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SCS ENGINEERS

Site Conceptual Model Summary

(2008 Update)

Island County Coupeville Solid Waste Facility Coupeville, WA

Presented to:

Island County

Department of Public Works
Solid Waste Division

Presented by:

SCS ENGINEERS
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September 2008
File No. 04205032.25

Offices Nationwide
www.scsengineers.com

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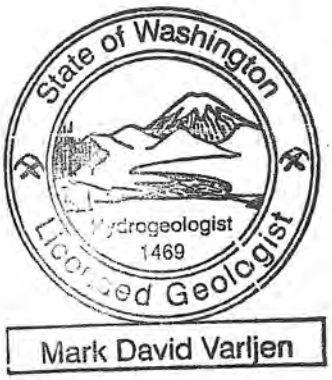

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1 INTRODUCTION

This document presents a summary of the Site Conceptual Model (SCM) for the Coupeville Solid Waste Complex. Stated simply, the SCM is a general representation of site conditions that illustrates the subsurface environment and relationship between site features, contaminants, retention/transport media, and receptors. The SCM is not a specific item itself, but rather a comprehensive idea about site conditions, based on all of the work completed at the site. This idea guides future site action, whether it be additional characterization, monitoring, and/or remediation.

This updated SCM overview reflects new information obtained following additional monitoring point installation completed in Spring-Summer 2008. Specifically, in 2008, two new monitoring wells were located downgradient from monitoring well pair E2S/E2D, where the most significant groundwater contaminants have been identified. The purpose of these new wells is to help define the maximum downgradient extent of the contaminants since previously there were no monitoring wells directly downgradient of the E2S/E2D well pair and the attenuation of contaminants had to be inferred based on an assumption that the SCM was accurate in this area. No significant changes to the SCM resulted from the findings from these new wells; however, this document has been updated to reflect the new data.

2 SITE FEATURES AND HISTORY

Figure 1 is a site map that shows site features. The site includes three separate disposal areas:

1. Town of Coupeville MSW Landfill (<1944-1971)
2. County MSW Landfill (1971-1992)
3. County CDL Landfill (1992-2001)

The town MSW landfill is unlined and is covered with soil and a partial asphalt surface.

The County MSW landfill is unlined and has an engineered cover and gas collection system.

The County CDL landfill is unlined and has a high clay content soil cover.

Details of the site history, detected contaminants, hydrogeologic conditions, potential receptors, and environmental controls and monitoring systems are described in the following documents which form the basis of the SCM. Several annotations are provided to assist in tracking the development of the SCM. Note that in addition to these named documents, the SCM acknowledges quarterly and annual groundwater monitoring reports that have been completed for the site.

2.1 SITE CLOSURE AND INVESTIGATION DOCUMENTS

- *Final Draft Report, Island County Ground Water Quality Assessment and Monitoring Program. Prepared for Island County Health Department, March 14, 1986, by Sweet, Edwards & Associates, Inc. (Installs initial groundwater monitoring wells).*

- *Installation of Gas Monitoring Wells. Prepared for Landau Associates, Inc., July 3, 1986, by SCS Engineers.*

- *Operation and Closure Plans, Island County Sanitary Landfill. Prepared for Island County Engineer, December, 1986, by Landau Associates, Inc. and SCS Engineers.*

- *Presentation of Landfill Gas Control Alternatives for the Island County Sanitary Landfill. Prepared for Island County Engineer, July 24, 1987, by SCS Engineers.*

- *Technical Provisions for Landfill Gas Migration Control Facilities. Prepared for Island County Engineer, October, 1987, by SCS Engineers.*

- *Landfill Gas Migration Control Facilities Operation, Maintenance and Monitoring Manual. Prepared for Island County Engineer, August, 1988, updated December 2005 and September 2008 by SCS Engineers.*

- *Island County Sanitary Landfill Closure Drawing, 1992, by SCS Engineers.*

Sometime between 1992 and 2001, the groundwater sampling program expanded to include more analytes (notably VOCs, which were detected in some wells) and additional exploratory and/or monitoring wells were installed by the County. These efforts were not systematically documented at the time.

In 2001, SCS Engineers was requested to provide assistance relating to groundwater contamination observed at the facility. SCS first suggested implementing consistent environmental monitoring using up-to-date methods, as well as preparation of up-to-date Sampling and Analysis plans (SAPs) for future groundwater and landfill gas data collection. SCS also recommended compiling all of the existing hydrogeologic information that had not been systematically documented, and integrating hydrogeologic data combined with engineering information in order to investigate the possible cause of groundwater contamination and best way to mitigate the situation. The hydrogeologic investigation was also recommended in order to identify potential receptors and the possible need for aggressive mitigation. This integration effort was necessary so that an initial SCM could be formulated.

- *Coupeville Solid Waste Facility Groundwater Sampling, Analysis & Quality Assurance Project Plan, Prepared for the Island County Solid Waste Department December 2001, updated September 2007 and July 2008, by SCS Engineers.*

- *Coupeville Solid Waste Facility Landfill Gas Monitoring Plan, Prepared for Island County Solid Waste Department, September 2002, Revised May 2003, February 2008, and September 2008, by SCS Engineers.*

- *Preliminary Hydrogeologic Study and Engineering Evaluation (Existing Data Analysis), Prepared for Island County Solid Waste Department, January 2002, by SCS Engineers.*

The conclusions of this work were that the site conceptual model was incomplete, that more monitoring wells were needed, and that LFG should be further investigated as a GW contamination source.

- *Report of the 2002 Exploratory Boring and Monitoring Well Installation Program at the Coupeville Solid Waste Facility, November 2002, by SCS Engineers.*
- *CDL Landfill Cover System Evaluation, Island County Coupeville Solid Waste Facility, Coupeville, Washington, October 2002, by SCS Engineers.*
- *Coupeville Solid Waste Complex Groundwater Sampling System Performance Audit and Pump Maintenance Activities, December 2002, by SCS Engineers.*
- *Landfill Gas Evaluation, Prepared for Island County Solid Waste Division, June 2003, by SCS Engineers.*

Although significant data gaps in the SCM were filled, SCS recommended that additional monitoring wells be installed based on the results from the 2002 drilling program.

- *Report of the 2003 Exploratory Boring and Monitoring Well Installation Program, Coupeville Solid Waste Facility, August 2003, by SCS Engineers.*

Following completion of this additional work, it was felt the SCM was adequate to determine the need for and to direct mitigation efforts, as well as to establish an appropriate monitoring program.

- *Site Conceptual Model Summary, Island County Coupeville Solid Waste Facility, Coupeville, Washington, January 2004, by SCS Engineers.*

Based on the distance of receptors and the positive indicators of contaminant natural attenuation, aggressive remediation or enhanced containment (beyond natural attenuation) of existing groundwater contaminants was not indicated; however, SCS recommended implementing contaminant source control measures, reducing infiltration through the CDL, and increasing LFG withdrawal, both inside and outside the footprint of the landfill.

- *Landfill Gas Control System Upgrades & Additions, As-Built Drawings, December 2005 by SCS Engineers.*

In addition to implementing these gas system improvements, the County also installed a low-permeability cover over the CDL and improved the drainage of surface water in order to minimize infiltration through the CDL waste. After a year of operating the upgraded systems, many positive effects on groundwater were seen; however, VOC concentrations in groundwater at one monitoring well pair (E2S, E2D) were not responding favorably. SCS therefore recommended investigating the possibility that still uncaptured LFG and soil gas may be influencing groundwater upgradient of this one monitoring well pair.

