Stantec

Monitored Natural Attenuation Work Plan

Former Bayliner Marine Facility
17825 59th Avenue NE
Arlington, Washington
VCP No.: NW2270
Facility Site ID: 51332889

Prepared For:

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1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) was retained by Brunswick Corporation (Brunswick) to prepare this Work Plan for implementation of Monitored Natural Attenuation (MNA) with application of institutional controls at the Former Bayliner Marine Facility located at 17825 59th Avenue NE, Arlington, Snohomish County, Washington (the "Site"). The location of the Site is shown in ***Figure 1***.

Previous investigations identified the presence of tetrachloroethene (PCE) in shallow groundwater associated with a former septic leach field near Building 11. Groundwater monitoring since December 2009 and recent modeling indicate that the PCE plume extends from Building 11 to the northwest approximately 600 feet. Monitoring well MW-4 had PCE concentrations above the Model Toxics Control Act (MTCA) Method A Cleanup Level (CUL) in the first two years of monitoring but has been below the Method A CUL during the past two years of monitoring. MW-2 and MW-6 to the west and east margins of the plume respectively have never had detectable concentrations of PCE (***Figure 5***).

Several remedial alternatives and estimated costs to address the PCE contamination were presented in the *Remedial Investigation and Feasibility Study* (RI/FS) prepared by Stantec dated January 7, 2011. In-Situ Chemical Oxidation (ISCO) and groundwater monitoring program was selected as a potentially viable remedial alternative for reducing PCE concentrations in groundwater. The *Work Plan* describing the ISCO and groundwater monitoring program was approved for implementation at the Site by the Washington State Department of Ecology (Ecology) on September 25, 2012. The remedial alternatives were evaluated based on several criteria including: protectiveness of human health and the environment, permanence, long-term effectiveness, technical implementability, administrative implementability, and cost. Stantec included an evaluation of three passive remedial alternatives including: MNA, institutional controls, and no action as possible longer-term strategies for achieving the remedial objectives for the Site.

Stantec issued an *In Situ Chemical Oxidation and Groundwater Monitoring Report* on February 10, 2015 describing the results of the June 2013 ISCO injection and four rounds of post-injection groundwater monitoring. The report concluded that while PCE concentrations have remained on Site and stable, ISCO injection in the presumed PCE source area did not result in significantly reduced PCE concentrations within the plume area. Based on the results of the ISCO and post-injection groundwater monitoring program, it was apparent that further active remedial actions are not likely to be effective in achieving the cleanup objectives within a reasonable restoration time frame.

Stantec prepared a *Technical Memorandum* with a proposed closure strategy for the Site on March 12, 2015. In this document, Stantec formally proposed MNA with application of institutional controls as the most suitable closure strategy for the Site. The MNA and institutional control strategy will ensure continued protection of human health and the environment and demonstrates compliance with cleanup standards. The objective of this approach is a formal No Further Action (NFA) determination from Ecology.

The *ISCO/Groundwater Monitoring Report* and *Technical Memorandum* were both submitted to Ecology's Voluntary Cleanup Program (VCP) for review and opinion in March 2015. In an Opinion Letter dated June 1, 2015, Mr. Dale Myers, the Ecology Site Manager, noted that "the normally expected degradation products of TCE, cis/trans isomers of dichloroethene (DCE) and vinyl chloride (VC) have not been observed at concentrations above laboratory reporting limits at any time with the exception of 16 µg/L of TCE in monitoring well MW-4 in 2009". Mr. Myers concluded that "conditions for reductive dechlorination of PCE in ground water may not be optimal for the Site".

Mr. Myer also noted that in "post in-situ chemical oxidation (ISCO) injections, concentrations of PCE in monitoring well MW-8 steadily increased from 34 µg/L to 42 µg/L and concentrations of PCE in MW-1 appears to have stabilized at 31 µg/L to 36 µg/L. Mr. Myers concluded that "Additional ground water monitoring and evaluation will be necessary to demonstrate (that) natural attenuation is occurring". Mr. Myers requested that Brunswick and Stantec prepare a Work Plan describing how MNA with institutional controls would be implemented at the Site.

This *Monitored Natural Attenuation Work Plan* presents compliance monitoring procedures and a contingency plan that address the remaining groundwater impacts, defines conditional points of compliance, presents information on the PCE plume, and discusses transport exposure pathways at the Site. The area of interest for this Work Plan is the area in the immediate vicinity of Building 11 and areas within the PCE plume to the northwest defined to be the "Site". The United States Environmental Protection Agency's (EPA) BIOCHLOR natural attenuation screening model was used to model groundwater conditions at the Site and confirm the applicability of the proposed closure strategy.

1.1 Purpose

This Work Plan for the Former Bayliner Marine facility provides a summary of environmental investigations, remedial efforts, and monitoring performed at the Site. It provides a summary of current groundwater sampling data and a description of the proposed groundwater monitoring program to support use of an MNA strategy at the Site.

The Work Plan also describes the process by which monitoring results might trigger a contingency response, a general description of potential contingency actions, and procedures for implementing the proposed contingency actions.

The objective of the MNA and institutional control strategy is to demonstrate stable groundwater conditions and obtain an NFA determination for the Site.

