Precipitation

The Yelm area has a climate characterized by dry, warm summers and wet, cool winters (WRCC 2010). The average annual rainfall totals 50.8 inches, nearly 85 percent of which falls during the months of October through April. Total rainfall is generally greatest during the month of November (8.1 inches) and lowest during July (0.8 inches). Air temperatures average 38.9 degrees Fahrenheit (°F) during the three coldest months of the year (December through February) and 61.5 °F during the three warmest months (July through September).

2.3 Surface Hydrology

Yelm is located within the Nisqually River drainage and is bordered to the east by Yelm Creek and to the west by Thompson Creek (Figure 1). Both creeks drain northward and discharge to the Nisqually River north of Yelm. Thompson Creek flows along the western margin of Yelm Prairie along the base of the Thurston Highlands west of Yelm. Thompson Creek originates from a wetland complex southwest of Yelm near the base of the highlands. Yelm Creek originates approximately 4.6 miles southwest of Yelm and receives flow from Goodwin Lake and other kettle depression lakes and minor tributary streams before discharging to the Nisqually River.

2.4 Hydrogeologic Setting

The Yelm area is situated in the south-central portion of the Puget Sound Lowland. The Puget Sound Lowland is a north-south-oriented basin that has experienced repeated deposition, erosion and reworking of geologic sediments during glacial and interglacial periods. The repeated glacial advances and retreats covered the area with layered, unconsolidated glacial and non-glacial deposits. The most recent glacial

advance into the Yelm area took place approximately 13,500 to 15,000 years ago and is known as the Vashon Stade of the Fraser Glaciation.

The groundwater system in the study area has been described as being composed of seven major hydrogeologic units (Drost et al. 1999). The hydrogeologic nomenclature of Drost et al. (1999) is used for this study to remain consistent with previous work. A summary of the lithologic and hydrologic characteristics of each unit is presented in Table 2 (adapted from Drost et al. 1999). The hydrogeologic units known to exist within this area of Thurston County from the surface downward include:

- Recessional Outwash (Qvr)
- Till (Qvt)
- Advance Outwash (Qva)
- Kitsap Formation (Qf)
- Salmon Springs(?) Drift (Qc)
- Unconsolidated and undifferentiated deposits (TQu)
- Bedrock (Tb)

The primary water-bearing units include the Qva, Qc, and TQu. The till (Qvt) and Kitsap Formation (Qf) units are typically composed of low-permeability, fine-grained sediments and act as confining layers for deeper groundwater flow systems. The hydrostratigraphic units (as interpreted from area well logs) are illustrated on geologic cross-sections adapted from Robinson and Noble (2001) and Golder (2010), and are provided in Appendix B. A brief description of each unit is provided in the subsections below.

2.4.1 Recessional Outwash (Qvr)

The recessional outwash deposits (Qvr) blanket most of Yelm east of the Thurston Highlands. The sediments were deposited by meltwater streams discharging from the glacier as it retreated from the Yelm area. With the exception of alluvial sands and gravels found along many of the local streams, the recessional outwash is the youngest geologic deposit in the area. The Qvr sediments are composed primarily of sand and gravel. Area well logs indicate the thickness to range between 10 and 50 feet. The Qvr unit is generally too thin to support groundwater supply wells; most wells in the area are completed in the deeper, more transmissive Qva aquifer.

2.4.2 Till (Qvt)

An unsorted mixture of rock debris known as glacial till (Qvt) underlies the Qvr unit and confines groundwater in the deeper Qva. The till was transported by the glacier as it advanced into the area and was deposited over the Qva. The Qvt deposits are generally composed of a mixture of sands, gravels, cobbles, and boulders within a compacted matrix of silt and clay. Drillers commonly refer to these deposits as “hardpan,” “cemented,” or “boulder clay.” The Qvt unit is found at depth throughout the Yelm

area and is exposed at the surface west of Yelm forming the eastern portion of the Thurston Highlands. The thickness generally ranges between 35 and 80 feet, and is known to exceed 100 feet in areas west and southwest of Yelm (Drost et al. 1999). The Qvt unit at SW Well 1A is approximately 145 feet thick (25 to 170 feet below ground surface [bgs]) and consisted predominately of cemented, fine-to-coarse sand and gravel with silt and cobbles. The Qvt unit is considered a confining bed (i.e., aquitard) and its cemented conditions limit its permeability.

2.4.3 Advance Outwash (Qva)

The advance outwash deposits (Qva) lie beneath and are confined by the overlying Qvt till. The Qva sediments were carried and deposited by meltwater streams discharging from the glacier as it advanced into the Yelm area. The Qva is a relatively permeable aquifer unit consisting generally of gravel in a matrix of sand with some sand lenses. The Qva is widespread throughout the subsurface ranging in thickness between 15 and 85 feet, and is the primary source for domestic and municipal water supplies in the Yelm area. Wells 1A and 2 are completed in and obtain groundwater from this unit.

2.4.4 Kitsap Formation (Qf)

The Kitsap Formation is a low-permeability, fine-grained confining layer that separates the overlying Qva unit from the deeper Qc and TQu units. The Qf unit is composed predominately of clay and silt, with some layers of sand and gravel, and may include some till or till-like deposits and minor amounts of peat and wood. The Qf unit is extensive throughout the Yelm area and its thickness generally ranges between approximately 25 and 80 feet. The Qf unit at SW Well 1A is approximately 21 feet thick (219 and 240 feet bgs) and consisted of both silt and clay with organics and fine-to-coarse sand with silt, gravel and cobbles.

2.4.5 Salmon Springs(?) Drift

Below the Qf is the Salmon Springs(?) Drift unit (Qc). The Qc unit consists mainly of coarse-grained sand and gravel and is characterized by its oxidized red or brown staining (i.e., iron-oxides). This unit is referred to as the Salmon Springs(?) Drift by Noble and Wallace (1966) because its stratigraphic relationships mapped in Thurston County are similar to the Salmon Springs Drift type-section mapped in Pierce County and north of Tacoma, Washington. The Qc unit is extensive throughout the Yelm area and its thickness typically ranges between 15 and 50 feet. The Qc unit is roughly 60 feet thick at SW Well 1A (240 and 300 feet bgs) and consists predominately of sand with gravel (stained reddish brown) and silt. Groundwater in the Qc is confined by the overlying Qf unit and is a supply source for some wells.

2.4.6 Unconsolidated and Undifferentiated Deposits (TQu)

Unconsolidated and undifferentiated deposits of the TQu underlie the Qc unit. The TQu consists of glacial and non-glacial sediments of clay, silt, sand, and gravel, and is known to consist of layers of fine-

grained deposits and coarse-grained water-bearing units (Drost et al. 1999). The TQu is widespread throughout the region, but its thickness is not well known.

SW Well 1A is completed within the coarse-grained, water-bearing layers of the TQu. The coarse-grained layers consist predominately of fine-to-coarse sand with some gravel, while the fine-grained layers generally consist of silt and clay with some fine sand. The TQu unit at SW Well 1A is at least 500 feet thick (from 300 feet bgs to the total explored drilling depth of 800 feet bgs). The total thickness however, remains unknown because bedrock was not encountered within the exploratory drilling depth.

2.4.7 Bedrock (Tb)

The deepest geohydrologic unit in the Yelm area is consolidated bedrock (Tb). The bedrock unit consists of sedimentary claystone, siltstone and sandstone and igneous bodies of andesite and basalt. The Tb unit is known to contain some water in fractures and joints, but is considered an unreliable source due to low yields and poor water quality (Drost et al. 1998).

2.5 Groundwater Movement

Groundwater in the Yelm area is derived from two different flow systems: shallow and deep. The shallow groundwater system consists primarily of the advance outwash (Qva) deposits, whereas the deeper, regional groundwater system consists of the older glacial deposits identified as the Salmon Springs(?) Drift (Qc) and unconsolidated and undifferentiated deposits of the TQu. Studies conducted by Robinson and Noble (1995 and 2001) indicate that the groundwater elevation and flow direction of the deeper system are different from those in the shallow system beneath Yelm. Groundwater within the shallow system generally flows in a northerly direction across Yelm Prairie toward the Nisqually River, whereas groundwater in the deeper system moves more northwesterly away from the Nisqually River toward Olympia, Washington.

3.0 WELLHEAD PROTECTION AREA DELINEATION

This section discusses the modeling approach used to delineate time-of-travel based WHPAs and identifies the 6-month and 1-, 5-, and 10-year WHPA capture zones for the City's existing supply wells (Wells 1A and 2) and planned future well (SW Well 1A).

3.1 Previous Wellhead Protection Areas

Wellhead protection areas (WHPAs) were originally delineated by Robinson and Noble (2001) for the City's active source wells using a combination of delineation methods: the near-well capture zones were delineated using an analytical approach, while hydrogeologic analyses and mapping techniques were used at distant locations from the wells. Planned capacity expansions and a new groundwater flow modeling tool capable of evaluating groundwater protection and development projects in the Thurston County area have prompted revisions to the previously mapped WHPA capture zones.

3.2 Modeling Approach

The WHPAs for the City's current and planned supply wells were delineated using the most up-to-date version of the McAllister Groundwater Model, which encompasses a broad area of Thurston County and was utilized to support the City's water right applications and mitigation program (City of Yelm 2011). Details of the model construction and calibration are provided by CDM (2002a and 2002b), Golder (2008a and 2008b), and City of Yelm (2011). This most up-to-date version of the McAllister Groundwater Model is hereafter referred to as the "existing model."

The existing model was modified in order to delineate updated WHPAs for the City's current and planned supply sources. Adaptations and modifications to the existing model for this use (including model refinements and updates), as well as a more detailed discussion of modeling approach and capture zone analysis, are presented in a Technical Memorandum provided in Appendix C. The adaptation resulted in a separate Yelm-specific tool that is hereafter referred to as the Yelm 2011 WHPA Model.

The WHPAs were delineated for the following City wells:

- SW Well 1A (recently drilled; planned new source)
- Wells 1A and 2 (current, approved sources)

3.3 Wellhead Protection Areas Modeling Results

Figure 2 displays the predicted 6-month and 1-, 5-, and 10-year time-of-travel capture zones for the City supply sources. Figures TM-2 and TM-3 of Appendix C show the model-predicted groundwater elevations in feet above mean sea level (amsl) and flow directions in the Yelm area for the Qva and TQu aquifers, respectively. The WHPA capture zones are summarized for each of the supply/aquifer sources in the following two subsections.

3.3.1 SW Well 1A – TQu Aquifer

The shape of the 6-month and 1-, 5-, and 10-year time-of-travel WHPA capture zones (using an annual average pumping rate of 584 gallons per minute [gpm] based on the maximum annual water right volume of 942 acre-feet) has a regular, elongated pattern and does not display any apparent sign of flow disruption from other wells or potential aquifer boundaries. No evidence of vertical flow was observed in the capture zones delineated for SW Well 1A. The capture zones exhibit a narrow and elongated pattern due to the highly transmissive nature of the TQu. The 6-month and 1-, 5-, and 10-year time-of-travel capture zones respectively extend roughly 460, 800, 3,300, and 6,400 feet upgradient from SW Well 1A. The capture zone is approximately 815 feet wide at its maximum width.

3.3.2 Wells 1A and 2 – Qva Aquifer

The capture zones delineated for Wells 1A and 2 (using a combined annual average pumping rate of 555 gpm based on the combined maximum annual water right volume of 894.92 acre-feet) are irregularly shaped and noticeably different than the capture zone for SW Well 1A. In particular, there is a bend in the mid part of the 5-year capture zone, which results from a combination of factors, including the presence of several domestic wells, the close proximity of model boundaries to the capture zone, and a decrease in aquifer hydraulic conductivity (from 640 to 70 feet per day [ft/day]). The width of the capture zone for Wells 1A and 2 is wider than that of SW Well 1A, which results from differences in aquifer thickness. The model thickness of the Qva is considerably less than the thickness of the TQu (Appendix C).

Vertical flow from the underlying Qf to the Qva is predicted by the model in close proximity of Wells 1A and 2 (west side of capture zone), and also from the model's river boundary downwards to the Qva in the south-western part of the capture zone where groundwater movement is predicted to travel west-east for a short distance. Because the WHPA model analyses were performed using steady-state simulations (i.e., worst-case scenario because the duration of pumping is assumed to be very long, long enough to reach equilibrium, and does not incorporate seasonal variability in pumping demand), vertical migration of groundwater is expected to be less than predicted by the model.

The new capture zones for Wells 1A and 2 vary from the previous delineations by Robinson and Noble (2001). Several changes account for the differences:

- Pumping rates were revised to incorporate increased capacity at these wells.
- A more realistic regional hydraulic gradient (consistent with the existing model) elongate the capture zones.
- The 2012 Yelm WHPA model represents an improved distribution of transmissivity and appropriate geological (model) layering to reflect observed hydrostratigraphic conditions.

Consequently, the revised capture zones should be viewed as more representative of actual conditions, despite being different than those delineated previously.

4.0 SUSCEPTIBILITY AND CONTAMINANT SOURCE INVENTORY

Aquifer susceptibility is the relative ability with which a contaminant can migrate from the land surface to a water supply source aquifer. Susceptibility is based primarily on local hydrogeologic factors and well construction. Aquifer vulnerability considers both the physical susceptibility to contaminant infiltration and the risk of exposure to contaminants. Exposure risk is primarily associated with land use in relation to the water supply area and the associated activities or types of chemicals used and/or stored.

4.1 Susceptibility Assessment

The primary factors influencing aquifer susceptibility include:

- Well construction, integrity, and usage
- Aquifer type (confined or unconfined)
- Characteristics of the hydrogeologic system

For example, with all else being equal, a relatively deep confined aquifer is less susceptible to contamination than a shallow, unconfined aquifer. In addition, wells that have been poorly constructed or improperly sealed and cased can potentially serve as a pathway for contaminants despite whether the well is deep and completed in a confined aquifer. The main mechanisms for transport of contaminants to the subsurface include:

- Discharge to the ground surface – Discharge of chemical products or waste materials through spills, stormwater runoff and/or intentional disposal. Such materials could infiltrate the surface sediments and potentially reach a drinking water source aquifer.
- Discharge to surface water bodies – Depending on its connection and interaction with groundwater, surface water bodies could transport contaminants to an aquifer system through natural recharge.
- Improperly abandoned or poorly constructed wells – Wells that have been improperly decommissioned or constructed with inadequate surface seals could act as direct conduits for transport of potential contaminants to an aquifer.

Based on the WDOH guidelines, the susceptibility of a well is rated as high, moderate, or low. Wells 1A and 2 are considered by the WDOH to have high susceptibility due to their relatively shallow depths and the highly transmissive nature of the Qva aquifer in this area. Despite both wells being completed in and obtaining water from the confined Qva aquifer, Well 2 is considered more susceptible due to its age. SW Well 1A, completed in the deep and confined TQu aquifer and sealed to approximately 328 feet bgs, is considered to have the lowest level of susceptibility. A Susceptibility Assessment Form for the City's planned additional supply well (SW Well 1A) is provided in Appendix D.

4.2 Contaminant Source Inventory

An essential component of wellhead protection is generating an inventory of potential sources of groundwater contamination that may threaten a source of supply. An inventory of potential contaminant

sources within and around the WHPAs for SW Well 1A and Wells 1A and 2 was generated and their potential risk prioritized based on the following steps:

- Environmental database searches to identify known or suspected soil and groundwater contaminant sources
- Conducting a field survey of the WHPAs to verify sites identified by the database search and identify any additional potential contamination sources
- Identifying potential groundwater quality concerns associated with land use practices within the WHPAs
- Prioritizing exposure risks to the WHPAs

4.2.1 Database Search

An inventory of known or suspected soil and groundwater contamination sites within a 2.5-mile radius encompassing the WHPAs was generated by compiling information from the following sources:

- Washington State Department of Ecology's (Ecology's) Facilities/Sites and Water Well databases (accessed March 16, 2012).
- United States Environmental Protection Agency's (EPA's) Facility Registration System database (accessed March 16, 2012).
- Environmental records compiled by Environmental Data Resources, Inc. (EDR 2012). An Executive Summary of the EDR report is included in Appendix E. Complete results of the report are included in a CD-ROM attached to the inside back cover of this report.