- *Landfill Gas Data Analysis and Characterization of Landfill Gas Composition, Coupeville Solid Waste Facility, Prepared for Island County Solid Waste Department, October 2007, by SCS Engineers.*

After observing some uncaptured gas with VOCs, SCS recommended additional soil gas extraction wells and monitoring probes, as well as replacing old liner "boots" that may be reducing the efficiency and effectiveness of LFG extraction from the existing wells. At this time, SCS also recommended installing additional monitoring wells downgradient of well pair E2S/E2D, where elevated VOCs were being detected in order to confirm the SCM, and establish whether or not the downgradient extent of impacted groundwater had been identified (in other words, to verify attenuation of the contaminant before it left the property).

- *Groundwater Monitoring Well, Gas Probe, and Native Soil Gas Well Installation, Coupeville Solid Waste Facility, September 2008, by SCS Engineers.*

3 HYDROGEOLOGY

Regional hydrogeologic information, including geologic maps and cross-sections, was presented in the 2002 Hydrogeologic Study and Engineering Evaluation. The information established the general hydrogeologic setting; however, site details that could affect contaminant introduction were not clearly illustrated. Site-specific cross sections (Figures 2 and 3) were subsequently prepared following the installation of new monitoring wells in 2002 and 2003. Figure 4 presents an additional site-specific cross section which includes the new monitoring well pair which was completed in April 2008.

There are essentially two water bearing zones separated by a semi-confining layer that are of interest at the site. An underlying confining layer has also been identified. Wells assumed to be completed in the shallow aquifer (aquifer 1) have a mid-screen elevation greater than 55 ft above mean sea level. Wells assumed to be completed in the lower aquifer (aquifer 2) have a mid-screen elevation less than 30 ft above mean sea level.

The uppermost aquifer is composed of gravel, sand, silt, and clay. Gravel is a large component of the formation near land surface and the grain size decreases with depth. The hydraulic conductivity is moderate to low, estimated at 12.25 ft/day (based on grain size analyses). Groundwater in this aquifer exists as a mound under the disposal areas, likely due to increased infiltration and the topography of the disposal area. Saturated conditions only exist under the disposal area and in locations where the underlying semi-confining layer is more fine-grained. The aquifer essentially pinches out to the east and west of the disposal areas. This is due to the elevation of the confining layer rising above the level of saturation or the disappearance of the confining layer. It is suspected the N-S trending of the shallow aquifer is related to historic drainage patterns. Groundwater flows downward and radially away from the center of the disposal area (see Figure 4). The gradient ranges between 0.005 ft/ft and 0.015 ft/ft. Assuming an effective porosity of 25% and the estimated hydraulic conductivity, the groundwater flow velocity in aquifer 1 is estimated to range between 0.25 and 0.76 ft/day.

The semi-confining layer located between the two aquifers is composed of silt and clay, but these fine-grained materials are mixed with sand and gravel in some places, so there are localized areas where there is likely considerable leakage through this layer which appears to vary in thickness from 15-75 feet thick. The average hydraulic conductivity of this confining layer has been estimated to be 0.436 ft/day (range 0.25 – 0.53 ft/day). Given the observed hydraulic gradient across the semi-confining layer of 0.151 – 0.206 (average 0.227) ft/ft and an effective porosity of 25%, groundwater flow velocities across the semi-confining layer are estimated to range between 0.227 and 0.481 ft/day. This means the travel time is between 1 - 6 months across the semi-confining layer.

The lower aquifer is predominantly composed of sand. While the gravel content is less than that of aquifer 1, the silt and clay content appears to be less than that of aquifer 1, resulting in a higher overall permeability. The hydraulic conductivity is moderate to high, estimated from grain size data at 224 ft/day. Based on observed gradients from 0.003 to 0.005 ft/ft and an assumed effective porosity of 25%, the estimated groundwater flow velocity in aquifer 2 is between 2.4 and 4.2 ft/day. Figure 5 depicts groundwater flow in aquifer 2. Flow is predominantly from the south and breaks to the northeast across the landfill, although there may be a potential component of flow that leaves the landfill to the northwest. The flux of groundwater in aquifer 2 is fed by on-flow from the south and leakage from aquifer 1.

Several water supply wells near the landfill are completed in aquifer 2. These wells are used for operations at the site and are not used for potable water. An analysis of continuous water level measurements collected from these wells (see Annual Environmental Monitoring Data Report, August 2003) indicated that pumping at these wells has no influence on the groundwater flow direction at the landfill (and hence no influence on migration of contaminants).

No significant temporal trends have been noted in groundwater elevations or resulting flow directions and gradients in either aquifer. Neither aquifer appears to be particularly reactive to individual precipitation events, likely due to the depth.

4 GROUNDWATER CONTAMINANTS

4.1 DETECTIONS AND SPATIAL PATTERNS

The influence of waste disposal activities on groundwater quality is apparent in the groundwater VOC detections, general chemistry, and field parameters. The monitoring wells immediately adjacent to the disposal areas indicate impacts to the groundwater. As expected, the impacts are more pronounced in the shallow aquifer wells than in the deep aquifer wells. Wells located in the second tier of the monitoring network (E4S, E4D, N5, NE1, E3, S11, SE1, and W2) are not demonstrating significant impacts. These wells confirm the concentration-reducing effects of natural attenuation mechanisms operating at the site (dilution, dispersion, adsorption, and most notably, biodegradation). These second-tier wells also effectively provide definition of the extent of downgradient impacts and serve as "sentinel" monitoring wells. That is, should any alarming upward trends in concentrations be observed in these wells, there would still be adequate response time to address the contamination before it migrated to the property line (or downgradient receptors beyond the property line).

Vinyl chloride is the predominant constituent of concern that has been detected in the groundwater at the site. Vinyl chloride has exceeded the Federal/State Drinking Water MCL of 2 ug/L at one location, deep aquifer monitoring well E2D, located immediately east (and downgradient) of the disposal area. Although detected at well E4D, vinyl chloride concentrations at this location (approximately 700 ft directly downgradient of E2D) are very near the analytical detection limit (and the WAC 173-200 groundwater quality protection standard) of 0.02 ug/L, significantly below the Federal/State Drinking Water MCL.

Nitrate has consistently been detected above drinking water standards at monitoring well S10S along the southern boundary of the disposal area, east (downgradient) of the animal shelter. This detection is thought to be related to the concentration of animal waste and/or a failing septic system at the animal shelter. The septic system has been replaced and concentrations appear to be declining.

The herbicide dicamba has been detected at monitoring well E1S. While there is no specific standard for dicamba under WAC 173-200, the detected concentration of dicamba is below the estimated MTCA method B cleanup goal. This well is the closest in the network to Highway 20, where there is a history of roadside herbicide application.

4.2 TEMPORAL TRENDS

Prior to implementing mitigation measures, increasing trends were observed in magnesium, sodium, chloride, sulfate, calcium, potassium, alkalinity, specific conductance, and the refrigerants Freon-21 and Freon-22. These trends spanned shallow and deep aquifer wells. Also of importance were the matching trends seen in vinyl chloride and dichlorodifluoromethane concentrations in first tier, shallow aquifer wells C1S, E1S, N2S, and S10S, indicating that landfill gas was likely an important contributor to the vinyl chloride detections. This suggested the need for enhanced landfill gas collection. Many wells showed sharp upward trends in several water quality indicators (Sodium, Specific Conductivity, Chloride, Sulfate) shortly after the CDL Landfill began accepting waste (~1995), hinting at the need to limit infiltration through the CDL.

Since the full-scale implementation of mitigation measures starting in 2005, contaminant concentrations have either exhibited downward trends or have at least been stable at all locations except well E2D, where vinyl chloride concentrations were observed to increase. This trend, coupled with landfill gas analytical data that suggested incomplete gas capture, led to the improvements to the gas collection system which were implemented in the summer of 2008.

4.3 REGULATORY EXCEEDANCES

Several constituents have been detected above WAC 173-200 groundwater quality protection standards during groundwater sampling events. Regularly detected constituents include 1,1-dichloroethane, methylene chloride, vinyl chloride, arsenic, iron, manganese, total dissolved solids (TDS), nitrate, and pH. The exceedances of arsenic, iron, manganese, and TDS are thought to be reflective of natural background conditions (at least partially, if not entirely). The detections of other constituents are almost certainly the result of waste disposal activities and are

the target of current groundwater contamination mitigation efforts. As previously mentioned, the most notable regulatory exceedance is the detection of vinyl chloride at monitoring well E2D, where the concentration of this constituent exceeds the Federal Drinking Water standard.

5 POTENTIAL CONTAMINANT INTRODUCTION MECHANISMS

5.1 LANDFILL GAS

A detailed landfill gas investigation was completed in June 2002 with the following conclusions:

- Landfill gas was thought to be contributing contaminants to groundwater. Compounds found in the site groundwater are consistent with compounds found in samples of landfill gas and soil gas.
- The horizontal extent of the gas plume in the vadose zone was as large as the combined area of all three landfills. This area allowed exposure of precipitation to contaminants in the vadose zone, creating the possibility that precipitation recharge could be transporting contaminants from the landfill gas into the groundwater, especially given the high permeability of the unsaturated zone sediments.
- The vertical extent of the gas plume appeared to extend to the groundwater. Contaminants exposed to the groundwater can be transported by direct contact and become soluble in the groundwater.
- It was speculated that landfill gas generation would continue at the site in significant quantities, and would continue to produce compounds detrimental to the groundwater quality. If left unattended, it was warned that this process of transporting contaminants in the vapor/gas phase through the vadose zone would continue.
- It was pointed out that the original gas systems installed at the site were not designed to remove gas from the vadose zone or provide source control of the landfill gas. The air injection system was designed to provide migration control to the south and southeast perimeter of the site. The original gas extraction system was designed to prevent uplift pressures on the landfill cover system of the County MSW Landfill. The old gas monitoring network was designed to be used with the old systems and therefore was not adequate for monitoring the deep, extensive gas plume at the site.

In response to the conditions noted above, the system was upgraded in 2004 to include enhanced landfill gas extraction and gas extraction from the vadose zone. Subsequent improvements were made in 2008 in response to conditions observed in the 2007 supplemental landfill gas study which identified that there was still uncaptured landfill gas following the 2004 system upgrades. Subsequently, new gas extraction wells and monitoring probes were completed in 2008 to address the problem.

5.2 SURFACE WATER DRAINAGE AND INFILTRATION

Drainage and infiltration analyses are presented in the 2002 Hydrogeologic Study and Engineering Evaluation. The conclusions were as follows:

- The average annual percolation through the three disposal areas were estimated as follows:
    - 2,600 gallons for the County MSW
    - 375,000 gallons for the City MSW Landfill, and
    - 638,000 gallons for the County CDL Landfill
- An additional 567,000 gallons of lateral drainage from the County MSW landfill was directed to the base of the County CDL landfill. It was unknown how much of this infiltrated through the waste (either directly or by not being captured by the sump and removed).
- The combined precipitation percolation and surface water drainage directed to the CDL materials provided significant opportunity for any contaminants in the CDL materials to be leached into groundwater. The hydraulic situation with the CDL Landfill was thought to be a contributor to groundwater contamination at the site.

From 2004 to 2005, drainage improvements were made at the site. A soil cover was constructed over the CDL landfill, and new trench drains were installed to route stormwater into a sump which pumps collected surface water to the northwest infiltration pond. Although the soil cover is not as effective as a geomembrane cover, the soil cover, grading, and removal of water to the infiltration pond has dramatically reduced the amount of water infiltrating through the CDL wastes.

6 FATE AND TRANSPORT OF CONTAMINANTS

Contaminants have migrated downward and outward from the disposal areas. Predominant contaminant migration has occurred to the north, northeast, and east of the disposal areas. Most contaminant detections have occurred along the perimeter of the disposal areas. Groundwater flow paths initially pointing to the south and carrying contaminants to monitoring well S10S along the south perimeter of the site appear to curl around to the east (see Figure 5).

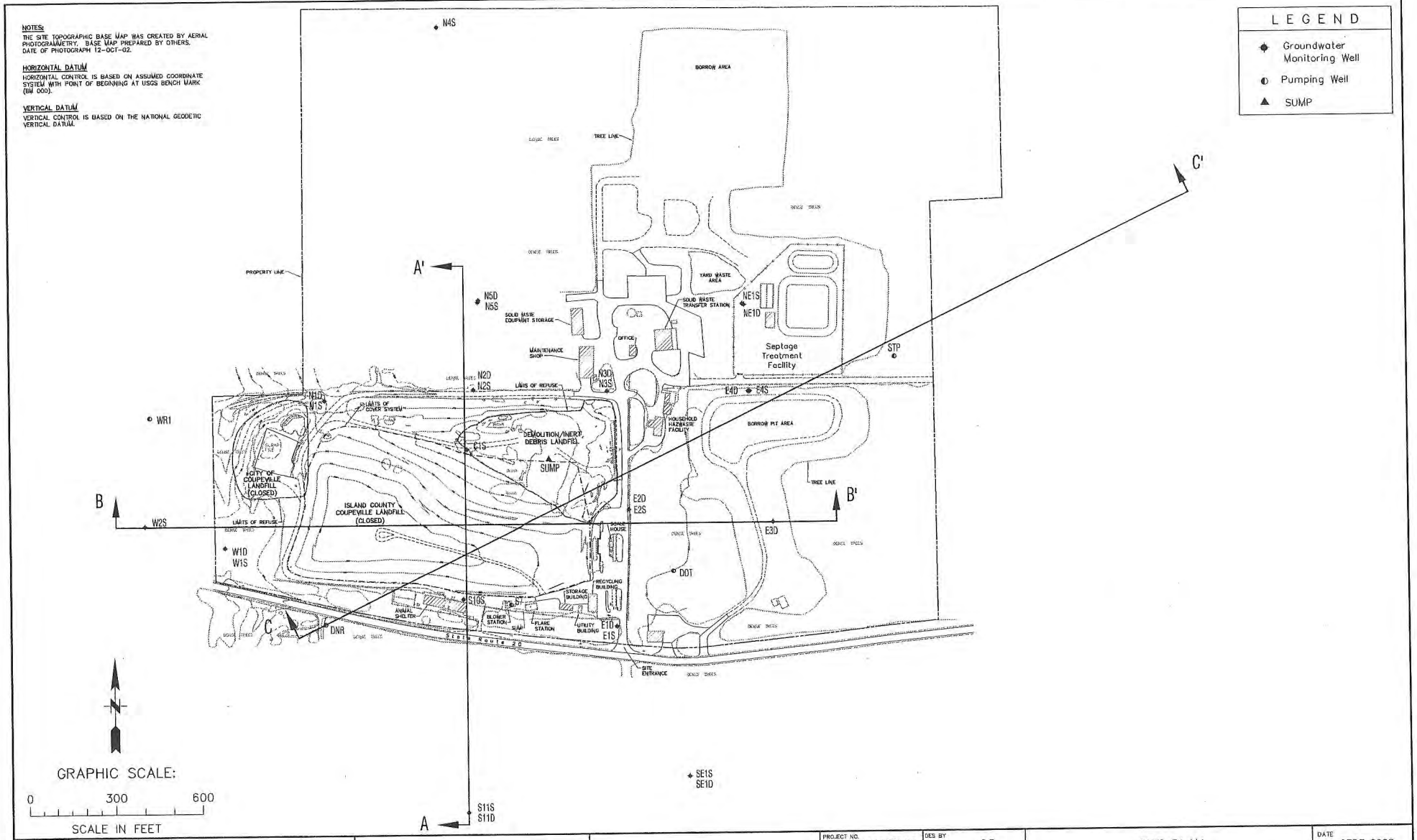
Dilution and dispersion of inorganic constituents has reduced contaminant concentrations to the east and northwest to the point where impacts by these constituents are not noticed in the "second tier" wells (E3D, NE1S and NE1D). Elevated chloride and TDS have been noted at well N5D, but the concentrations are still well below applicable standards,