The findings of known or suspected sites of contamination based on results from these sources are summarized in a later section.

4.2.2 Field Survey

City of Yelm personnel conducted windshield surveys of the WHPAs in April 2012. These surveys included drive-by reconnaissance to verify sites identified by the database search and identify any additional potential contamination sources. Mail and telephone surveys, door-to-door surveys, and personal interviews were not performed.

4.3 Land Use

Land zoning within Yelm and the surrounding area generally consists of residential, rural residential, agriculture, commercial, industrial, institutional, and open-space districts. Figure 3 shows current land-use zoning categorized into four general land-use types: residential, rural residential, commercial/industrial, and institutional/open space. Land use types making up these general classifications are listed in Table 3.

Information contained in the following subsections was largely adapted from the City's Water System Plan (Brown and Caldwell 2010) and modified as needed to address any land use types identified in association with the newly delineated WHPAs.

4.3.1 Residential and Rural Residential

The City of Yelm is predominantly made up of residential districts. Potential contaminant issues related to residential land use include: fertilizer and pesticide applications, use of petroleum hydrocarbons, small livestock operations, and nitrate loading and disposal of household chemicals through septic systems.

A primary concern for residential areas, particularly residential areas within the City's urban growth boundary (UGB), is the impact of nitrogen. Properly maintained and used septic systems convert organic nitrogen to nitrate. Most septic drain fields discharge effluent to the unsaturated zone above unconfined aquifers, and contaminants can percolate to the saturated zone and contaminate groundwater. Livestock operations and other hobby farming can also result in nitrate entering groundwater.

The City maintains a Septic Tank Effluent Pump (STEP) sewer system and is nearly all sewered. There are however, some septic systems that remain within the City limits. From the City's general sewer plan work, this represents approximately 157 septic systems. The City's UGB is almost all on septic systems. The City's goal is to connect septic systems to their STEP sewer system as they develop or as existing systems fail.

Hobby farms, lawns, and flowerbeds represent potential hazards because they typically receive application of fertilizers, herbicides, and pesticides. The presence of multiple sources of pesticides can result in the potential for additive loading to the groundwater system, resulting in a possible progressive decline in water quality.

Agricultural land uses also present risk concerns. Agricultural activities can cause several types of water quality problems, mostly resulting from fertilizers, pesticides, or manure/wastes. Agricultural activities were grouped within rural residential areas.

4.3.2 Commercial/Industrial

The most likely potential contaminants related to commercial/industrial sites include, but are not limited to, petroleum hydrocarbons and metals. These potential contaminants are generally due to the historical or current presence of heating oil and fuel in underground storage tanks (USTs). Additional potential contaminants could also be associated with auto repair and metal fabricator facilities.

Petroleum hydrocarbons can become a serious concern for wellhead protection in commercial and industrial areas, as well as residential areas. There are numerous potential sources for petroleum hydrocarbons within the WHPA. They include gasoline stations, industrial and commercial operations

that fuel and maintain equipment and vehicles, home/commercial heating oil tanks and bulk transport of such fuels. Petroleum hydrocarbons are typically stored in USTs in volumes ranging from 300 gallons per tank (residential use) to up to 10,000 gallons per tank (gasoline service stations). Large spills involving petroleum hydrocarbons are a greater risk than small spills (leaks, etc.).

Groundwater contamination from metals is a potential threat at commercial and industrial sites, which typically handle or use materials with significant metallic constituents (paints, waste oil, etc.), historical pesticides (historical pesticides were typically metal-based compounds), and metal plating shops (cyanides and heavy metals).

Hazardous material storage is a common activity associated with industrial and commercial land uses. Spilled or inappropriate disposal of chemicals poses a significant threat to groundwater quality. Solvents that leak downwards from the surface or subsurface are a major threat to water supplies, as a small quantity can affect a large portion of an aquifer or surface water body. Risk from spilled chemicals can be mitigated by implementing proper handling methods and spill prevention measures.

4.3.3 Institutional/Open Space

Land use activities associated with institutional and open space types include designated forestland and timberland, parks, and undeveloped land (Table 3). These land use types are expected to have the lowest potential for contamination because of the nature and low impact of activities occurring there and because none coincide with any of the delineated WHPAs (Figure 3).

4.4 Potential Groundwater Quality Concerns

The following discussion briefly summarizes the potential groundwater quality concerns associated with the land use types identified within the WHPAs. These concerns can generally be grouped into five categories: nitrates, pesticides, petroleum hydrocarbons, metals, and corrosive materials. The types of concerns in relation to land use are summarized in Table 4 and are discussed in more detail below.

Information contained in the following subsections was largely taken from the City's Water System Plan (Brown and Caldwell 2010) and from the previous WHPP (Robinson and Noble 2001), and modified as needed to address any new land uses identified in association with the modified WHPAs.

4.4.1 Nitrates in Groundwater

There are multiple potential sources of nitrate that could be released to groundwater in the WHPAs. These potential sources include septic systems, livestock operations, and fertilizer applications to lawns, golf courses, timber growing sites, and sewer systems.

Septic systems are used in areas that are not served by sewer systems. Although the City of Yelm is nearly all sewered, areas outside the city boundary and within the UGB are on septic. Wastewater

released from septic systems or leaking sewer systems contains bacteria, nutrients, and may contain household chemicals. However, the principal concern from poorly maintained and used septic systems is the impact of nitrogen, which is converted and transported as nitrate in the groundwater system. Nitrate is the primary constituent of concern because of its relatively high mobility in groundwater systems and its potential harmful health effects to humans at high concentration levels. Regional studies have shown that groundwater quality impacts from septic systems used in residential developments vary widely based on hydrogeologic setting, housing density, and system ages, types, and maintenance.

Though nitrate loading from adequately designed, maintained and operated septic systems is generally small, an improperly used system in highly porous soils can allow pathogens to reach groundwater unimpeded. Evidence of this type of septic system failure is not readily visible since drainage from these systems does not cause ponding or odor problems. As previously mentioned, the City's goal is to connect septic systems to their STEP sewer system as they develop or as existing systems fail. In cases where sewer connection is not possible, there are ways to protect against septic nitrate loading:

- Ensure that all new septic systems going into areas of excessively draining soils in the WHPAs are carefully designed and properly installed
- Ensure that all water supply wells withdraw water from beneath a protective confining (low permeability) layer such as till

Agriculture is an additional land use practice within the WHPAs that could result in the release of nitrate into the groundwater system. Properly designed and operated livestock facilities can mitigate the potential for nitrate releases by implementing best management practices defined by the Natural Resources Conservation Service. Poorly managed facilities can release nitrate via surficial runoff and infiltration to the underlying groundwater system.

An additional practice that can leach nitrate to the groundwater is fertilization, especially if applied above recommended rates. Fertilizers usually contain nitrogen in the form of ammonia or nitrate. Though nitrate is the form most readily taken up by plants, ammonia is usually converted to nitrite, and then nitrate, by bacteria in soils. Nitrate is highly mobile in groundwater, so fertilizer application in excess of plant uptake can result in surplus nitrate being transported to groundwater. Fertilizers typically contain other chemicals that could migrate to groundwater, including potassium, sulfate and phosphorus, but their impact to water quality is generally not at the same magnitude as the impact from nitrate.

The presence of multiple sources of nitrate in the wellhead protection management areas, primarily in land use areas designated as rural residential, results in the potential for additive nitrate loading to the groundwater system and the potential for decline in water quality. Nitrate levels have been below 5 milligrams per liter (mg/L) in samples collected from Wells 1A and 2 since 2005. Nitrate was below the

method detection limit of 0.0076 mg/L in the initial groundwater quality characterization sample collected at SW Well 1A on October 13, 2010.

4.4.2 Pesticides

Pesticide use typically ranges from larger-scale treatment by certified applicators to smaller-scale homeowner use for yard maintenance and pest control. Pesticides are typically used in residential areas, along transportation corridors, at golf courses, and in farming and forestry operations. For these locations and land uses, the heaviest use of pesticides may be at farming or forest operations or along transportation corridors to prevent unwanted plant growth and damage caused by insects. Pesticides discussed herein include a suite of related products:

- Insecticides – The most widely used insecticides available today are of the organophosphate type. Organophosphates are used in agriculture, in homes and gardens, and in veterinary practice.
- Herbicides – Herbicides are used in transportation corridors, typically by State and County transportation departments. Herbicides are used mainly to keep highway shoulders free from unwanted plant growth.
- Fungicides – Fungicides are used extensively in industry, agriculture, and residential uses for seed grain and crop protection, and control and suppression of molds, mildews, and yeasts. Typically, fungicides are applied throughout the growing season, whereas most herbicides and insecticides are applied only once.

There are numerous pesticides that are restricted to permitted use and a wide variety of unpermitted, commercially available products. When applied in accordance with manufacturer specifications, pesticides are relatively immobile because they are consumed by the pests or become adsorbed to soil. Most of the products are toxic to humans and animals in small quantities, with specific risk-bases toxicity data available for active ingredients in the commonly used products. Not all pesticides are mobile in groundwater, and not all pesticides are stable or persistent in the environment. Consequently, the potential for pesticides to migrate to groundwater, degrade or transform into other chemical compounds, or persist long enough to contaminate groundwater, varies by usage and between individual pesticides and classes of pesticides.

The likelihood of pesticide use in land use types that coincide with the WHPAs creates the potential for additive loading to the groundwater system resulting in a possible decline in water quality. To date, pesticides have not been a detectable problem in the samples collected from Wells 1A and 2. No synthetic organic compounds (SOCs) or herbicides were detected in the groundwater quality characterization sample collected at SW Well 1A on October 13, 2010.

4.4.3 Petroleum Hydrocarbons

There are numerous potential sources for petroleum hydrocarbons within and near the WHPAs. These include gasoline stations, industrial and commercial operations that fuel and maintain equipment and

vehicles, and home and commercial heating oil tanks. Petroleum hydrocarbons are typically stored in USTs in volumes ranging from 300 gallons (residential use) to up to 10,000 gallons per tank (gasoline service stations). Larger storage volume requirements, greater than 10,000 gallons, are typically stored above ground.

Petroleum hydrocarbons are not highly soluble in water. Their solubility is related to the length of the hydrocarbon chains that comprise the material. Short chain hydrocarbons, the types which are found in gasoline, are typically more soluble than longer chain hydrocarbons, which are found in diesel fuel and heating oil. The greatest potential threat to a wellhead is from sources of petroleum hydrocarbons close to the wellhead because of the limited potential for natural attenuation in the subsurface. Petroleum hydrocarbon releases may also be more of a threat at sites where other types of solvent have been spilled. The materials can sometimes act as co-solvents and increase the solubility of petroleum product, and, therefore, increase the likelihood of transport of the petroleum hydrocarbons to a wellhead.

Volatile organic compounds (VOCs) have not been detected in Well 2 since 1990 or Well 1A since 2005, and have never exceeded state drinking water maximum contaminant levels (MCLs). Synthetic organic compounds (SOCs) have never been detected in Wells 1A or 2. No VOCs or SOCs were detected in the groundwater quality characterization sample collected at SW Well 1A on October 13, 2010.

4.4.4 Metals

Groundwater contamination from metals is a potential threat at commercial and industrial sites, which handle, store, or use materials with significant metallic constituents (paints, waste oil, etc.), historical pesticide use areas (historical pesticides were typically metal-based compounds), and metal plating and auto repair shops (cyanides and heavy metals). Metals are not highly soluble in water. Their solubility is generally related to pH and oxidation-reduction potential (Eh) in the aquifer. High concentrations of metals typically do not migrate far from their source areas because of their low solubility, tendency to adsorb to clay particles or organic matter, tendency to precipitate (depending on Eh/pH relationships), and/or tendency to substitute for other minerals in the aquifer. State regulated inorganic contaminants, including primary and secondary metals, have never exceeded their established contaminant levels at Wells 1A or 2. The only inorganic constituent having a concentration above its regulatory criteria in the initial groundwater quality characterization sample collected at SW Well 1A on October 13, 2010 was manganese. Total manganese was detected at 0.15 mg/L. Manganese above the secondary MCL (SMCL) does not pose a risk to human health or the environment. Meeting the SMCL for manganese is not a mandatory requirement, and is only provided as a recommendation for aesthetic quality.

4.4.5 Corrosive Materials

Corrosive materials (acidic and basic compounds) may be present in some products used, or contained in waste materials generated from or stored at commercial/industrial facilities within the WHPAs. Materials

such as these can change the pH of shallow ground water and induce corrosion problems in structures that are in contact with the groundwater (foundations, pipelines, etc.). Changing pH of groundwater could result in mobilizing and/or immobilizing other constituents, like metals, as described above. Extreme changes in pH may make groundwater unsuitable for human consumption or for use in industrial processes. However, the buffering capacity of native soils and rock may minimize the migration of corrosive groundwater. Groundwater pH at Wells 1A and 2 and at SW Well 1A from an initial groundwater quality characterization sample collected on October 13, 2010, are within the SMCL range (6.5 to 8.5), and no monitored constituents have indicated an apparent concern regarding corrosive substances.

4.5 Risk Priority Rankings for Potential Contaminant Source Sites

A total of 120 known or suspected soil and groundwater contamination sites were identified by the database searches (Figure 4). Each site was ranked according to three factors, or decision levels, to define risk priority. The decision levels were, in decreasing order of importance:

- Level I – Proximity of the potential hazard to the WHPA
- Level II – Type of contamination at the site
- Level III – Straight-line distance to the closest wellhead in feet

To determine the risk priority rankings, each known and potential contamination site was prioritized using Decision Level I. Sites having equal Level I priority rankings were then further sub-prioritized using Decision Level II. If sites were still equal in priority, they were further sub-prioritized under Decision Level III. The methodology for prioritizing contaminant risk was based on the methodology of the previous contaminant source inventories (Brown and Caldwell 2010; Robinson and Noble 2001). This methodology is described in the following sections.

4.5.1 Decision Level I – Potential Contaminant Source Site Location Relative to Wellhead Protection Area

For the first decision level, the prioritization of the known or suspected contaminant source sites was based on the particular time-of-travel capture zone the site was located within. The Decision Level I sub-priority rankings are listed in Table 5. Sites located within the 6-month capture zone were assigned a sub-priority level ranking of one, while sites within the 10-year capture zone were assigned a sub-priority level ranking of four. In summary, the shorter the travel time, the higher the position in the priority level, with a level of one being the highest. Sites identified outside of the WHPAs were given a sub-priority level ranking of five if their location was hydraulically upgradient (i.e., groundwater flow toward the well; similar to “upstream” for surface water) and assigned a six if hydraulically downgradient (i.e., groundwater flow away from the well; or “downstream”).

4.5.2 Decision Level II – Type of Contamination

For the second decision level, the sites were sub-prioritized based on the type of contamination identified in the state or federal environmental database search results and whether site contamination is known or suspected. The Decision Level II sub-priority rankings and their associated contaminated site types are listed in Table 6. Known contaminant sites were assigned sub-priority levels between one and three depending upon the contaminated site type: confirmed or State cleanup sites were assigned a sub-priority level of one, whereas voluntary cleanup sites for example were assigned a level of three. Sites with Leaking USTs were assigned a level of two. Potential contaminant sites were assigned sub-priority levels between four and ten. Examples of level four sites include recycling facilities and hazardous waste generators, whereas facilities and sites of interest for example were assigned a level of ten. In summary, known contaminant source sites were assigned higher sub-priority levels (depending upon contaminated site type) than potential contaminant source sites.