The organic contaminants detected in perimeter monitoring wells are expected to undergo natural attenuation. To investigate this theory, SCS assessed the potential for biodegradation using the screening method presented in the USEPA publication entitled Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (EPA/600/R-98/128, September 1998). These results are presented in the Fourth Quarter 2002 Monitoring Report. The conclusions of this evaluation were that the groundwater system in the vicinity of the contaminant source (i.e. the disposal areas) is characterized by low dissolved oxygen (generally less than 1 mg/L), indicating an anaerobic system favorable for reductive dechlorination. Under

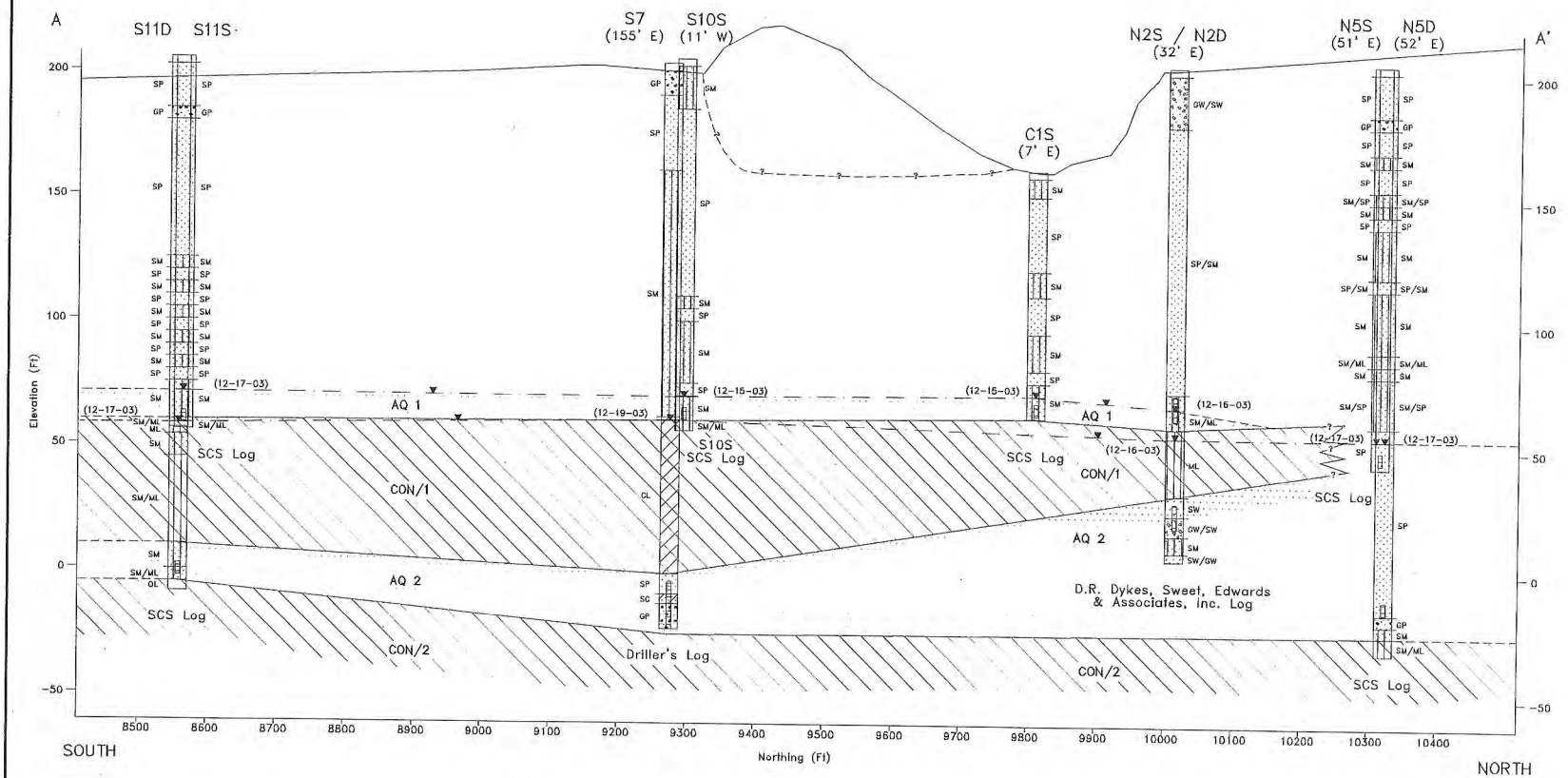
NOTES:
THE SITE TOPOGRAPHIC BASE MAP WAS CREATED BY AERIAL PHOTOGRAMMETRY. BASE MAP PREPARED BY OTHERS. DATE OF PHOTOGRAPH 12-OCT-02.

HORIZONTAL DATUM
HORIZONTAL CONTROL IS BASED ON ASSUMED COORDINATE SYSTEM WITH POINT OF BEGINNING AT USGS BENCH MARK (BM 000).

VERTICAL DATUM
VERTICAL CONTROL IS BASED ON THE NATIONAL GEODETIC VERTICAL DATUM.



SCS ENGINEERS STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS 2405 140TH AVE NE, SUITE 107, BELLEVUE, WA 98005 (425) 746-4600			PROJECT NO. 04205032.25 SCALE AS SHOWN CAD FILE FIGURE 1	DES BY S.B. CHK BY M.V. APP BY M.V.	SITE PLAN ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY COUPEVILLE, WASHINGTON	DATE SEPT 2008 FIGURE 1



LEGEND

- SP Poorly graded sands or gravelly sands, little or no fines
- SW Well graded sands, gravelly sands, little or no fines
- GC Clayey gravels, gravel-sand-clay mixtures, plastic fines
- CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
- SM Silty sands, sand-silt mixtures, non-plastic fines
- GP Poorly graded gravels or gravel-sand mixtures, little or no fines
- GW Well graded gravels, gravel-sand mixtures, little or no fines
- ML Inorganic silts and very fine sands, rock flour silty or clayey fine sands or clayey silts with slight plasticity
- SC Clayey sands, sand-clay mixtures, plastic fines
- GM Silty gravels, gravel-sand-silt mixtures, non-plastic fines
- OL Organic silts and organic silty clays of low plasticity
- Well screen interval
- Water level (Date measured)

AQ 1 = Aquifer 1
CON/1 = Confining Layer 1
AQ 2 = Aquifer 2
CON/2 = Confining Layer 2

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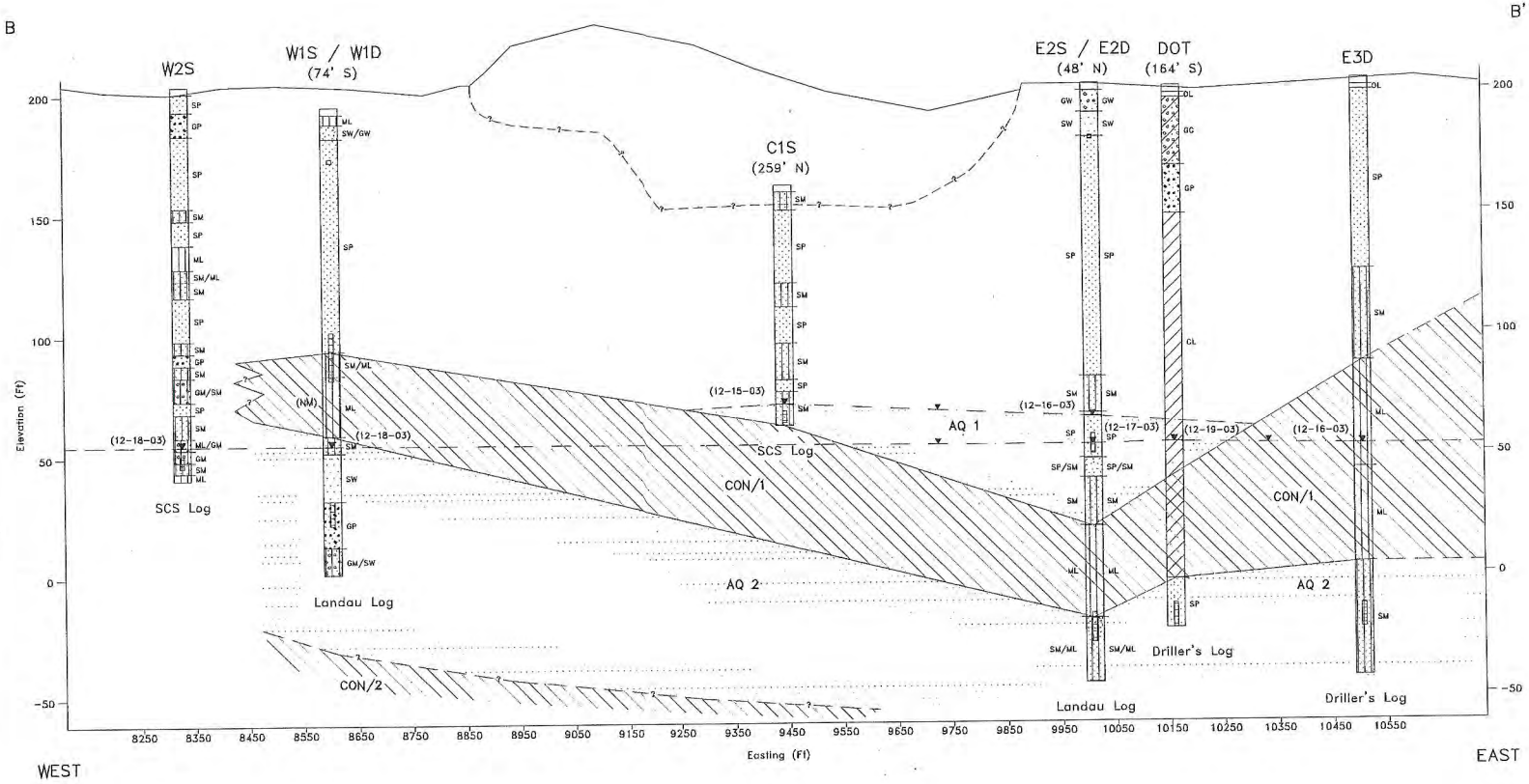
PROJECT NO. 04205032.25	DES BY E.D.	CROSS SECTION A-A'	DATE SEPT 2008
SCALE AS SHOWN	CHK BY E.D.	ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY COUPEVILLE, WASHINGTON	FIGURE 2
CAD FILE FIGURE 2	APP BY M.V.		



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AQ 1 = Aquifer 1
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AQ 2 = Aquifer 2
CON/2 = Confining Layer 2

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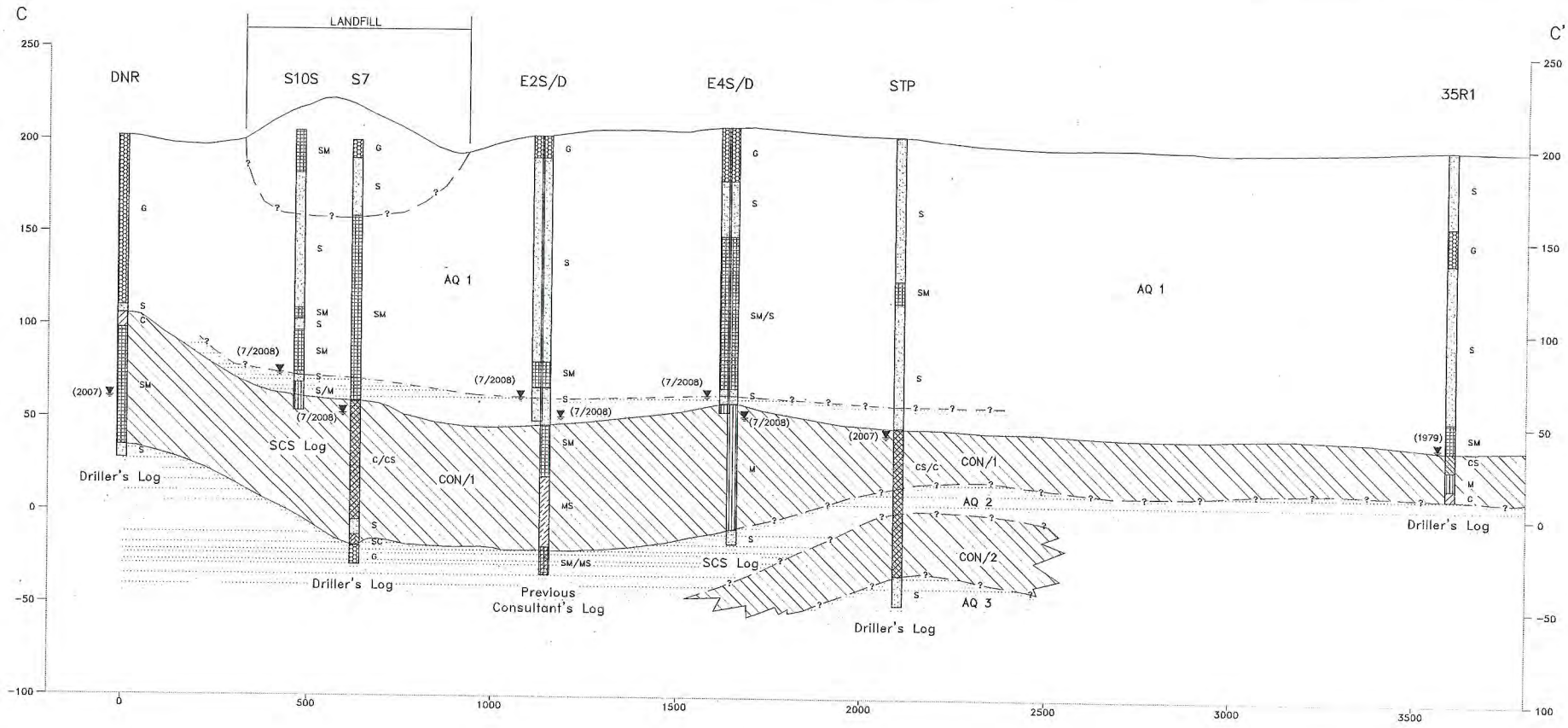
PROJECT NO. 04205032.25	DES BY E.D.	CROSS SECTION B–B'	DATE SEPT 2008
SCALE AS SHOWN	CHK BY E.D.	ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY COUPEVILLE, WASHINGTON	FIGURE 3
CAD FILE FIGURE 3	APP BY M.V.		



LEGEND

G Gravel	C Clay	SC Clayey Sand	AQ 1 = Aquifer 1
S Sand	CS Sandy Clay	MS Sandy Silt	CON/1 = Confining Layer 1
M Silt	SM Silty Sand	Water level (Date measured)	AQ 2 = Aquifer 2
			CON/2 = Confining Layer 2
			AQ 3 = Aquifer 3

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PROJECT NO. 04205032.25	DES BY S.B.	CROSS SECTION C–C'	DATE SEPT 2008
SCALE AS SHOWN	CHK BY M.V.	ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY COUPEVILLE, WASHINGTON	FIGURE 4
CAD FILE FIGURE 4	APP BY M.V.		

these observed conditions, reductive dechlorination is highly feasible. Highly halogenated compounds such as PCE and TCE can easily degrade to DCE and Vinyl Chloride under these conditions. Vinyl Chloride, however, degrades under aerobic conditions. Fortunately, the monitoring data suggest that aerobic conditions return downgradient of the contaminated zone (N3S; N5S; NE1S), creating an ideal series of biogeochemical conditions to degrade all of the contaminants. Furthermore, methane is not present at high concentrations in the downgradient locations, further supporting the oxidization of vinyl chloride.