4.5.3 Decision Level III – Straight Line Distance from Wells

For known contamination sites, or potential contamination sites having the same sub-priority level ranking for both Decision Levels I and II, the straight-line distance (in feet) from the site to the closest wellhead was used to sub-prioritize further. Sites closer to a supply source were given a higher priority level position than sites further away.

4.6 Contaminant Source Inventory Results

The following discussion presents sites identified by the contaminant source inventory and their associated risk priority rankings. A total of 120 potential contaminant source sites were identified by the database searches and windshield survey, and ranked according to the scheme outlined above. A complete list of rankings is provided in Table 7 and their locations are shown in Figure 4. Potential contaminant sources identified within the 100-foot Sanitary Control Area (SCA) for Wells 1A and 2 and SW Well 1A are also discussed.

4.6.1 Wells 1A and 2

Of the 120 potential contaminant source sites identified, 23 coincide with the WHPAs delineated for Wells 1A and 2. Ten sites are located in the 6-month capture zone and the remaining 13 are within the 1-year capture zone. The potential contaminant source locations coinciding with each WHPA zone for Wells 1A and 2 are shown in Figure 5 and briefly discussed below. Each site is further described in Table 7.

- Sanitary Control Area (SCA) – Wells 1, 1A and 2 are each located in separate secured well houses and the site is surrounded by security fencing. Small amounts of oils, lubricants, cleaning fluid, and paint are stored within the buildings. The building for Well 1 includes a separate space for storage of caustic soda. A 200kW generator with 300 gallon capacity diesel fuel tank is located adjacent to the Well 2 pump house on a

concrete pad with a 6-inch curb. The wells are located within 100 feet of a public roadway or parking lot. Spill prevention, containment, and response/treatment measures to address these potential contaminant concerns and minimize potential impacts in the event of an accidental release are described in Chapter 5 and Appendix 5 of the City's Water System Plan (Brown and Caldwell 2010). To date, there have been no known spills at the well site.

- 6-Month Capture Zone – The 6-month capture zone extends approximately 3,500 feet upgradient (to the southeast) of Wells 1A and 2. A total of 10 sites (Sites 1 through 10) were identified within this zone, two of which are identified as known contaminated sources (Sites 1 and 2 on Figure 5). Site 1, the highest ranked site, is a gas station that was identified on the Confirmed and Suspected Contaminated Site List and has received a No Further Action determination. Site 2 is a drugstore identified as a small quantity hazardous waste generator. The remaining sites are primarily businesses that store or handle hazardous chemicals, have USTs onsite, or that have been identified as having a 5D2-class Underground Injection Control well for stormwater purposes.
- 1-Year Capture Zone – The 1-year capture zone extends approximately 6,300 feet upgradient of Wells 1A and 2. A total of 13 sites (Sites 11 through 23) were identified within this zone, one of which was identified as a known contaminated source (Site 11 on Figure 5). Site 11 is a gas station / convenient store identified on the Emergency Response Notification and Hazardous Materials Incident Report Systems lists for an accidental spill of 20 gallons of unleaded gasoline. The remaining sites are primarily businesses that store or handle hazardous chemicals or that have USTs onsite.
- 5- and 10-Year Capture Zones – No known or potential contaminant sites were identified in the 5- or 10-year capture zones. Land use type in these zones is designated as rural residential. Potential groundwater quality concerns associated with these land use types were discussed in previous sections of this report.

4.6.2 SW Well 1A

SW Well 1A is located in an undeveloped area zoned for residential land use held in full legal control by the City of Yelm (refer to Appendix F for Declaration of Covenant). A facility to enclose and protect SW Well 1A is currently in the design phase, but has not been constructed. Currently, the well casing terminates approximately 3 feet above the ground surface and is capped and secured. The facility will include a secured well house and flow monitoring components with a separate area to store and handle disinfection/treatment chemicals, and may also include a backup power generator for emergency use. The well site/facility will be controlled by security fencing. When developed, the area will likely include grass cover, sidewalks and a paved driveway. The Spill Response Plan (Appendix H; discussed in Section 5.4) will be reevaluated and updated as needed to address any site specific conditions after the SW Well 1A facility is constructed and put into service. In the interim, the response measures detailed in the plan are appropriate for implementation should a spill occur in the vicinity of SW Well 1A.

No known or suspected soil or groundwater contamination sites were identified within the 100-foot SCA of SW Well 1A (Appendix F). When the facility is constructed and the site fully developed, potential contaminant sources within the SCA may include those associated with water treatment chemicals handled or stored at the well site or stormwater runoff. A stormwater retention pond currently exists east of SW Well 1A, but is planned for relocation before the well is put into service. At full site/area

development, the SCA will partially overlap a public roadway, but because the well is sealed to a depth approximately 328 feet bgs and obtains water from a deep aquifer overlain by two confining layers (Qt and Qf), SW Well 1A is considered to have the lowest level of susceptibility, and infiltration of surface contaminants is unlikely. Infiltration of surface contaminants from stormwater is further mitigated by the City by routinely sweeping roadways and cleaning stormwater catch basins.

No known or suspected soil or groundwater contamination sites were identified within the 6-month or 1-, 5-, and 10-year WHPA capture zones (Figure 4).

Land use type within the SCA, 6-month and 1-year capture zones is designated as residential with some areas in future transition to commercial and institutional space, whereas types within the 5- and 10-year capture zones are designated as both residential and rural residential. Potential groundwater quality concerns associated with these land use types were discussed in previous sections of this report.

5.0 MANAGEMENT STRATEGY

The key elements of a WHP program include a management strategy, a spill response plan, a contingency plan and recommended improvements. The key management strategies include monitoring and data management, land use, regional coordination, and public education and notification programs. This chapter presents the management strategies the City currently employs, and identifies recommended improvements.

5.1 Land Use and Regulatory Control

Controlling future development in WHPA capture zones through land use regulations is an important tool used by the City and by Thurston County to reduce the risk of groundwater contamination. The Yelm Municipal Code (YMC) is the City's primary mode of enforcement and regulation of activities within the WHPAs.

5.1.1 City of Yelm

YMC 14.08 identifies general and specific-use performance standards for areas designated as critical aquifer recharge areas (CARA). The general performance standards [YMC 14.08.110(C)] address proposed activities and development as follows:

- Proposed activities will not cause contaminants to enter the aquifer and will not adversely affect recharging of the aquifer.
- The proposed activity must comply with the water source protection requirements and recommendations of the EPA, WDOH, and the Thurston County Environmental Health Division.
- All new development, redevelopment, and small parcel development shall meet the water quality requirements of the stormwater manual as adopted by the city of Yelm.

Special use performance standards [YMC 14.08.110(D)] address:

- Storage Tanks – All storage tanks proposed to be located in a CARA must comply with local building code requirements and must conform to requirements for underground [YMC 14.08.110(D)(1)(a)] and aboveground [YMC 14.08.110(D)(1)(b)] storage tanks.
- Vehicle Repair and Servicing – Such activities must be conducted over impermeable pads and within a covered structure. Chemicals used must be stored in a manner that protects them from weather and provides containment should leaks occur. No dry wells shall be allowed in CARAs on sites used for vehicle repair and servicing.
- Use of Reclaimed Water for Surface Percolation or Direct Recharge – Water reuse projects for reclaimed water must be in accordance with the adopted water or sewer comprehensive plans that have been approved by Ecology and by the WDOH.

5.1.2 Thurston County

Thurston County assumes leadership of determining land use activities within WHPAs located outside city limits. Thurston County has adopted a Nonpoint Source Pollution Ordinance, which in part targets small

quantity generators within WHPAs within Thurston County. The purpose of this ordinance is to minimize environmental impacts from hazardous materials. The County also implements a Business Pollution Prevention Program to provide education and technical assistance inspections for small quantity generators. This program is sponsored by the Thurston County Hazardous Waste Program and addresses activities such as proper storage, use, floor washing activities, incidental dumping, abandoned materials, and intentional ground disposal of hazardous wastes.

The County's primary mechanism for controlling land use within WHPAs is the Critical Areas Ordinance (CAO). Functions of the CAO include controlling types of land use and residential densities within hydrogeologically-sensitive areas. The County also requires:

- Turf Management Plans and Integrated Pest Management Plans to identify potential sources of groundwater contamination.
- Farm Plans for agriculture located within 1-year capture zones.

In 2012, Thurston County adopted new regulations for critical areas, which address changing buffer zones for wetlands, streams, wildlife habitat, marine bluff hazard areas, and landslide hazard areas. The amendment addresses channel migration when assessing areas prone to high groundwater flooding. The WHPAs delimitated in this WHPP will be provided to the County upon finalization of the plan (Section 5.3.2) and the City plans to work with the County to ensure that these WHPAs are designated as CARAs in the CAO.

5.2 Public Education

Public education and voluntary action are critical to protecting public and private drinking water supplies. Public participation in the groundwater protection planning and management strategies increases awareness and ownership of the program. Public education is also an important component of non-regulatory wellhead protection strategies, which rely on homeowners and residents to properly maintain private wells and correctly dispose of household hazardous wastes. Public education can be accomplished in a number of ways, including brochures, mailers, utility bill inserts, press releases, booths at special events, meetings, and workshops. The City will provide WHPP public education information annually as a component of their drinking water consumer confidence report.

Public education programs focused on wellhead/groundwater protection can emphasize the following issues:

- Proper use of household chemicals, especially lawn chemicals such as fertilizers and pesticides. Many homeowners fail to use lawn chemicals in accordance with the label, and chemical over-use, especially when combined with over-watering, can lead to impacts to groundwater supplies. Educate homeowners about the importance of following the manufacturer's instructions when using lawn and household chemicals.

- Correct disposal of household hazardous wastes including waste oils, paint, lawn chemicals, and other household hazardous materials. Inappropriate disposal of these substances, including pouring chemicals on the ground or down the drain into a septic system, can create a threat to groundwater quality. The implementation of periodic no-cost hazardous waste collection days can be an effective tool for encouraging proper disposal, especially when paired with public education efforts.
- Appropriate maintenance of private wells and septic systems. Public education efforts to encourage correct maintenance of septic systems and private wells can include making resources available on a website, flyers, or brochures.
- Increase awareness of residents and business owners/operators located in WHPAs. Hands-on learning and technical assistance opportunities for households, business owners, teachers, and students can help develop knowledge, teach new skills, and ultimately change the attitudes, practices, and behaviors of those living or working in WHPAs.

5.3 Notifications

This section includes notification lists and example letters to both the identified potential contaminant sources and to the regulatory agencies, local governments, and emergency responders notifying them of the City's WHPAs.

5.3.1 Notification to Owners of Potential Sources of Contamination

Separate letters of notification will be delivered to those owners/operators located within the WHPAs and identified as potential sources of contamination. These letters will include a map of the WHPAs and the locations of potential and known sources of ground water contamination. The list of owners/operators to be contacted are those identified in Table 7 as having prioritizations of 1 and 2 under the Decision Level I risk priority ranking (Sites 1 through 23). An example letter is included in Appendix G. Letters will be sent to these owners/operators within 90 days of WHPP approval by WDOH and once every 2 years thereafter.

5.3.2 Notification to Regulatory Agencies and Local Governments

Regulatory agencies and local governments will be provided separate letters of notification. These letters will include information of the water-supply system, WHPA boundaries, and locations of potential and known sources of ground water contamination within the wellhead protection area boundaries. An example letter and list of appropriate regulatory agencies that should be notified after any changes are made to WHPAs are included in Appendix G. Letters will be sent to these agencies and local governments within 90 days of WHPP approval by WDOH and once every 2 years thereafter.

5.3.3 Notification to Local Emergency Responders

Separate letters of notification will be delivered to the appropriate emergency responders. These letters will include results of the susceptibility assessment and the findings of the wellhead protection inventory so that local emergency responders can evaluate whether changes in emergency response procedures (e.g., incident/spill response) are needed to better protect groundwater within the WHPAs. The list of

incident responders to be contacted and provided with information regarding the City's WHPAs is included in Appendix G. Letters will be sent to these local emergency responders within 90 days of WHPP approval by WDOH and once every 2 years thereafter.

5.4 Spill Response Plan

Spill response planning is an important aspect of both an emergency management plan and a WHP program. Chapter 5 (Spill Response Plan) of the City's Water System Plan (Brown and Caldwell 2010; included in Appendix H for reference) describes spill prevention measures currently in place to prevent the accidental release of pollutants in the area of Wells 1A and 2, and describes spill treatment and response actions to be taken to minimize potential damages in case a spill does occur. This plan remains valid as no significant changes that would impact the emergency response measures identified have occurred since the Water System Plan was last updated in 2010, and the general response plan is valid for any potential spills in the vicinity of SW Well 1A. The 2010 Spill Response Plan will be reevaluated and updated as needed to address any site-specific conditions after the SW Well 1A facility is constructed and put into service (i.e., if any chemicals not identified in the current plan are stored and used at SW Well 1A the plan will be updated to provide detailed information regarding these chemicals).

5.5 Contingency Plan

A contingency plan is required as part of the WHPP in the event that a natural disaster or contamination event results in the temporary or permanent loss of the City's water supply source. Chapter 5 (Spill Response Plan) of the City's Water System Plan (Brown and Caldwell 2010) presents an initial evaluation of the feasibility of developing alternative sources of supply, including interconnects with other neighboring water systems or distribution of purchased water. Based on this initial evaluation, neighboring systems have little extra capacity and would provide little benefit in terms of contingency planning of the loss of an existing source. The most effective contingency effort is the development of SW Well 1A.

SW Well 1A was drilled and tested in 2010 to explore the potential of developing a new groundwater source from a deeper portion of the regional aquifer system (the TQu unit). Aquifer and water quality testing has shown that the well is capable of producing high quality water at a yield of 2,100 gpm and is planned to be in operation in late 2014 or early 2015.

Because SW Well 1A withdraws water from a deep well-confined portion of the regional aquifer system, its hydraulic connection to shallower aquifer units is limited. Results from a pumping test conducted to assess the deep aquifer system did not result in observable response in nearby observation wells completed in overlying units suggesting little-to-no hydraulic connection between the shallow aquifer source for Wells 1A and 2 and the deeper TQu (Golder 2010). Consequently, SW Well 1A is much less vulnerable to surface contamination and could function as an emergency supply source in the event of the

temporary or permanent loss of Wells 1A and 2, depending upon the magnitude and characteristics of the contamination.

5.6 General Considerations for New Monitoring Wells

Groundwater quality monitoring can provide early notification to allow for sufficient time to implement emergency response or contingency planning measures in the event that a drinking water source becomes threatened. Figure 6 shows the general locations recommended for groundwater quality monitoring in the WHPA for Wells 1A and 2. The general locations targeted are within the model predicted 6-month and 1-year capture zones and downgradient of known or suspected soil or groundwater contamination sites. Factors associated with selecting an actual location, such as land ownership and access, have not been considered at this time. The recommended general locations are discussed below and listed in decreasing priority:

- MW 1 – Located within the 6-month capture zone downgradient of one known (Site 1) and four potential (Sites 6-9) contaminant sources.
- MW 2 – Located in the 6-month capture zone downgradient of one known (Site 2) and four suspected (Sites 3-5 and 10) contaminant sources.
- MW 3 – Located with the 1-year capture zone downgradient of several potential contaminant source sites.
- MW 4 – Located within the 1-year capture zone southwest and cross-gradient of MW-3. This location is recommended to monitor for potential contaminants associated with rural residential land use activities, including agricultural.

The monitoring wells should be completed within the Qva aquifer to depths between approximately 50 and 70 feet bgs.

Because no known or suspected contamination sites were identified within any of the WHPAs for SW Well 1A and because the well is sealed into a deep aquifer overlain by two confining layers, no monitoring wells are recommended at this time. Groundwater quality monitoring in the SW Well 1A WHPAs should be reconsidered if subsequent contaminant inventory updates identify known or suspected soil or groundwater contamination sites that have the potential to threaten this source of supply.