Supportive information to note in the data includes the low dissolved oxygen concentrations which suggest anaerobic conditions. The methane concentrations potentially indicate that bacterial methanogenesis may be occurring (methanogenic bacteria, which require anaerobic conditions, are known to degrade chlorinated solvents). It is uncertain whether or not the methane is present from landfill gas or if it is being produced from bacteria with the groundwater. Hydrogen and other electron donors (required for reductive dechlorination) are present. Other inorganic data (notably alkalinity) also provide evidence that biodegradation is occurring.

Additional supportive indicators are the presence of the appropriate daughter products in the samples. In particular, cis-1,2-DCE is present in comparatively elevated concentrations compared to trans-1,2-DCE, indicating that cis-1,2-DCE is present as a daughter product. The data suggest that reductive dechlorination is not only feasible, but that it is occurring.

The groundwater flow velocity in Aquifer 2 is estimated to range between 2.4 and 4.2 ft/day. Therefore the minimum groundwater travel time between monitoring well E2D and E4D is between 120-208 days (assuming no dilution, dispersion, adsorption, or degradation of the contaminant). High concentrations of vinyl chloride have been observed at E2D for a time far exceeding this travel time. Therefore, if natural attenuation was not occurring, similar concentrations to what was observed at well E2D would be seen at monitoring well E4D. However, vinyl chloride has only been detected at E4D at a concentration just barely above the detection limit, thus confirming the natural attenuation processes.

7 RECEPTORS

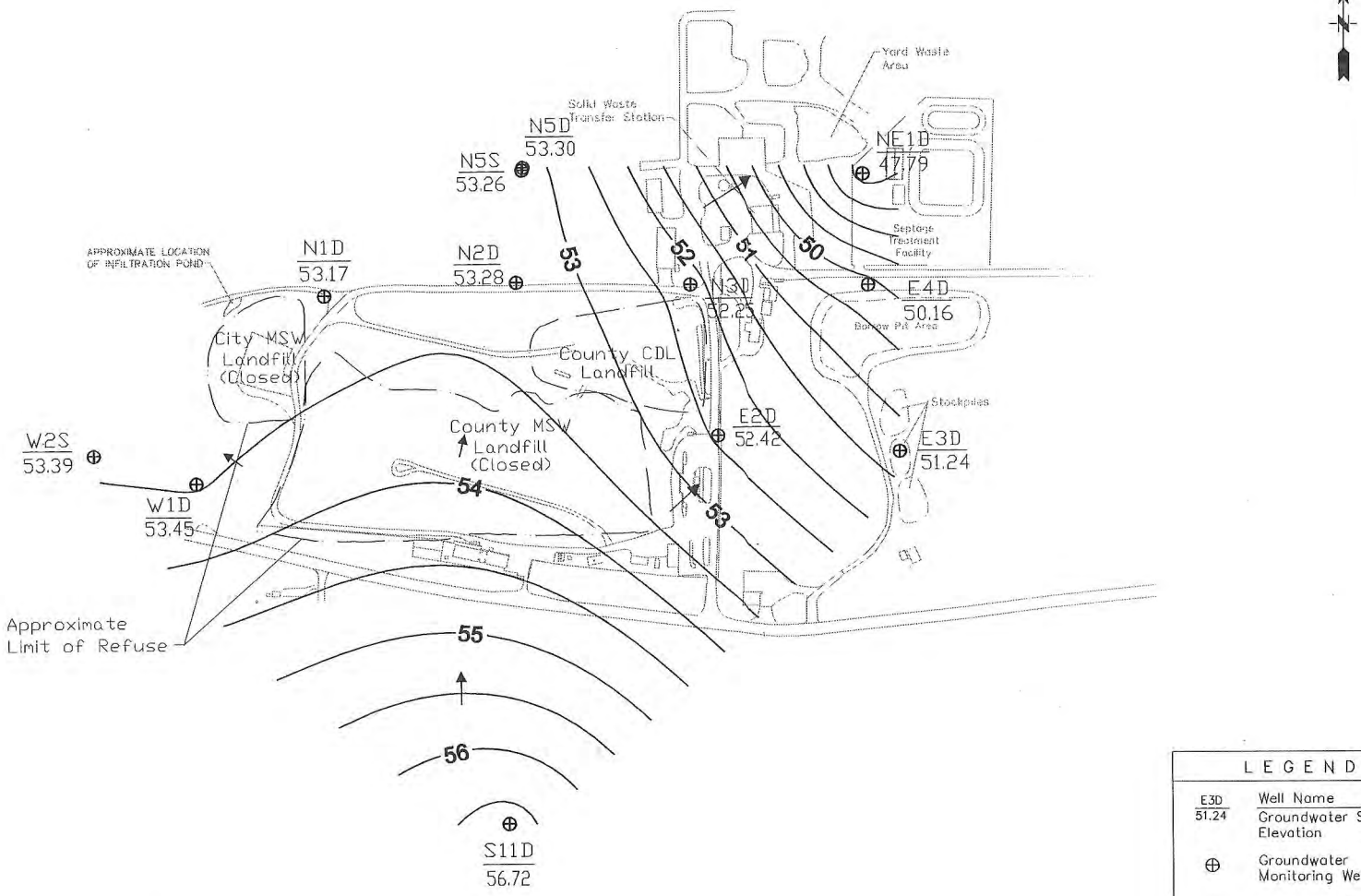
The regional cross sections presented in the 2002 Hydrogeologic Study and Engineering Evaluation established the general hydrogeologic setting and illustrated the relationship of the site to off-site receptors, notably several domestic wells located northeast of the site.

Cross-section C-C' in this document (Figure 4) helps illustrate in more detail the relationship to the nearest downgradient receptor, which is a shallow domestic well located approximately 2700 ft downgradient from the disposal area and approximately 2000 ft downgradient of monitoring wells E4S and E4D. Based on the elevation of the bottom of the well, it is assumed the well taps Aquifer 2, the deeper of the two water bearing zones identified at the site.