5.6.1 Monitoring and Data Management

Recommended monitoring at these wells should include both water quality and water level monitoring. Analytes recommended for water quality monitoring include nitrate, total coliform bacteria, VOCs, and select metals and herbicides. For MWs 1 through 3, the recommended sampling frequency should be biannually for select herbicides and quarterly for the remaining analytes. MW 4 should be sampled for all of these same analytes, but on a biannual basis. Groundwater levels are recommended to be measured at each well during each water quality sampling event. The proposed sampling schedules should be reviewed after the first complete year of monitoring based on the initial results.

Data collected from the network of monitoring wells should be maintained in a database. Laboratory water quality test results should be reviewed for quality control and assurance, compared to state drinking water quality criteria and water quality data collected at Well 1, and evaluated for declining water quality trends.

6.0 SUMMARY

Golder Associates Inc. (Golder) has prepared this report to update the City's WHPP in order to prevent contamination of groundwater used as the City's source of drinking water supply. The following WHPP updates have been made:

- An updated discussion of the hydrogeologic characteristics of the area now that a deeper supply source aquifer (TQu) has been identified.
- Revised WHPAs for Wells 1A and 2 using a numerical groundwater flow model and the planned pumping capacities.
- Newly delineated WHPAs for the planned SW Well 1A supply source using the numerical groundwater flow model and planned pumping capacity.
- Susceptibility assessment for the planned SW Well 1A source supply.
- A contaminant source inventory within the updated and newly defined WHPAs.

6.1 City Production Wells

Wells 1A and 2 are the City's sole drinking water supply sources. These two wells are screened in and obtain water from the confined Qva aquifer. Based on the findings from a deep groundwater resource exploration project in the Tahoma Terra area west of downtown, the City has constructed a new groundwater supply well (SW Well 1A). SW Well 1A is screened in and obtains water from the confined TQu aquifer. Further development of this well as a drinking water supply source is currently underway.

6.2 Wellhead Protection Area Delineations

The WHPAs for the City's current and planned supply wells were delineated using the most up-to-date version of the McAllister Groundwater Model utilized to support the City's water right applications and mitigation program. This model was adapted to delineate updated WHPAs for the City's current supply sources (Wells 1A and 2) and new WHPAs for the City's planned source (SW Well 1A). The adaptation resulted in a separate Yelm-specific tool that is referred to as the Yelm 2011 WHPA Model.

6.3 Known Potential Contaminant Sources

A total of 120 known or suspected soil and groundwater contamination sites were identified by a field survey within the WHPA boundaries and environmental database searches within a 2.5-mile radius encompassing the WHPAs. Of the 120 potential contaminant source sites identified, 23 coincide with the WHPAs delineated for Wells 1A and 2. Ten of 23 sites identified are located within the 6-month capture zone, two of which were identified as known contaminated sources (Sites 1 and 2 on Figure 5). The remaining 13 sites are within the 1-year capture zone, one of which was identified as a known contaminated source (Site 11 on Figure 5). No known or potential contaminant sites were identified in the 5- or 10-year capture zones for Wells 1A and 2. No known or suspected soil or groundwater contamination sites were identified within any of the WHPA capture zones delineated for SW Well 1A.

6.4 Management Strategy

The City currently employs the following management strategies to prevent and protect against contamination of the City's drinking water supply sources:

- Controlling future development in WHPA capture zones through land use regulations.
- Enforcement and regulation of activities within the WHPAs through the City's Municipal Codes.
- Notification to owners and operators of potential sources of contamination that are located within the City's WHPA boundaries as well as the local agencies or jurisdictions that regulate them.
- Spill prevention measures to prevent the accidental release of pollutants, and spill treatment and response actions to be taken to minimize potential damages in case a spill does occur.
- Contingency measures to implement in the event that a natural disaster or contamination event results in the temporary or permanent loss of the City's water supply source.

7.0 RECOMMENDATIONS

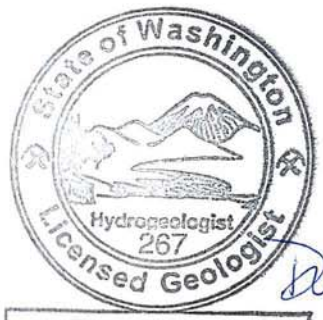
The following pollution prevention and risk reduction measures are recommended to compliment the City's current commitment to protect its groundwater sources and maintain a safe and reliable community water supply:

- Adopt new WHPAs – To continue to protect the valuable groundwater resource, the City should use the newly-defined WHPAs to enforce land use restrictions on certain high-risk activities. The City should also engage in discussions with the operators of potential non-point source contaminants, such as golf courses and farmers, to establish and apply best management practices to reduce the risk of impacting the source waters.
- Integrate WHPAs into Thurston County CAO– The WHPAs extend beyond City limits into areas under the jurisdiction of the county. The City should work with the County to ensure that these WHPAs are designated as CARAs in the CAO.
- Public Outreach/Education – Increase public awareness and ownership of the WHP program through outreach efforts focused on groundwater protection, such as brochures, utility bill inserts, press releases, booths at special events, meetings and workshops, and/or posting public signage throughout the parts of the community that are located within the WHPAs. Include WHPP information with annual drinking water quality assurance reports as a baseline level of public outreach and education.
- Groundwater Protection Monitoring Wells – We recommend installation of new monitoring wells dedicated to determine the groundwater quality from known or suspected contaminated sites and improve the understanding of the local groundwater conditions. These wells are as follows:
  - MW 1 – Located within the 6-month capture zone downgradient of one known (Site 1) and four potential (Sites 6-9) contaminant sources
  - MW 2 – Located in the 6-month capture zone downgradient of one known (Site 2) and four suspected (Sites 3-5 and 10) contaminant sources
  - MW 3 – Located with the 1-year capture zone downgradient of several potential contaminant source sites
  - MW 4 – Located within the 1-year capture zone southwest and cross-gradient of MW-3. This location is recommended to monitor for potential contaminants associated with rural residential land use activities, including agricultural.
- Water Quality Monitoring Data – Water quality data collected from the network of monitoring wells should be maintained in a database. Laboratory water quality test results should be reviewed for quality control and assurance, compared to state drinking water quality criteria and water quality data collected at Well 1, and evaluated for declining water quality trends.
- Spill Response Plan Update – The Spill Response Plan (Appendix H) should be reevaluated and updated as needed to address any site specific conditions pertaining to SW Well 1A after the facility is constructed and put into service.

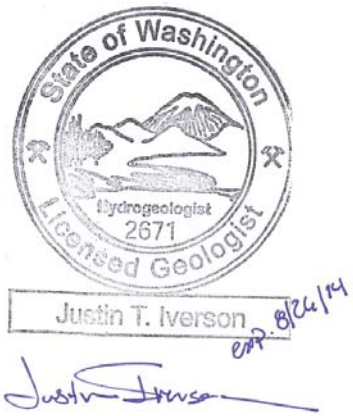
With these actions, it is our opinion that the City of Yelm will both comply with State regulations, and continue to ensure that the long-term supply of high-quality drinking water remains available to its residents.

8.0 SIGNATURE PAGE

GOLDER ASSOCIATES INC.



David Banton, LHG
Principal Hydrogeologist



Justin Iverson, LHG
Senior Hydrogeologist

DB/JI/cb

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TABLES

Table 1: City of Yelm Wells

WDOH Source No.	Alternative Name	Well Tag ID	Status/Usage	Well Diameter (in)	Well Depth (ft bgs)	Screened Interval (ft bgs)	SWL (ft bgs)	Capacity (gpm)	TRS Location	(1) Aquifer Unit
01	Well 1	AAA-943	Active/Emergency	12	63	53-63	30	275	T17N R2E S19	Qva
02	Well 2	AAA-944	Active/Permanent	12	61	50-61	30	1,700		
03	Well 3	AAA-945	Not Active/Monitoring	12	40	n/a	n/a	500	T17N R2E S20	Qvr?
04	Well 4 (3A)	AGP-800	Not Active/Emergency	12	55	24-34	16	400		
05	Well 1A	ALG-255	Active/Permanent	12	67	57-67	30	1,700	T17N R2E S19	Qva
n/a	SW Well 1A	ALM-113	New active/permanent source pending WDOH approval	12	633	369-437 487-547 611-625	103	2,100	T17N R1E S23	TQu

Notes:

(1) Qvr - Recessional Outwash; Qvt - Glacial Till; Qva - Advance Outwash; Qf - Kitsap Formation; Qc - Salmon Springs(?) Drift; Tqu - Unconsolidated and Undifferentiated Deposits; and Tb - Bedrock. Further descriptions of each unit are provided in Table 2.

WDOH - Washington State Department of Health

in - inches

ft bgs - feet below ground surface

gpm - gallons per minute

Table 2: Lithologic and Hydrologic Characteristics of Geohydrologic Units

System	Series	Geologic unit		Geohydrologic unit, in this report[1]	Typical thickness (feet)	Lithologic characteristics	Hydrologic characteristics
Quaternary	Holocene		Alluvium	Qvr Qvrm	10-40	Alluvial and deltaic sand and gravel along major water courses. Moderately to well-sorted glacial sand and gravel, including kettled end moraine	An aquifer where saturated. Groundwater is mostly unconfined. Perched conditions occur locally.
	Pleistocene	Vashon Drift	Recessional outwash and end moraine				
			Till	Qvt[2]	20-55	Unsorted sand, gravel, and boulders in a matrix of silt and clay.	Confining bed, but can yield usable amounts of water. Some thin lenses of clean sand and gravel.
			Advance outwash	Qva	10-45	Poorly to moderately well-sorted, well-rounded gravel in a matrix of sand with some sand lenses.	Ground water, mostly confined. Used extensively for public supplies near Tumwater.
		Kitsap Formation		Qf[3]	20-70	Predominantly clay and silt, with some layers of sand and gravel. Minor amounts of peat and wood.	Confining bed, but in places yields usable amounts of water.
		Salmon Springs(?) Drift (Noble and Wallace, 1966) / Deposits of "penultimate" glaciation (Lea, 1984)		Qc	15-70	Coarse sand and gravel, deeply stained with red or brown iron oxides.	Water is confined. Used extensively for industrial purposes near Tumwater.
		Unconsolidated and undifferentiated deposits		TQu	Not known	Various layers of clay, silt, sand, and gravel of both glacial and nonglacial origin.	Contains both aquifers and confining beds. Water probably confined.
Tertiary	Miocene and Eocene	Bedrock		Tb	Not known	Sedimentary rocks consisting of claystone, siltstone, sandstone, and minor beds of coal. Igneous bodies of andesite and basalt.	Poorly permeable base of unconsolidated sediments. Locally an aquifer, but generally unreliable. Water contained in fractures and joints. Well yields relatively small. Numerous abandoned wells.

[1]The identification of geohydrologic units in this report is a "best estimate" based on drillers' logs and existing surficial geology maps.
[2]Includes "late Vashon lake deposits" (Washington State Department of Ecology, 1980). May include till of "penultimate" glaciation (Lea, 1984).
[3]Includes alluvium younger than Kitsap Formation in Nisqually River delta. May include some Vashon till (where multiple tills are present). May include till of "penultimate" glaciation (Lea, 1984).

SOURCE: Drost et al. 1999

Table 3: Land Use Types

Residential	Rural Residential	Commercial and Industrial	Institutional and Open Space
All other residential not elsewhere coded	Agriculture classified under current use chapter 84.34 RCW	Arterial commercial	Educational services
High density residential 14	Long term agriculture	Automobile parking	Designated forest land under chapter 84.33 RCW
Household, 2-4 units	Rural	Central business district	Institutional
Household, multiunits (5 or more)	Rural 1/10	Commercial	Institutional district
Household, single family units	Rural residential 1/5	Contract construction services	Military reservation
Low density residential	Rural residential resource 1/5	Governmental services	Open space
Master planned community	Urban reserve 1/5	Heavy commercial	Open space land classified under chapter 84.34 RCW
Moderate density residential		Industrial	Open space park
Residential		Large lot commercial	Parks
Residential lamird 1/1		Light industrial	Timberland classified under chapter 84.34 RCW
Residential lamird 1/2		Mining activities and related services	Undeveloped land
Residential lamird 2/1		Miscellaneous services	
		Neighborhood commercial	
		Other retail trade	
		Professional services	
		Retail trade - automotive, marine craft, aircraft, and accessories	
		Retail trade - eating and drinking	
		Retail trade - general merchandise	
		Utilities	

Table 4: Land Use Risk Concerns

Land Use Category	Nitrates	Pesticides and Fertilizers	Petroleum Hydrocarbons	Metals	Corrosive Materials
Residential and Rural Residential	Yes	Yes	Yes	Limited	No
Commercial/Industrial	No	Yes	Yes	Yes	Yes
Institutional/Open Space	Yes	Yes	Limited	Limited	No

Table 5: Level I Sub-Prioritization – Potential Contaminant Source Site Location Relative to Wellhead Protection Area

Sub-Priority Level	Description
1	WHPA Zone 1 (6 month time of travel capture zone)
2	WHPA Zone 2 (1 year time of travel capture zone)
3	WHPA Zone 3 (5 year time of travel capture zone)
4	WHPA Zone 4 (10 year time of travel capture zone)
5	Outside the WHPAs - Hydraulically Upgradient of the WHPA(1)
6	Outside the WHPAs - Hydraulically Downgradient of the WHPA(1)

Note: (1) Determined based on the Potentiometric Surface Map Presented in Appendix C.

Table 6: Level II Sub-Prioritization – Type of Contamination

Sub-Priority Level	Known or Suspected Contamination	Type of Contaminated Site	Code
1	Known	Confirmed and Suspected Contaminated Sites State Clean-up Sites	CSCSL NFA SCS
2	Known	Leaking Underground Storage Tanks	LUST
3	Known	Washington Independent Clean-up Report Emergency Response Notification System Hazardous Materials Incident Report System Voluntary Clean-up Site DOE Enforcement Action Final	ICR ERNS HMRIS VCP ENF F
4	Potential	Resource Conservation Recovery Act Sites Toxic Chemical Release System Facility Index System Emergency/Hazard Chemical RPT Tier 2 Recycling Facility Hazardous Waste Generators, Managers, or Planners Hazardous Waste Manifest Information	RCRA TRIS FINDS EHCR2 RECYCLING HAZ WASTE MANIFEST
5	Potential	Operational Underground Storage Tanks Financial Assurance for a UST	UST FA
6	Potential	Active or Inactive Facilities that fail to meet RCRA Solid Waste Facility or Landfill site	SPILLS SFW/LF
7	Potential	FIDRA/TSCAL Tracking System (Pesticide Use)	FTTS
8	Potential	Clandestine Drug Labs	CDL
9	Potential	National Pollution Discharge Permit	NPDES
10	Potential	Underground Injection Wells Facilities and Sites of Interest to WA DOE	UIC All SITES

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
1	EDR 24	YELM SHELL	706 YELM AVE E, YELM, WA 98597	UST, FINANCIAL ASSURANCE, RCRA-NONGEN, VCP, ICR, FINDS, MANIFEST, LUST FACILITY, CSCSL NFA	1	1	1,814
2	DOE 19	YELM RITE AIDE	VANCIL RD & SR507 , YELM, WA 98597	VCP	1	3	2,849
3	EDR 13	RITE AID 5286 YELM AVE	909 YELM AVE E, YELM, WA 98597	RCRA, ALL SITES, FINDS, MANIFEST, HAZARDOUS WASTE GENERATOR, HAZARDOUS WASTE PLANNER	1	5	2,508
4	EDR 11	JIFFY LUBE STORE 2812	1002 E YELM AVE, YELM, WA 98597	ALL SITES, FINDS, EMERGENCY/HAZ CHEM RPT TIER2	1	5	2,895
5	WSS 16	SAFEWAY GAS STATION	1109 YELM AVE E, YELM, WA 98597	UST	1	5	3,180
6	WSS 20	WALT'S TIRE SERVICE	509B YELM AVE E, YELM, WA 98597	ALL SITES	1	10	1,225
7	WSS 21	NAPA AUTO PARTS	509A YELM AVE E, YELM, WA 98597	ALL SITES	1	10	1,225
8	EDR 5	CHURCH OF JESUS CHRIST OF LDS	10423 CLARK ROAD SE, YELM, WA 98597	UIC	1	10	1,726
9	WSS 23	EAGLE CAR WASH	403 YELM AVE, YELM, WA 98597	ALL SITES	1	10	2,023
10	WSS 22	LES SCHWAB TIRE	811 YELM AVE E, YELM, WA 98597	ALL SITES	1	10	2,734
11	EDR 7	16507 STATE ROUTE 507 SE	16507 STATE ROUTE 507 SE, YELM, YELM, WA	HMRIS, ERNS	2	3	4,521
12	EDR 17	RAINIER CHEVRON	16518 YELM AVE SE, YELM, WA 98597	FINDS, UST	2	5	4,472
13	EDR 9	HASSAN CORPORATION	16507 SR 507, YELM, WA 98597	FINANCIAL ASSURANCE, RCRA, UST, HAZARDOUS WASTE GENERATOR	2	5	4,545
14	DOE 24	YCOM NETWORKS CONST YARD	10812 BALD HILL RD SE , YELM, WA 98597	EMERGENCY/HAZ CHEM RPT TIER2, ALL SITES, FINDS	2	5	5,826
15	EDR 4	PUGET SOUND ENERGY- PSE	10730 MORRIS ROAD, YELM, WA	SPILLS	2	7	4,943
16	WSS 19	O'REILLY'S AUTO PARTS	902 ALGIERS DR NE, YELM, WA 98597	ALL SITES	2	10	2,433
17	WSS 18	YELM FAMILY DENTISTRY	106 PLAZA DRIVE, YELM, WA 98597	ALL SITES	2	10	3,716
18	WSS 13	QT SPA NAILS	B102 CREEK ST, YELM, WA 98597	ALL SITES	2	10	4,208

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
19	WSS 14	DESERT TANING	B104 CREEK ST, YELM, WA 98597	ALL SITES	2	10	4,208
20	WSS 17	AUTO ZONE	1210 YELM AVE E, YELM, WA 98597	ALL SITES	2	10	4,208
21	WSS 12	J & I POWER EQUIPMENT	10615 BALD HILL RD, YELM, WA 98597	ALL SITES	2	10	4,762
22	WSS 15	YELM AUTO MALL	16150106TH AVE, YELM, WA 98597	ALL SITES	2	10	4,774
23	WSS 11	DEL'S FARM SUPPLY	10616 BALD HILL RD, YELM, WA 98597	ALL SITES	2	10	4,925
24	EDR 70	LIVINGSTON BOATS INC	406 RAILROAD ST, YELM, WA 98597	RCRA, FTTS, FINDS, MANIFEST, TRIS, HAZARDOUS WASTE GENERATOR, CSCSL NFA	5	1	1,737
25	EDR 137	BILLS TOWING	801 W YELM AVE, YELM, WA	ALL SITES, CSCSL NFA, FINDS, STATE CLEAN-UP SITE	5	1	3,697
26	EDR 151	WOOD FABRICATORS	1001 NE RHOTON RD, YELM, WA 98597	RCRA-NONGEN, ICR, ALL SITES, CSCL NFA, FINDS, LUST FACILITY, HAZARDOUS WASTE GENERATOR	5	1	4,425
27	EDR 191	FLYING M	35618 HWY 507 S, MCKENNA, WA 98558	UST, LUST FACILITY	5	2	12,312
28	DOE 20	NISQUALLY PINES PROPERTY	8903 PEPPERIDGE LN SE , YELM, WA 98597	VCP	5	3	7,848
29	EDR 182	13431 SOLBERG RD.	13431 SOLBERG RD., YELM, WA	ERNS	5	3	17,407
30	DOE 46	US DEA NEAT RD YELM	20104 NEAT RD, YELM, WA 98597	HAZARDOUS WASTE GENERATOR	5	5	340
31	DOE 13	YCOM NETWORKS PLANT OPS	105 2ND ST, YELM, WA 98597	EMERGENCY/HAZ CHEM RPT TIER2, HAZWASTE	5	5	668
32	EDR 48	MICHAEL J MCCASLIN	107 S 1ST ST, YELM, WA 98597	UST, ALL SITES, FINDS	5	5	894
33	EDR 51	GORDERS AUTO REBUILD	103 1ST ST N, YELM, WA 98597	RCRA, FINDS, UST, ALL SITES, HAZARDOUS WASTE GENERATOR	5	5	919
34	EDR 55	YELM EXTENSION SCHOOL	107 FIRST ST NORTH, YELM, WA 98597	FINDS	5	5	925
35	EDR 40	FRONTIER VILLAGE PROF DRYCLEAN	404 1ST ST SE & MOSMAN, YELM, WA 98597	RCRA, ALL SITES, FINDS, HAZARDOUS WASTE GENERATOR, INACTIVE DRYCLEANER	5	5	1,011

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
36	EDR 37	MOUNT RAINIER CLINIC INC	503 1ST ST S, YELM, WA 98597	ALL SITES, FINDS, EMERGENCY/HAZ CHEM RPT TIER2	5	5	1,057
37	EDR 59	YELM EXTENSION SCHOOL	203 N FIRST ST, YELM, WA 98597	FINDS	5	5	1,111
38	EDR 67	HARTS LAKE ASSOCIATES	402 NW RAILROAD, YELM, WA 98597	UST, ALL SITES, FINDS	5	5	1,732
39	EDR 6	MILL POND INTERMEDIATE SCHOOL	909 MILL RD SE, YELM, WA 98597	FINDS	5	5	1,874
40	EDR 60	YELM MIDDLE SCHOOL	402 YELM AVE. W, YELM, WA 98597	FINDS	5	5	1,895
41	EDR 64	LACKAMAS ELEMENTARY	16240 BALD HILL RD, YELM, WA 98597	FINDS	5	5	1,904
42	EDR 91	SAMANTHA RIDGE	502 CRYSTAL SPRINGS ST, YELM, WA 98597	ALL SITES, CONSTRUCTION SW GP	5	5	2,410
43	DOE 32	HERTERS INC	MAIN ST , YELM, WA 98597	RCRA, HAZARDOUS WASTE GENERATOR	5	5	2,463
44	EDR 92	LASCO BATHWARE	801 NORTHERN PACIFIC, YELM, WA 98597	RCRA, ALL SITES, TRIS, FINDS, MANIFEST, AIRS, FINANCIAL ASSURANCE, UST	5	5	2,703
45	EDR 94	CENEX HARVEST STATES YELM	509 RHOTON RD, YELM, WA 98597	ALL SITES, FINDS, EMERGENCY/HAZ CHEM RPT TIER2	5	5	2,742
46	EDR 98	PENSKE TRUCK LEASING CO LP	801 NORTHERN PACIFIC RD BLDG 2, YELM, WA 98597	RCRA, ALL SITES, FINDS, MANIFEST, HAZARDOUS WASTE GENERATOR	5	5	2,786
47	EDR 112	NORTHWEST DELI MART 46	608 YELM HWY, YELM, WA 98597	FINDS, UST, EMERGENCY/HAZ CHEM RPT TIER2	5	5	2,899
48	EDR 125	CENTRAL REDDIMIX INC	705 RHOTON RD, YELM, WA 98597	FINDS	5	5	3,374
49	EDR 126	GLACIER NORTHWEST	705 NORTHWEST RHOTON ROAD, YELM, WA	ALL SITES, SPILLS, NPDES, UST, FINDS, TRIS	5	5	3,374
50	FRS 41	YELM COMMUNITY SCHOOLS TRANS DEPT	401 COATS ST NW, YELM, WA 98597	RCRA, UST, HAZARDOUS WASTE GENERATOR	5	5	3,663
51	EDR 81	JOHNS MEADOWS	16440 MIDDLE RD SE, YELM, WA	ALL SITES, CONSTRUCTION SW GP	5	5	3,734
52	EDR 80	FORT STEVENS ELEMENTARY	16525 100TH WAY SE, YELM, WA 98597	FINDS	5	5	4,137

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
53	EDR 159	HOFFMAN PLAT	9405 CULLENS ROAD, YELM, WA 98597	FINDS, ALL SITES, CONSTRUCTION SW GP	5	5	4,572
54	EDR 164	CULLENS ROAD PLAT	9329 CULLENS RD, YELM, WA 98597	ALL SITES, NPDES, FINDS, MUNICIPAL IP	5	5	4,842
55	EDR 148	T AUTOMOTIVE SERVICE	16713 CANAL RD SE, YELM, WA 98597	RCRA-NONGEN, ALL SITES, FINDS, HAZARDOUS WASTE GENERATOR	5	5	5,456
56	EDR 170	YELM WWTP AND WATER RECLAMATION FACILITY	931 NORTHERN PACIFIC ROAD, YELM, WA 98597	ALL SITES, FINDS	5	5	5,706
57	EDR 1	CITY OF YELM	105 W YELM AVE, YELM, WA 98597	ALL SITES, NON ENFORCEMENT FINAL	5	5	5,828
58	EDR 3	YELM PRAIRIE ELEMENTARY	16535 110TH AVE. SE, YELM, WA 98597	FINDS	5	5	6,011
59	EDR 166	YELM DRUG CHEMICAL DU	NW COR OF FLUME RD & BRIDGE RD, YELM, WA 98597	RCRA-NONGEN, ALL SITES, FINDS, HAZARDOUS WASTE GENERATOR	5	5	6,974
60	DOE 26	WAL MART SUPERCENTER 3705	17100 SR 507 SE , YELM, WA 98597	HAZ WASTE MANAGEMENT ACTIVITY, HAZARDOUS WASTE GENERATOR, RCRA, FINDS, ALL SITES, SPILLS, MANIFEST	5	5	7,721
61	EDR 145	YELM MAINTENANCE SITE	17526 HWY 507 SE, YELM, WA 98597	UST, ALL SITES, FINDS	5	5	9,696
62	EDR 122	BNH AUTO WRECKING	17505 110TH AVE SE, YELM, WA 98597	RCRA, FINDS, ALL SITES, HAZARDOUS WASTE GENERATOR	5	5	10,291
63	DOE 17	WE & B LIMITED	15708 123RD AVE , YELM, WA 98597	SWF/LF, RCRA, FINDS, ALL SITES, SPILLS, MANIFEST, RECYCLING	5	5	10,466
64	EDR 132	VAIL RD DRUG LAB	11515 VAIL RD SE, YELM, WA 98597	RCRA-NONGEN, ALL SITES, FINDS, HAZARDOUS WASTE GENERATOR	5	5	11,770
65	EDR 183	NISQUALLY VALLEY CARE CENTER	9414 357TH ST S, MCKENNA, WA 98558	FINDS, ALL SITES, NPDES, MUNICIPAL IP	5	5	11,790
66	EDR 139	FOUR CORNER GROCERY	11500 BALD HILLS RD, YELM, WA 98597	FINANCIAL ASSURANCE, UST, ALL SITES, FINDS, ENFORCEMENT FINAL	5	5	11,891
67	EDR 199	WEST AIR AVIATION	18324 COOK RD 6, YELM, WA 98597	RCRA, ALL SITES, FINDS	5	5	14,719

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
68	DOE 52	CENTURYTEL ROYAL CITY	101 CATALPA AVE NE, ROYAL CITY, WA 99357	EMERGENCY/HAZ CHEM RPT TIER2	5	5	15,526
69	FRS 32	WA DOT YELM	SR 507 MP 29.6 NORTHSIDE, YELM, WA 98597	HAZWASTE, EMERGENCY/HAZ CHEM RPT TIER2	5	5	17,036
70	FRS 8	DESCHUTES DRUG LAB	VAIL RD & DESCHUTES T16N R2E S, YELM, WA 98597	RCRA	5	5	17,530
71	FRS 44	YELM GARAGE	112 SE YELM AVE, YELM, WA 98597	UST	5	6	882
72	EDR 57	NISQUALLY VALLEY GOLF COURSE	MOSSMAN & EDWARDS, YELM, WA 98597	UST, ALL SITES	5	6	1,524
73	EDR 65	SAFEWAY FUEL CENTER YELM AVE	1109 A YELM AVE E, YELM, WA 98597	UST, ALL SITES	5	6	1,947
74	EDR 114	PARKS PLACE	608 W YELM AVE, YELM, WA 98597	FINANCIAL ASSURANCE	5	6	2,899
75	DOE 37	CENTRALIA CITY LIGHT YELM HYDRO	14024 YELM HWY SE , YELM, WA 98597	UST, ENFORCEMENT FINAL	5	6	3,622
76	DOE 41	VALLEY TRADING POST VALLEY GROCERY	15547 VAIL RD SE , YELM, WA 98597	UST	5	6	11,624
77	DOE 58	WALTS PLACE STORE	POST OFFICE HWY 500 FT S, MCKENNA, WA	UST	5	6	12,418
78	DOE 27	DYLANS CORNER	15201 VAIL RD , YELM, WA 98597	UST	5	6	13,143
79	EDR 118	CREAMERY TRANSPORT CO INC	17025 HANNUS RD SE, YELM, WA 98597	UST, ALL SITES	5	6	13,641
80	EDR 44	NA	222 YELM AVENUE EAST, YELM, WA	SPILLS	5	7	632
81	EDR 36	NA	118 MOSSMAN AVENUE SOUTHEAST, YELM, WA	SPILLS	5	7	872
82	EDR 61	AMTEK	406 RAILROAD STREET, YELM, WA	SPILLS	5	7	1,724
83	EDR 90	NA	16145 RAILWAY RD, YELM, WA	SPILLS	5	7	2,640
84	EDR 109	CHIROPRACTIC OFFICE	604 YELM HWY SE, SUITE A, YELM, WA	SPILLS	5	7	2,881

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
85	EDR 116	WESTSTAR INC	608 YELM AVENUE, YELM, WA	ALL SITES, SPILLS	5	7	2,899
86	EDR 46	PUGET SOUND ENERGY	15235 105TH AVENUE SOUTHEAST, YELM,WA	SPILLS	5	7	3,608
87	EDR 2	UNKNOWN	10826 VANCIL ROAD, YELM, WA	SPILLS	5	7	3,840
88	EDR 143	NA	909 YELM AVENUE WEST, YELM, WA	SPILLS	5	7	4,215
89	EDR 56	UNKNOWN	10405 GROVE ROAD SE, YELM, YELM, WA	SPILLS	5	7	5,435
90	EDR 147	NA	16747 CANAL ROAD SE, YELM, WA	SPILLS	5	7	5,478
91	EDR 178	PREVIOUS OWNER	119 VIEW DRIVE NORTHWEST, YELM, YELM, WA	SPILLS	5	7	5,815
92	EDR 47	NA	10535 GROVE ROAD, YELM, WA	SPILLS	5	7	6,014
93	EDR 174	NA	9543 BRIDGE ROAD SOUTHEAST, YELM, WA	SPILLS, CDL	5	7	7,332
94	EDR 169	GERBER & SONS	9801 BRIDGE RD SE, YELM, WA	SPILLS	5	7	7,706
95	EDR 188	RESIDENCE	9132 BRIDGE RD, YELM, WA	SPILLS	5	7	7,808
96	EDR 195	NA	9110 PEPPERIDGE LANE SOUTHEAST, YELM, WA	SPILLS, CDL	5	7	7,810
97	EDR 89	UNKNOWN	11610 HOBIE STREET SOUTHEAST, YELM, WA	SPILLS	5	7	8,221
98	EDR 87	NA	17246 110 TH AVENUE SOUTH EAST, YELM, WA	SPILLS	5	7	9,329
99	EDR 20	UNKNOWN	15011 119TH WAY SE YELM., YELM, WA	SPILLS	5	7	9,721
100	EDR 162	NA	HWY 507/ VAIL RD SE, YELM, WA	SPILLS	5	7	10,792