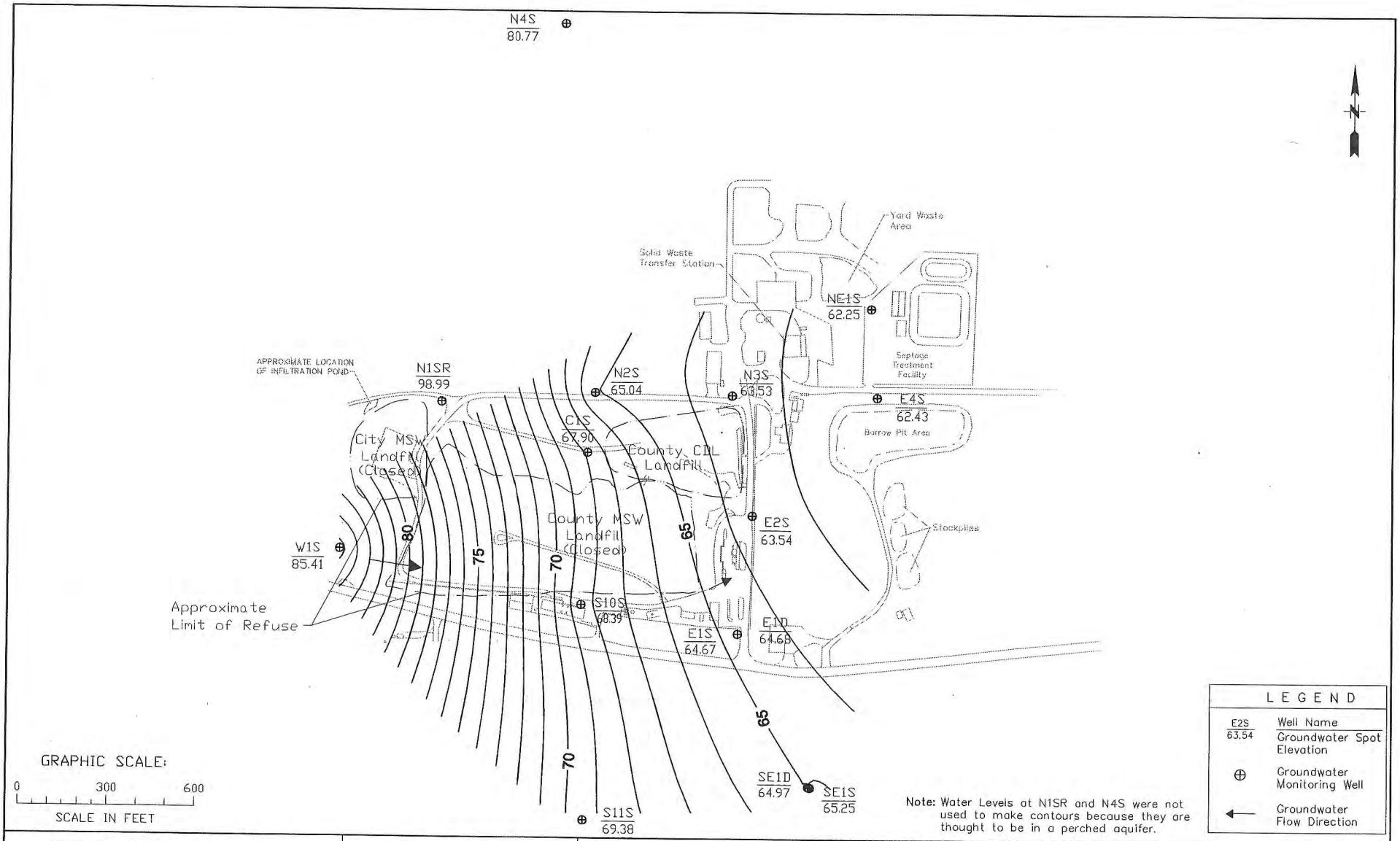
The groundwater flow velocity in Aquifer 2 is estimated to range between 2.4 and 4.2 ft/day. Therefore, the minimum groundwater travel time between monitoring well E2D

and the receptor well is estimated to be between 1.3 – 2.3 years, assuming that there is no dilution, dispersion, adsorption, or degradation of the contaminant. All of these concentration-reduction mechanism processes are known to operate at the site, therefore the actual contaminant travel time would be greater than this. In all likelihood, the rate of natural attenuation is such that the maximum extent of the contaminant plume is far less than this distance.

Site data has demonstrated that natural attenuation is occurring and it is expected that this attenuation will prevent off-site migration and impacts to receptors provided source control is implemented and additional contaminants at higher source concentrations are not allowed to enter the groundwater system. Mitigation efforts implemented at the site since 2004 have been designed to meet this objective.



SCS ENGINEERS STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS 2405 140TH AVE NE, SUITE 107, BELLEVUE, WA 98005 (425) 746-4600	DATA REVIEW FOR THE THIRD QUARTER 2008 ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY COUPEVILLE, WASHINGTON		PROJECT NO. 04205032.25 SCALE 1" = 300' CAD FILE Figure 2	DES BY S.B. CHK BY S.B. APP BY M.V.	JULY 2008 AQUIFER 2 GROUNDWATER ELEVATION MAP	DATE SEPT 2008 FIGURE 6



SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
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DATA REVIEW
FOR THE THIRD QUARTER 2008
ISLAND COUNTY COUPEVILLE SOLID WASTE FACILITY
COUPEVILLE, WASHINGTON

PROJECT NO. 04205032.25	DES BY S.B.	JULY 2008 AQUIFER 1 GROUNDWATER ELEVATION MAP	DATE SEPT 2008
SCALE 1" = 300'	CHK BY S.B.		FIGURE 5
CAD FILE Figure 1	APP BY M.V.		

ATTACHMENT A

SCOPE OF WORK AND FIELD PROCEDURES

ESSC-OC-#5
Monitoring Network Enhancement for
Further Assessment of Groundwater Contamination by Vinyl Chloride

Island County Solid Waste Complex, Coupeville, WA

1 PROJECT MANAGEMENT

This task involves general contract management activities, scheduling and managing subcontractors, ordering supplies, scheduling and managing field activities, reviewing subcontractor and supplier invoices, and preparing overall project invoices and project close-out activities. This task also includes general communication, correspondence, status updates, and project meetings as necessary.

2 LOGISTICS EVALUATION/UTILITY CLEARANCE FOR MONITORING WELLS

Earth Science Strategies Consulting, Inc. (ESSCI) staff will visit the site to evaluate drilling equipment access and potential traffic, site operations, and utility line interferences, and select and mark final locations for monitoring wells in consultation with Island County Solid Waste (ICSW) staff, as appropriate. ESSCI assumes any required site preparation activities, as identified as part of this task in conjunction with ICSW, such as vegetation removal, will be conducted by ICSW. When selecting final locations, ESSCI will attempt to minimize the amount of required site preparation and minimize possible disruptions to site operations to the extent possible.

3 HEALTH AND SAFETY PLAN

ESSCI will review and update as necessary the site-specific health and safety plan for this site prior to implementing field work. The health and safety plan will describe the hazards associated with the various work activities planned for the project, how to recognize and avoid those hazards, appropriate precautions and protective equipment, and decontamination procedures. Both chemical and physical hazards will be addressed in the plan. The final plan will be reviewed, signed and followed by all field personnel. The site-specific health and safety plan will be consistent with state and federal requirements for work at potentially contaminated sites and will cover ESSCI employees. Subcontractors will be provided a copy of the site-specific health and safety plan but will be required to work under their own health and safety plan to cover their employees.

4 BOREHOLE ADVANCEMENT AND GROUNDWATER MONITORING WELL CONSTRUCTION

ESSCI will contract with a licensed drilling subcontractor to complete soil borings and construct monitoring wells as outlined in the "Work Plan for Further Assessment of Groundwater Contamination by Vinyl Chloride" (ESSCI, January 28, 2013). ESSCI will select a subcontractor with the best perceived value to Island County, based on capabilities, availability, and price. State prevailing wages will apply to all subcontracted work. In accordance with the Minimum Standards for Construction and Maintenance of Wells (WAC 173- 160), the drilling contractor will notify the Department of Ecology of their intent to construct the proposed wells at least seventy-two hours before starting work.

All subcontractor site work will be performed under the supervision of an ESSCI hydrogeologist. In addition to supervising the drilling crew, ESSCI's field hydrogeologist will log the stratigraphy of each boring (visual/textural classification according to the ASTM/USC system) and direct the installation of the groundwater monitoring wells. Monitoring wells will be constructed in accordance with WAC 173-160-420 (Minimum Standards for Construction and Maintenance of Wells; Resource Protection Wells) and according to industry standard practices for resource protection wells. Decisions regarding total boring depth and well screen placement will be made based on field observations of stratigraphy and observed groundwater levels.

DRILLING AND GEOLOGIC LOGGING

Boreholes will be advanced using the sonic drilling method. Sonic drilling employs the use of high-frequency, resonant energy to advance a core barrel or casing into subsurface formations. The method is very fast, produces less investigation-derived waste than other methods, and produces nearly continuous relatively undisturbed core samples. At this site the sonic drill will be used to first advance a core barrel (either 4", 6", or 8" diameter) up to 20 ft depending on geologic conditions. The core will be extracted for geologic logging and soil sampling, a temporary steel casing advanced to the point that the core barrel was advanced, and the hole cleaned out (again using a core barrel; however the sediments removed from this core run will be disturbed and unsuitable for logging and sampling). The procedure is repeated until the desired depth is reached.