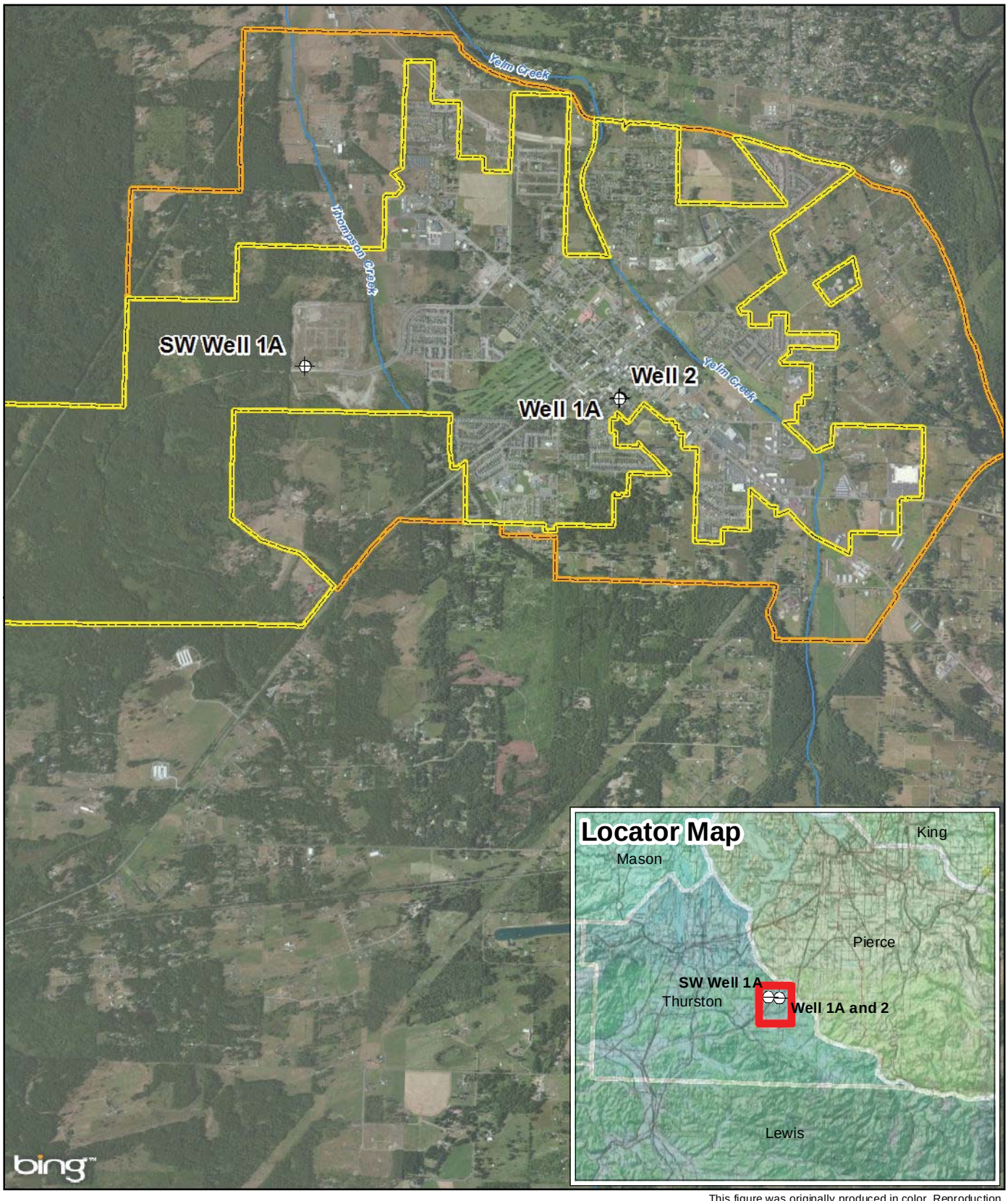
Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
101	EDR 19	NA	15836 123 AVENUE, YELM, WA	SPILLS	5	7	11,066
102	EDR 158	NA	110TH AND VAIL ROAD SOUTHEAST, YELM, WA	SPILLS	5	7	11,428
103	EDR 39	NA	15218 123RD AVENUE SOUTHEAST, YELM, WA	SPILLS	5	7	11,504
104	EDR 124	NA	11647 VAIL ROAD SOUTHEAST, YELM, WA	SPILLS	5	7	12,113
105	EDR 45	PUGET SOUND ENERGY	12520 MORRIS ROAD SE, YELM, WA	SPILLS	5	7	12,304
106	EDR 190	UNKNOWN	35807 94TH AVENUE SOUTH, MCKENNA, WA.	SPILLS	5	7	12,558
107	EDR 177	NA	11234 AERO LANE SE, YELM, WA	SPILLS	5	7	13,182
108	EDR 138	NA	14945 129TH LANE SE, YELM, WA	SPILLS	5	7	14,012
109	EDR 196	NA	12635 WAGON WHEEL ROAD SOUTHEAST, YELM, WA	SPILLS	5	7	14,140
110	EDR 197	NA	13103 ZELLER ROAD SE, RAINIER, WA	SPILLS	5	7	16,150
111	EDR 62	YELM SD 2	404 YELM AVE W, YELM, WA 98597	FTTS	5	8	1,901
112	EDR 187	15913 SE 90TH AVE	15913 SE 90TH AVE, ROCHESTER, WA	SPILLS, CDL	5	9	6,327
113	EDR 97	NA	11822 HOBBY ST SE, YELM, WA 98597	CDL	5	9	9,292
114	EDR 161	NA	12220 HILLCREST, YELM, WA 0	CDL	5	9	11,346
115	EDR 88	TODAY'S DENTAL	502 WEST YELM AVENUE, YELM, WA 98597	UIC	5	10	2,446
116	EDR 117	TAHOMA TERRA INFILTRATION GALLERIES	14848 LONGMIRE ST SE, YELM, WA 98579	UIC	5	10	3,063

Table 7: Contaminant Source Inventory and Risk Priority Ranking

Rank #	Ref #	Name	Address	List Source Type	Decision Level		
					I	II	III (feet)
117	EDR 111	YELM AREA RELIABILITY	16302 RAILWAY RD SE, YELM, WA 98597	ALL SITES, NPDES	5	10	3,461
118	EDR 173	YELM HIGH SCHOOL 12	1315 YELM AVE. W, YELM, WA 98597	FINDS	6	5	4,900
119	EDR 179	YELM COMMUNITY SCHOOLS	14901 YELM HWY SE, YELM, WA 98597	RCRA, ALL SITES, FINDS, HAZARDOUS WASTE GENERATOR	6	5	4,910
120	EDR 172	NA	14504-C SE BERRY VALLEY RD, YELM, WA	CDL	6	9	2,579

FIGURES



LEGEND

- Well
- Yelm City Limits
- Yelm Urban Growth Area
- Creek

0 4,000

Scale in Feet

Map Projection:
NAD83 State Plane WA
South FIPS 4602 Feet
Source:
Microsoft (Imagery), Washington DOE (Counties),
City of Yelm (City Limits, Urban Growth Area), NHD (Creek),
USGS (Topo map), Golder Associates, Inc.(Wells)

N

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

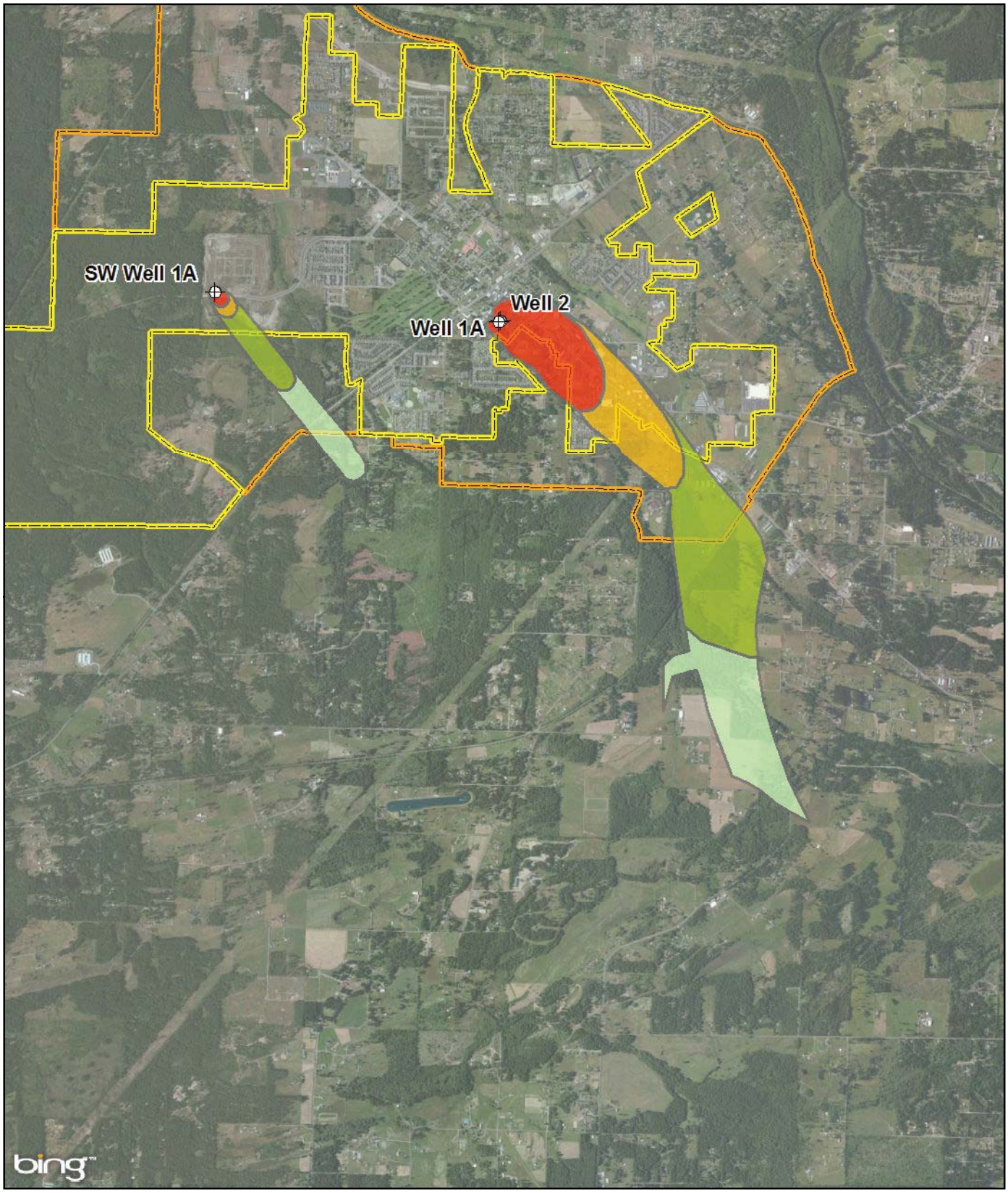
FIGURE **1**

WELL LOCATION

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F01_Well_Locations.mxd

Golder Associates



LEGEND

- Well
- Yelm City Limits
- Yelm Urban Growth Area

Wellhead Capture Zone

- 6 month
- 1 year
- 5 year
- 10 year

0 4,500

Scale in Feet

Map Projection:
NAD83 State Plane WA
South FIPS 4602 Feet

Source:
Microsoft (Imagery), City of Yelm (City Limits, Urban Growth Area), Golder Associates, Inc.(Wells, Wellhead Capture Zone)

N

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

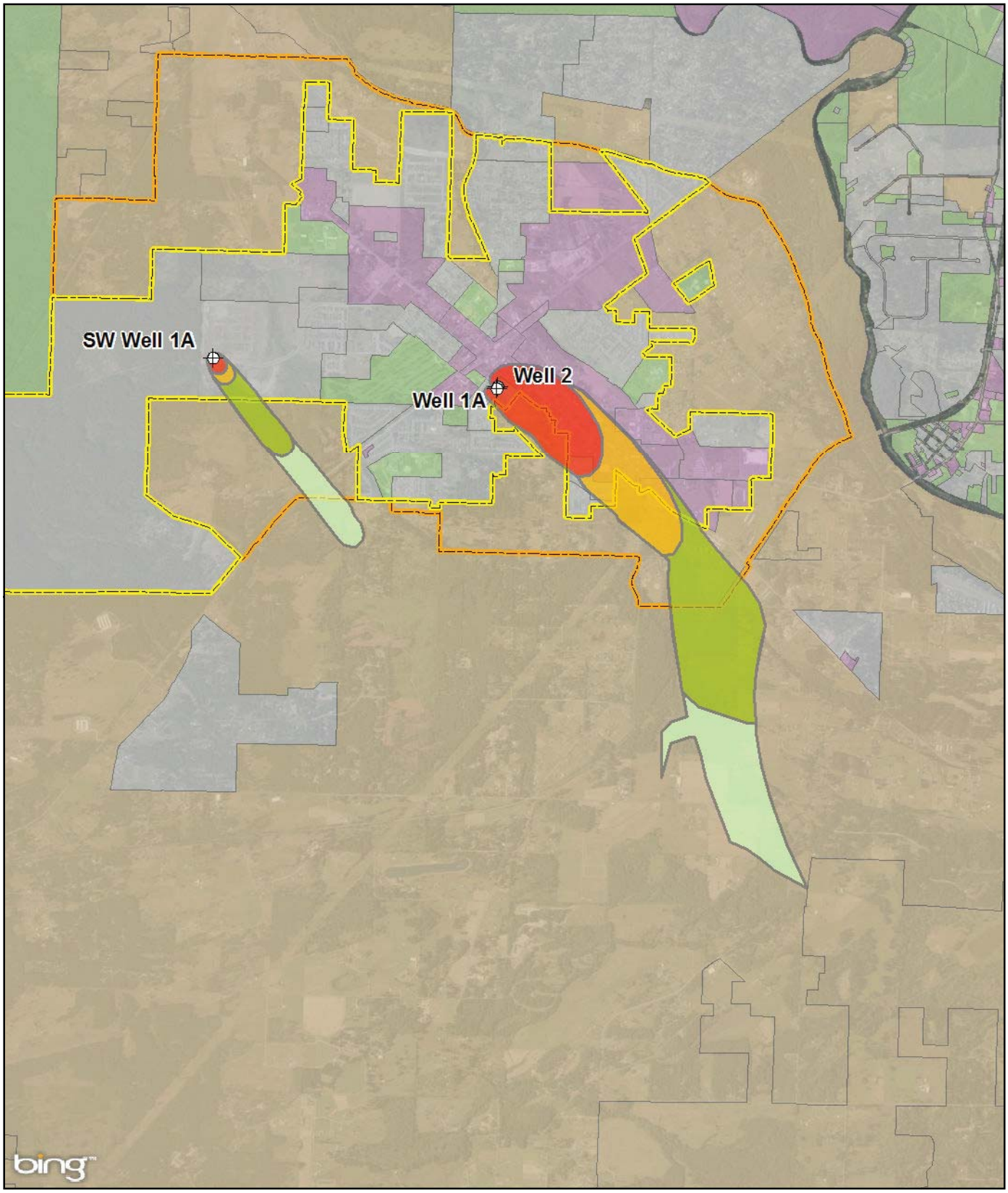
FIGURE **2**

WELLHEAD PROTECTION AREAS

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F02_Wellhead_Protection_Areas.mxd

Golder Associates



LEGEND

- Well
- Yelm City Limits
- Yelm Urban Growth Area

Wellhead Capture Zone

- 6 month
- 1 year
- 5 year
- 10 year

Land Use

- Commercial/ Industrial
- Institutional/ Open Space
- Residential
- Rural Residential

0 4,500

Scale in Feet

Map Projection:
NAD83 State Plane WA South
FIPS 4602 Feet

Source:
Microsoft (Imagery), City of Yelm (City Limits, Urban Growth Area), Thurston County and WA DOE (Land Use), Golder Associates, Inc.(Wells, Wellhead Capture Zone)

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

N

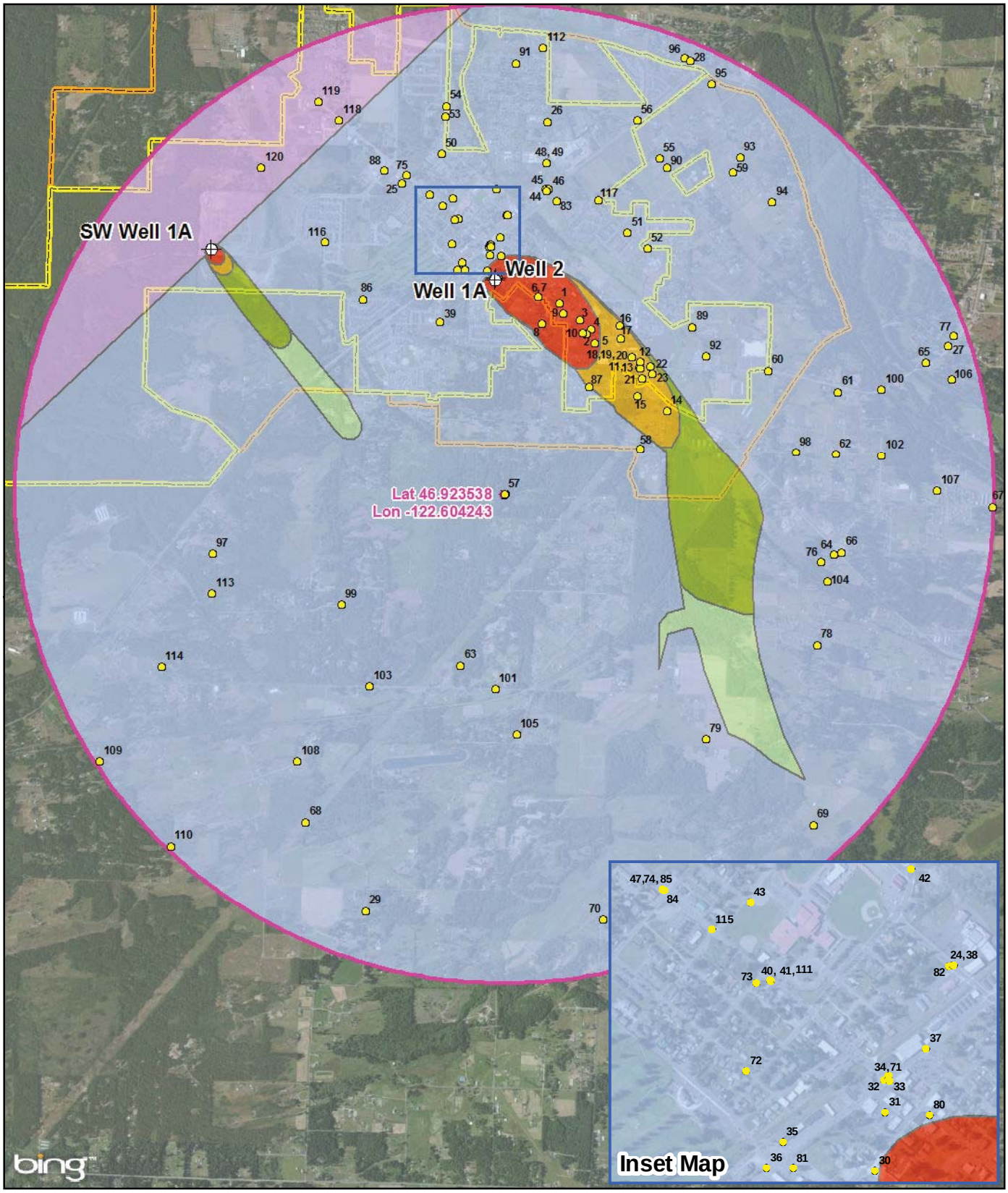
FIGURE **3**

LAND USE

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F03_Zoning.mxd

Golder Associates



LEGEND

- Well
- Yelm City Limits
- Yelm Urban Growth Area
- 2.5 Mile Radius Vertex
- 2.5 Mile Radius Boundary
- Facilities Rank #

(See Table 7)

Decision Level I Areas

- 1 (6 month)
- 2 (1 year)
- 3 (5 year)
- 4 (10 year)
- 5 Upgradient
- Downgradient

0 4,500

Scale in Feet

Map Projection:
NAD83 State Plane WA South FIPS 4602 Feet
Source:
Microsoft (Imagery), City of Yelm (City Limits, Urban Growth Area), Golder Associates, Inc.(Wells, Decision Level 1 Areas, 2.5 mile Boundary and Center)

N

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

FIGURE **4**

DECISION LEVEL I HAZARD AREAS AND FACILITIES

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F04_Decision_Level_1 w Haz Rank.mxd

Golder Associates

LEGEND

Well

Yelm City Limits

Yelm Urban Growth Area

Decision Level 1 Areas

1 (6 month)

2 (1 year)

3 (5 year)

4 (10 year)

5 Upgradient

Decision Level I and II Ratings Hazard Rank #

1, 1 | 2, 3

1, 3 | 2, 5

1, 5 | 2, 7

1, 10 | 2, 10

(See Table 7)

0 1,680

Scale in Feet

Map Projection:
NAD83 State Plane WA South FIPS 4602 Feet
Source:
Microsoft (Imagery), City of Yelm (City Limits, Urban Growth Area), Golder Associates, Inc.(Wells, Decision Level 1 Areas, Facilities)

N

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

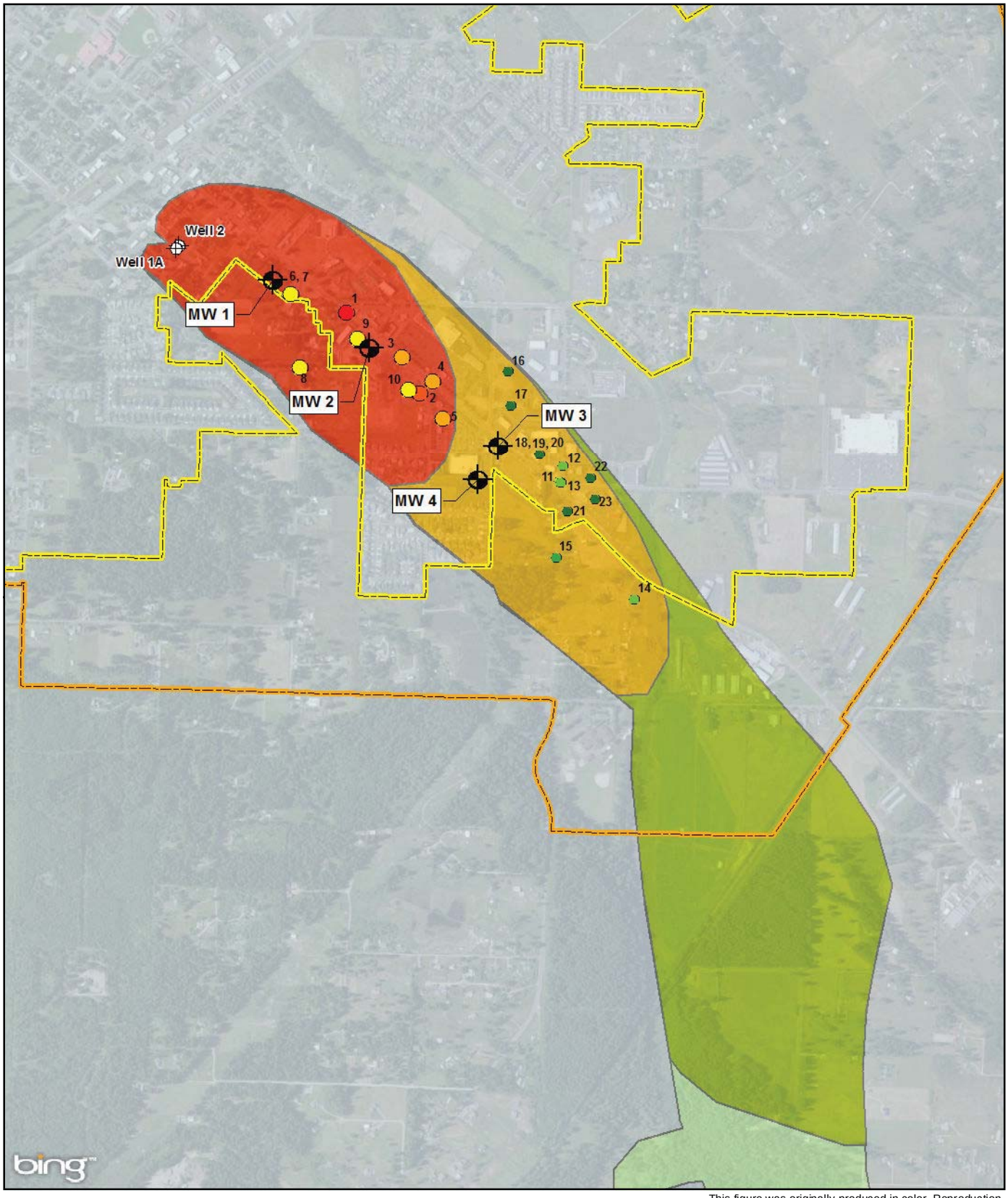
FIGURE **5**

DECISION LEVEL I (PRIORITIZATION 1 AND 2) WITH DECISION LEVEL II SUB-PRIORITIZATION

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F05_Decision_Level_1_Haz1_and2.mxd

Golder Associates



LEGEND

- Well
- Recommended Monitoring Well Locations
- Yelm City Limits
- Yelm Urban Growth Area

Decision Level 1 Areas

- 1 (6 month)
- 2 (1 year)
- 3 (5 year)
- 4 (10 year)
- 5 Upgradient

Decision Level I and II Ratings Hazard Rank #

- 1, 1
- 1, 3
- 1, 5
- 1, 10
- 2, 3
- 2, 5
- 2, 7
- 2, 10

(See Table 7)

0 1,680

Scale in Feet

Map Projection:
NAD83 State Plane WA South FIPS 4602 Feet
Source:
Microsoft (Imagery), City of Yelm (City Limits, Urban Growth Area), Golder Associates, Inc.(Wells, Decision Level 1 Areas, Facilities)

N

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

FIGURE **6**

RECOMMENDED MONITORING WELL LOCATIONS

YELM WELL HEAD PROTECTION PLAN

Path: S:\Projects\2011\2011 Water Group Projects\113-99719 Yelm WHPP\Task 4 - Wellhead Protection Plan\Figures and Tables\GIS\mxds\11399719F06_RecommendedMonitoringWells.mxd

Golder Associates

APPENDIX A
CITY PRODUCTION WELLS
WELL REPORTS AND BOREHOLE LOGS

Well 1A

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

- [x] Construction
- [ ] Decommission *ORIGINAL INSTALLATION Notice of Intent Number* 178813

PROPOSED USE: [x] Domestic [ ] Industrial [ ] Municipal [ ] DeWater [ ] Irrigation [ ] Test Well [ ] Other

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

[x] New well [ ] Reconditioned [ ] Deepened — *Method:* [ ] Dug [ ] Bored [ ] Driven [ ] Cable [x] Rotary [ ] Jetted

DIMENSIONS: Diameter of well 12 inches, drilled 69 ft.
Depth of completed well 67 ft.

CONSTRUCTION DETAILS

Casing Installed: [x] Welded 12" Diam. from +2 ft. to 59 ft.
[ ] Liner installed " Diam. from ft. to ft.
[ ] Threaded " Diam. from ft. to ft.

Perforations: [ ] Yes [x] No
Type of perforator used
SIZE of perfs in. by in. and no. of perfs from ft. to ft.

Screens: [x] Yes [ ] No [x] K-Pac Location 55
Manufacturer's Name JOHNSON
Type SLOTTED Model No.
Diam. 9" Slot size .050 from 57 ft. to 67 ft.
Diam. Slot size from ft. to ft.

Gravel/Filter packed: [ ] Yes [x] No [ ] Size of gravel/sand
Materials placed from ft. to ft.

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

PUMP: Manufacturer's Name
Type: H.P.

WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 29 ft. below top of well Date 4/22/05
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? [ ] Yes [x] No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
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 500 gal./min. with stem set at 50 ft. for 4 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? [ ] Yes [x] No

CURRENT
Notice of Intent No. W186586

Unique Ecology Well ID Tag No. ALG255
Water Right Permit No. 4630 /Certificate #3561
Property Owner Name CITY OF YELM
Well Street Address 204 2nd STREET SE
City YELM County THURSTON
Location SW 1/4-1/4 SW 1/4 Sec 19 Twn 17N R 2E EWM or WWM [x] circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg Lat Min/Sec Long Deg Long Min/Sec
Tax Parcel No. 64420500100

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation. Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
BROWN SANDY LOAM, COBBLES, LOOSE,DRY	0	2
BROWN MEDIUM SANDY GRAVEL, TIGHT,	2	
DRY, BOULDERS		32
BROWN MEDIUM TO COARSE SANDY	32	
GRAVEL WITH BOULDERS, LOOSE, WET		46
BROWN MEDIUM SANDY GRAVEL, TIGHT,	46	
BOULDERS, DRY		54
BROWN MEDIUM TO COARSE SANDY	54	
GRAVEL WITH COBBLES, LOOSE, WATER		67
BROWN MEDIUM SANDY GRAVEL TO	67	
BOULDERS, TIGHT, WET		69

RECEIVED
JUN 01 2005
DEPARTMENT OF ECOLOGY

Start Date 4/18/05 Completed Date 4/22/05

WELL CONSTRUCTION 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.