At this site, a conductor casing/telescopic procedure will be used to prevent cross-contamination during drilling between the shallow (~145-150') water bearings zones and the target zone at ~200-220'). A 10" diameter temporary casing is for proposed monitoring wells E5D and E6D; 8" diameter for E7D and E8D up until approximately 5 ft into the semi-confining layer (expected to be encountered at approximately 150' below land surface at all of the borehole locations). At this point the casing will be retracted approximately 1 ft and a bentonite slurry will be pushed out of the borehole to seal the casing into the confining layer. After the bentonite has set for at least 24 hrs, drilling will proceed using smaller diameter core

barrels (4" or 6") and steel casing (8" for E5D and E6D; 6" for E7D and E8D) until the target depths have been reached, expected to be between 200 – 220' below land surface.

All soil cores will be extruded into plastic liners or a suitable contained area for inspection. Following visual description of the removed soil cores, soils from the saturated zones will be checked for the presence of VOCs by placing soil collected from the core at 5 ft intervals into zip-top plastic bags (one for each interval), allowing the soil to equilibrate with the headspace air in the bag for approximately 15 minutes, and then evaluating the headspace air in with a photoionization detector (PID). All PID readings will be recorded on the boring logs. Any soil showing a positive indication of VOCs based on the PID reading will be segregated from other drill cuttings and placed on plastic sheeting in an area for storage pending further characterization and proper disposal. The stored soil cuttings will be covered to prevent rainfall contact pending laboratory analysis and disposal decisions. This scope of work does not include characterization and disposal of contaminated soil cuttings. Should PID screening suggest possible VOC contamination of the soil cuttings, ESSCI will submit an addendum to the scope of work to characterize and properly manage these cuttings. All other soil cuttings will be placed in steel storage bins and transported to an appropriate area on ICSW property, as designated by ICSW staff. All drilling equipment will be decontaminated between boreholes to minimize the potential for cross-contamination. Due to the nature of the drilling method, the drilling process is not expected to generate contaminated water during drilling that will require special handling or disposal.

SOIL SAMPLING AND LABORATORY ANALYSES

Samples for laboratory analysis will be collected from the cores extracted from the boreholes at the elevations selected for the monitoring well screens. Samples for VOC analysis will be collected from undisturbed cores using an ENCORE sampler. Samples for other parameters will be transferred into laboratory-provided glass jars. All samples for chemical analysis will be packed in a cooler kept at 4 degrees C and shipped to a certified analytical laboratory. Geotechnical samples will be packed in protective packaging and shipped to a soils lab for analysis. Analyses will include:

- Volatile Organic Compounds
- Total Organic Carbon
- Bulk Density
- Grain Size
- Effective Porosity

WELL INSTALLATION

Once the target depth has been reached at each location, a groundwater monitoring well will be installed. Monitoring wells E5D and E6D will be completed as 4" diameter wells with wire-

wrapped stainless steel screens to facilitate their possible future use as remediation wells (injection or extraction), should this be necessary. Monitoring wells E7D and E8D will be completed as 2" diameter wells with machine-slotted PVC screens. All screens will be 5' long. Screen slot size and sandpack specifications will be selected to be appropriate for the materials encountered in the target screen zones. Schedule 80 PVC casing with centralizers will be used for all monitoring wells. Following placement of the clean silica sand filter in the annular space between each well screen and the formation, the well will be vibrated and/or surged to ensure the filter pack is seated and there are no void spaces. The remainder of the annular space in each boring will be filled with hydrated chip bentonite, pelletized bentonite, or bentonite grout, as conditions dictate as the steel casing is extracted. The PVC well casings will terminate approximately 2.5 feet above the ground surface unless the well is in a located in a traffic area (locations E6D, and possibly E7D), in which case it will be terminated approximately 6 inches below the ground surface. Each well will be completed at the ground surface with either flush-mount subsurface vaults for wells in traffic areas, or "stick-up" protectors surrounded by protective bollards in other areas. Well identification tags will be affixed to the wells and permanent elevation reference point will be market on the top of the PVC casings.

GROUNDWATER MONITORING WELL DEVELOPMENT

Each groundwater monitoring well will be developed by ESSCI staff following installation to ensure good hydraulic connection between the well and the aquifer and to remove any solids that could potentially be mobilized during the sampling process. Sometimes a "skin" of clay and silt particles forms on the borehole wall as a result of drilling. The development process is designed to remove this skin to maximize hydraulic continuity, as well as to "set" the sand pack and remove fine-grained material from the area immediately adjacent to the well screen. Adequate development is necessary to ensure accurate water levels (fine soil particles can plug the well openings), the long-term viability (water production ability) of the wells, and the elimination of artifact turbidity in samples which can interfere with laboratory analyses. Well development will be accomplished using surging and high volume pumping. Turbidity will be measured and documented during the development process, and development will proceed until turbidity has declined and stabilized to the maximum extent possible. All non-disposable well development equipment will decontaminated using a nonphosphate detergent (Alconox) wash and an initial clean tap water rinse followed by a final distilled water rinse.

GROUNDWATER MONITORING WELL SURVEYING

After completion of the groundwater monitoring wells, a licensed surveyor will be contracted to measure and record actual locations and elevations (top of casing and land surface) of the newly installed monitoring wells, accurate vertically to the nearest 0.01 ft. The coordinates and vertical elevation will be tied into nearby wells in the monitoring network.

HYDRAULIC CONDUCTIVITY TESTING

Slug tests will be conducted on the new monitoring wells to measure hydraulic conductivity. The slug testing procedure involves instantaneously removing a "slug" of water from the well casing and measuring the rate of water level recovery. A variety of mathematical treatments (depending on geologic conditions and monitoring well configuration) are then applied to the data to develop an estimate of hydraulic conductivity. Given that the wells screens from these proposed monitoring wells will be submerged, the casing pressurizing method of slug testing will be used to maximize the size of the "slug," which increases the representativeness of the results. To implement the slug tests, a pressure transducer will be installed in each well prior to testing. The well casing will then be pressurized to depress the static water level in the well to a point just above the well screen. After the desired displacement has been achieved and the water level and casing pressure have stabilized, the pressure will be instantaneously released from the well casing, allowing the water level to rise. The change in water level will be recorded by the pressure transducer connected to a data logger. At least two slug tests will be completed at each of the four groundwater monitoring wells. The pressure transducer will be decontaminated between each well using a standard three-step process (Alconox detergent, tap water rinse, distilled water rinse).

INSTALLATION OF DEDICATED BLADDER PUMPS

Following well development and slug testing, each new monitoring well will be outfitted with a dedicated QED model P1250 (stainless steel body, Teflon bladder) bladder pump with stainless steel inlet screen, Teflon-lined polyethylene tubing, well cap, and discharge adaptor. Pump intakes will be set at the midpoint of each screen.

5 REPORTING AND DOCUMENTATION

A well installation report will be prepared that documents the field procedures, conditions encountered, as-built construction details, and testing results. The report will include the following components:

- A site vicinity map
- A brief site description and background section
- A summary of the field procedures and observations during borehole advancement, well construction, development, and dedicated bladder pump installation
- Formal geologic/well completion logs that illustrate the lithology and construction of the new groundwater monitoring wells
- Summary tables containing new well construction data (including survey coordinates and elevations) and dedicated pump information
- Slug test data analysis and presentation of results
- Summary tables of laboratory data

- As-built map of groundwater monitoring well locations

The report will be prepared by and stamped by a Washington State licensed Hydrogeologist.