[ ] Driller [ ] Engineer [ ] Trainee Name (Print) ROGERAY PHYTHIAN
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2053

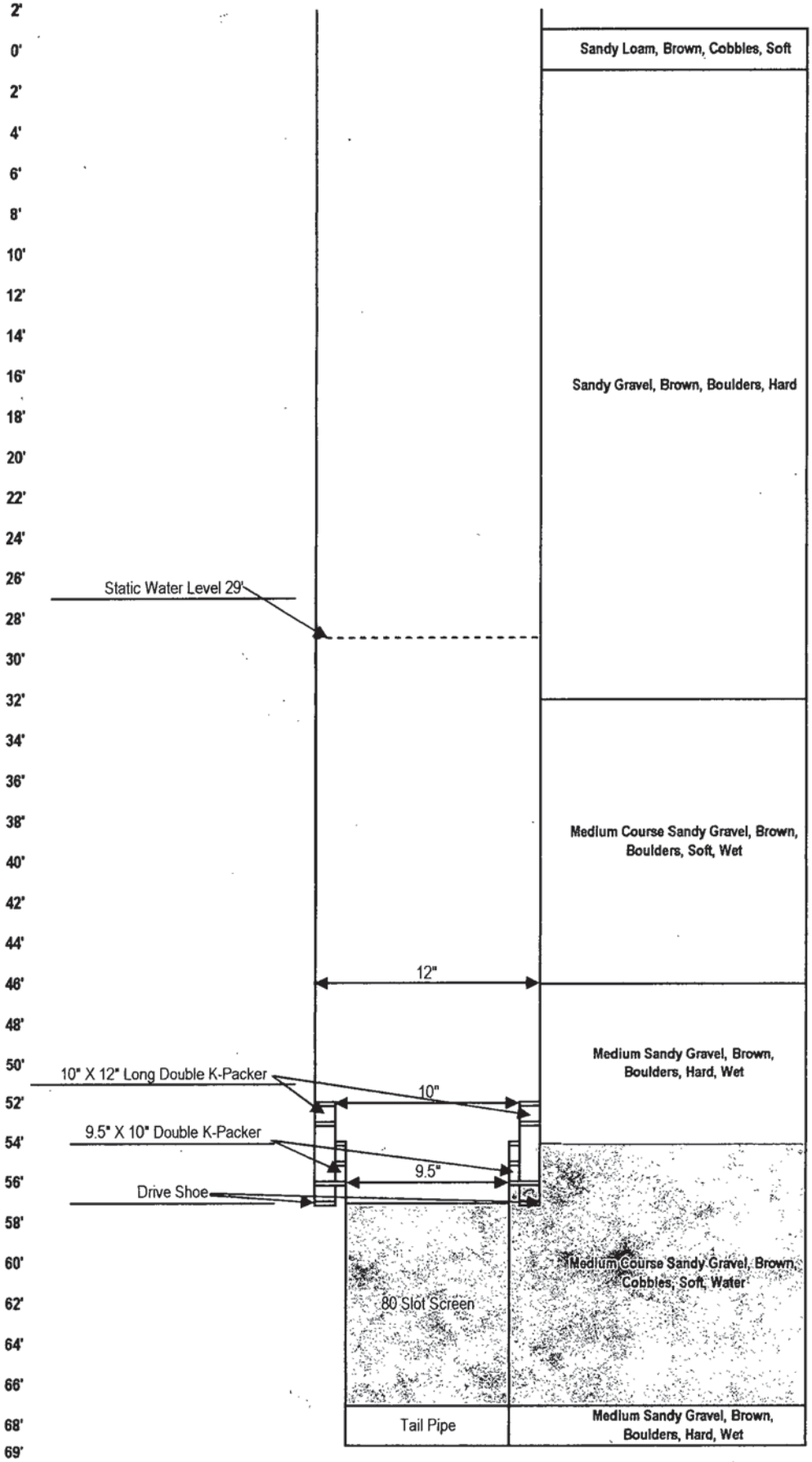
If TRAINEE,
Driller's Licensed No.
Driller's Signature

Drilling Company ARCADIA DRILLING INC.
Address PO BOX 1790
City, State, Zip SHELTON WA 98584
Contractor's Registration No. ARCADDI098K1 Date 4/27/05

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05) The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.

City Of Yelm Well Number 1A



Well Address:
204 2nd St. SE
Yelm WA
Thurston County

Owner:
City of Yelm

SW 1/4 of the SW 1/4 Sec. 19 Twn. 17N Ran. 2E

Tax Parcel Number:
64420500100

Water Right Information:
Application No. 4924
Permit No. 4630
Certificate No. 3561

Notice of Intent Number:
W186586

Well Identification Number:
ALG255

Drilled By:
Arcadia Drilling, Inc.
PO Box 1790
Shelton WA 98584
Rogeray Phythian LI # 2053

Design By:
William Neal LI# 2625

Date Drilled
May 14 to May 22, 2005

Arcadia Drilling, Inc.
PO Box 1790 Shelton, WA 98584
(360) 426-3395 voice (360) 426-1455 fax

YELM WELL NO. 2

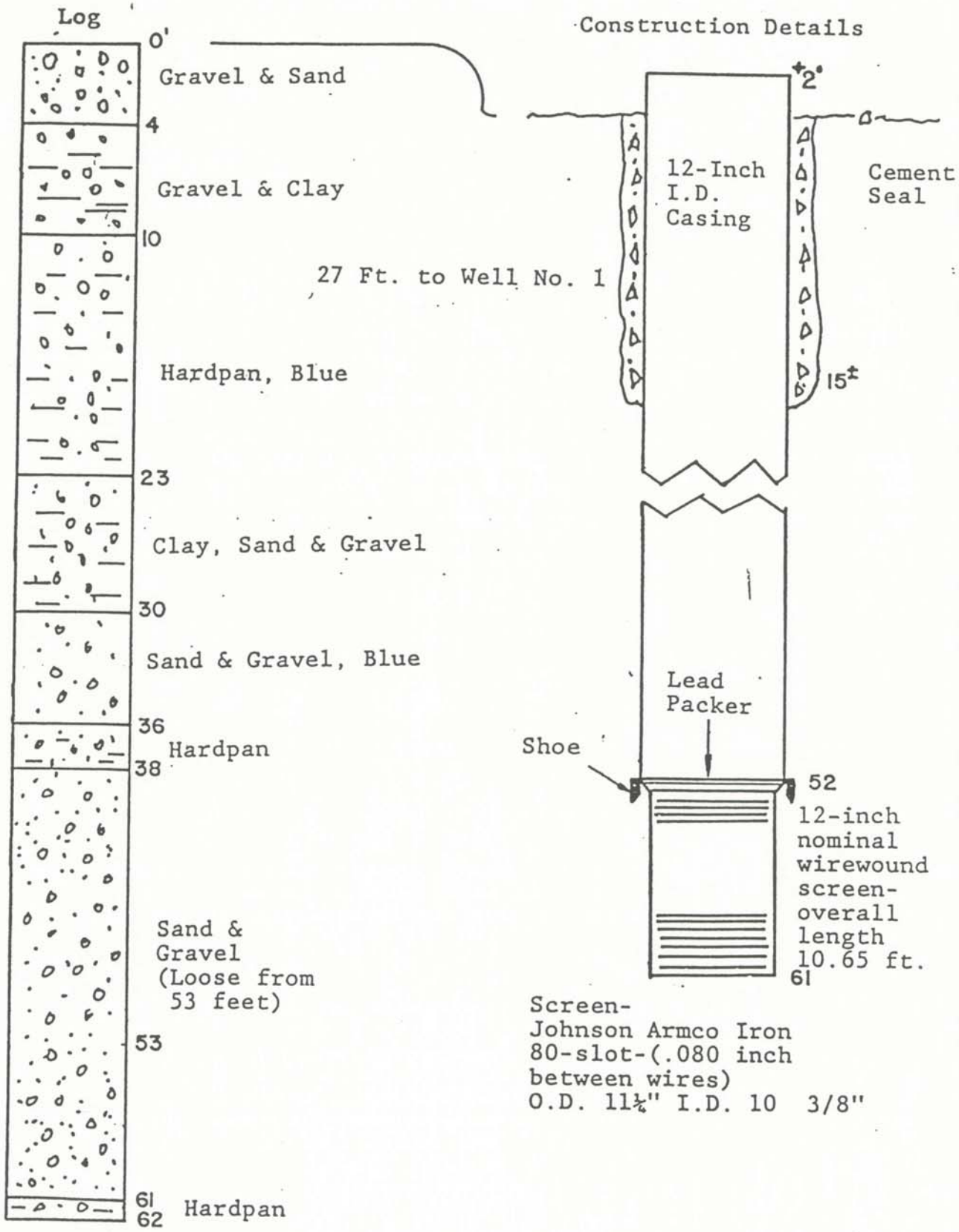


PLATE NO. III-2

SW Well 1A

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

DEPARTMENT OF ECOLOGY State of Washington

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number WE11324

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

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

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

DIMENSIONS: Diameter of well 12" inches, drilled 800 ft. Depth of completed well 633 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 12" Diam. from +2 ft. to 367.5 ft.

☐ Liner installed ____" Diam. from ____ ft. to ____ ft.

☐ Threaded ____" Diam. From ____ ft. to ____ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used

SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☒ Yes ☐ No ☐ K-Pac Location

Manufacturer's Name Johnson Screen

Type Wire-wrapped Model No.

Diam. 8" Slot size 0.035 from 352 ft. to 357 ft.

Diam. 8" Slot size 0.035 from 369 ft. to 437 ft.

Gravel/Filter packed: ☒ Yes ☐ No Size of gravel/sand 10x20

Materials placed from 353 ft. to 633 ft.

Surface Seal: ☒ Yes ☐ No To what depth? 327.7 ft.

Material used in seal Neat cement

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? Depth of strata

Method of sealing strata off

PUMP: Manufacturer's Name Goulds

Type: Lineshaft turbine H.P.

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.

Static level 102.5 ft. below top of well Date 10/6/10

Artesian pressure N/A lbs. per square inch Date

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

WELL TESTS: Drawdown is amount water level is lowered below static level

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

Yield: 2100 gal./min. with 82.2 ft. drawdown after 73 hrs.

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

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 ____ gal./min. with stem set at ____ ft. for ____ hrs.

Artesian flow ____ g.p.m. Date

Temperature of water 54 Was a chemical analysis made? ☐ Yes ☐ No

CURRENT

Notice of Intent No. WE11324

Unique Ecology Well ID Tag No. ALM113

Water Right Permit No. Application G2-29804, G2-29805 and G2-29806

Property Owner Name City of Yelm

Well Street Address Tahoma Blvd SE & Dotson St. SE

City Yelm County Thurston

Location SE 1/4-1/4 SE 1/4 Sec 23 Twn 17 R 1E **(s, t, r Still REQUIRED)** EWM ☒ Or WWM ☐

Lat/Long Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____

Tax Parcel No. (Required) 78640000024

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Fine sand w/ some silt	0	25
Med/fine sand, gravel, cobble	25	170
Med/fine sand with grave/silt	170	219
Silty with fine sand and wood	219	240
Silty sand/iron oxide stainin	240	300
Silty sand with wood	300	370
Silty sand	370	400
Silt and clay	400	453
Fine sand and silt	453	470
Silt and clay, some wood	470	485
Silty fine sand	485	525
Med to coarse sand	525	552
Silt with fine sand	552	610
Fine to med sand/gravel	610	630
Silt/clay with wood	630	665
Fine to coarse sand/gravel	665	675
Silt/clay	675	800

Start Date 4/27/10 Completed Date 10/8/10

WELL CONSTRUCTION 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.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Duane Stevenson

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2795

IF TRAINEE: Driller's License No:

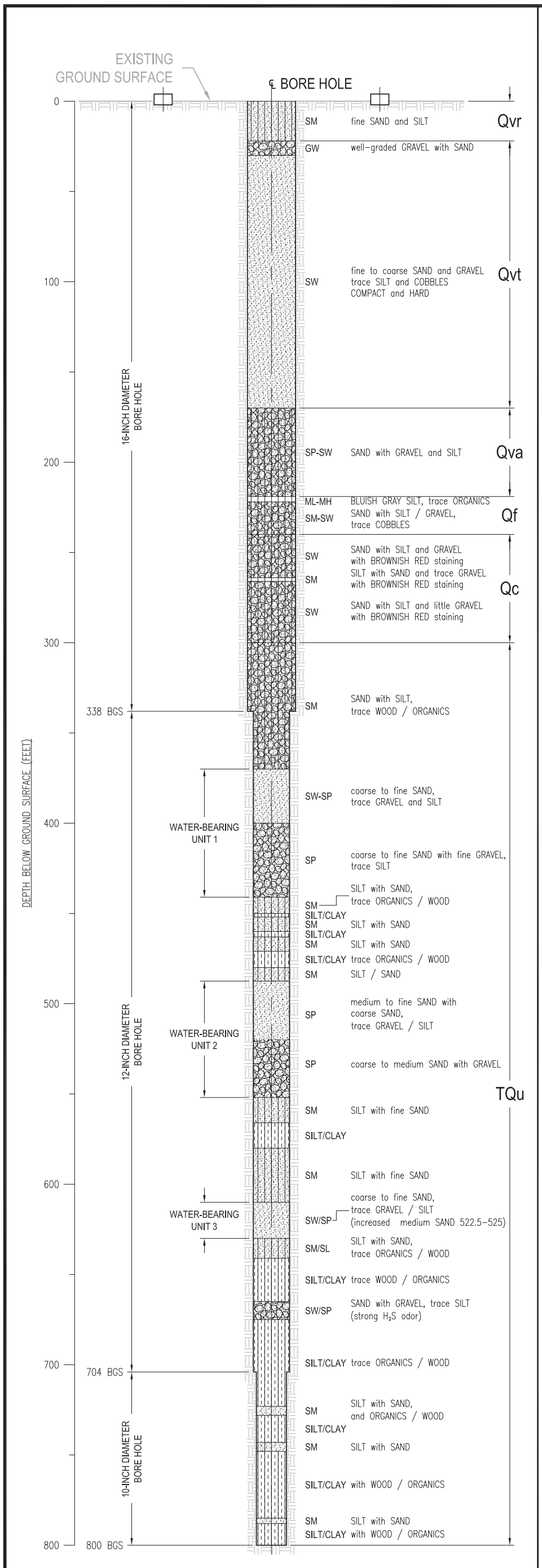
Driller's Signature:

Drilling Company Boart Longyear

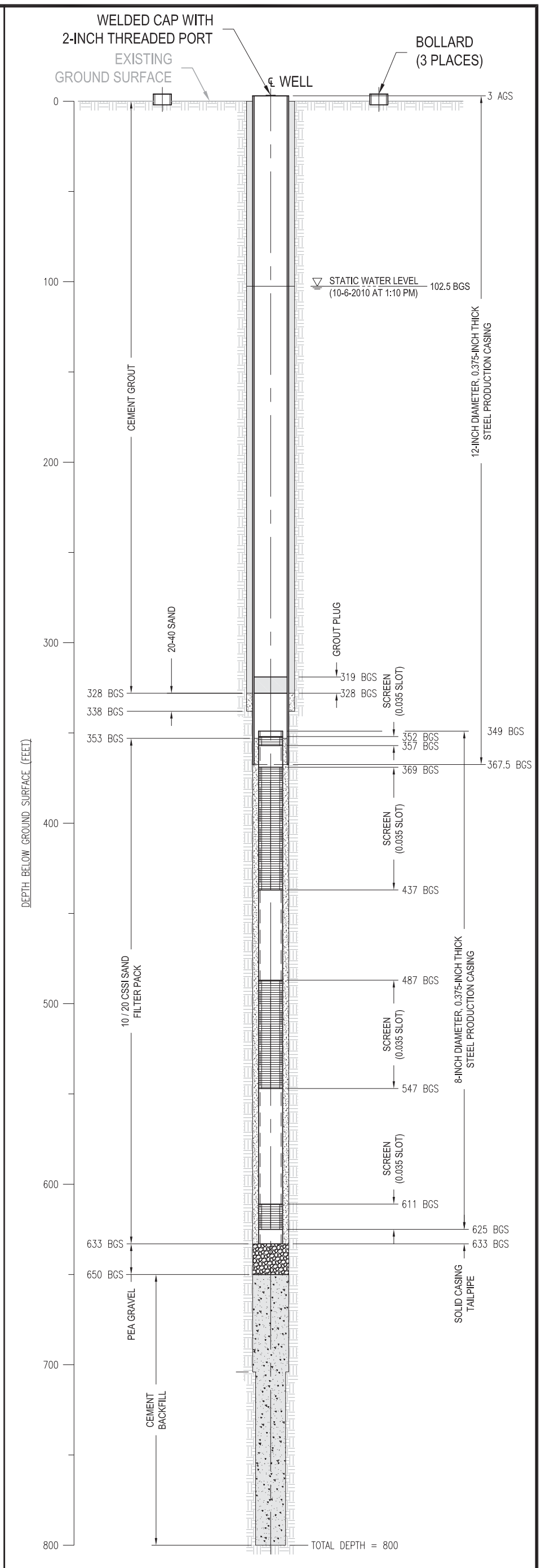
Address 11277 SW Clay St, Suite A

City, State, Zip Sherwood, OR 97140 , ,

Contractor's Registration No. Date



GEOLOGICAL LOG
(HORIZONTAL EXAGGERATION = 20:1)



WELL ASSEMBLY
(HORIZONTAL EXAGGERATION = 20:1)

NOTES:
1. ALL DIMENSIONS ARE IN FEET, EXCEPT AS NOTED.

AS-BUILT SCHEMATIC OF SW WELL 1A

COY/SW Well No. 1A/WA

Golder Associates