1.2 Scope of Work

The Work Plan is based upon the MNA approach described in Ecology's guidance document entitled *Guidance for Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation*, Ecology Publication No. 05-09-091 (Version 1.0) dated July 2005. Stantec also utilized EPA's BIOCHLOR natural attenuation screening model (Version 2.2) to model subsurface conditions at the Site.

This Work Plan has been prepared in accordance with the Model Toxics Control Act (MTCA) general requirements for compliance monitoring contained in Washington Administrative Code (WAC) 173-340-410 and incorporates points presented by Mr. Myers in his Opinion Letter dated June 1, 2015. A copy of this letter is included as ***Appendix A***.

The primary objective of the Work Plan is to describe the proposed MNA program and how this approach ensures that natural attenuation will continue to be effective and protective of human health and the environment during the restoration time frame.

The main elements of the Work Plan are:

- Define the number and location of monitoring wells in the compliance well network consisting of both conditional points of compliance (compliance wells) and performance wells;
- Present the monitoring parameters i.e. the Contaminants of Concern (COCs), as well as primary and secondary geochemical indicators evaluated to monitor the performance of natural attenuation;
- Present the results of the BIOCHLOR groundwater modeling;
- Define the monitoring frequency of wells in the compliance well network;
- Discuss protocols for demonstrating compliance; and,
- Develop a Contingency Plan describing the types of triggers that would require additional action if one or more of wells in the network showed an increase in PCE concentration.

2.0 SITE DESCRIPTION

The former Bayliner Marine facility is a 32.8-acre industrial property located east of Arlington Airport. The Site contains three office buildings and 13 industrial buildings constructed between 1969 and 1996. The Site also includes employee parking lots, outdoor equipment storage areas, and three stormwater retention ponds. The Site operated as a fiberglass boat manufacturing facility from 1968 until operations ceased in December 2008. Prior to 1968, the Site consisted of undeveloped land.

Historic uses of the Site and adjoining properties are described in detail in the March 2009 *Phase I Environmental Site Assessment (ESA)* report. The Site was undeveloped land prior to 1968, when it was developed as a fiberglass boat manufacturing plant. Building 4, constructed in 1969, was the first manufacturing building on the site. Other buildings were added between 1971 and 1996. The facility operated continuously as a fiberglass boat manufacturing plant from 1968 to 2008.

According to the City of Arlington Development Services office, the Site has a current zoning designation of GI (General Industry). Potable water is supplied to the site by the City of Arlington, and electrical power is serviced by Snohomish Public Utility District.

Floor trench drains are present in Buildings 3, 4, and 10. According to Bayliner personnel, these drains discharge to the retention ponds on the south side of the property. Exterior stormwater drains from around the property are also routed to the retention ponds. Sanitary sewage from sinks and toilets within the buildings originally discharged to two on-site septic systems. Maps reviewed in the records of the Snohomish County Health Department depict the septic leach field locations to be as shown on ***Figure 2***. One of the leach fields was located between Building 9 and Building 12A. The other was just outside the southeast corner of Building 11. According to a sewer permit technician with the City of Arlington, the septic systems were decommissioned and the Site buildings were connected to the municipal sanitary sewer between 1987 and 2005.

The majority of the former Bayliner Marine facility is covered by buildings or paved surfaces, minimizing the risk for migration of PCE vapors to ambient outdoor air. Indoor air samples collected in April 2010 in Buildings 4, 8, 10, 11, 14, and 17 did not detect PCE concentrations in the indoor air above the applicable indoor air screening level.

2.1 Release History and Source Area

The review of former Bayliner facility history provided in previous reports identified three potential sources of releases of hazardous substances to the subsurface environment: the former underground fuel storage tanks, the three stormwater retention ponds, and the two former septic system leach fields. Previous soil and groundwater investigations did not find evidence of any releases from the fuel tanks. No Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), or metals were detected at concentrations above Method A soil CULs in soil samples collected from the retention ponds. However, PCE concentrations above the Method A CULs were identified in groundwater.

The highest concentrations of PCE in groundwater were found in the samples located near the former septic system leach field near Building 11(MW-1 and MW-8), with the next highest concentrations in the samples from the downgradient (northwest) side of Building 11. Soil samples from the borings near the edge of the former leach field contained low concentrations of PCE that appear more likely to represent capillary zone smearing of PCE from the groundwater than remnants of a historic subsurface PCE release to the leach field.

According to interviews with Bayliner facility personnel and representatives of Brunswick Corporation, there was no known history of PCE storage or use at the facility. PCE has not proved to be an effective solvent for use with the fiberglass materials in the boat manufacturing process, and therefore is not typically used in, or present at, such facilities. The relatively low detected concentrations of PCE in groundwater suggest that the quantity of PCE released was small, and not related to routine use at the facility.

Although the origin of the PCE impacts cannot be confirmed in the absence of an identifiable point source in the soil, it is assumed that small quantities of PCE were used for a brief time at the facility. It appears possible that a small quantity of PCE could have been disposed into sink drains at the facility which discharged to the septic system leach field near Building 11, resulting in leaching of the contaminant into the underlying shallow groundwater.

The Bayliner facility began operations in 1968, and decommissioning of the septic systems at the site started in 1986. Thus, it is very likely that the releases(s) of PCE occurred 25 to 40 years ago, and that impacts to soil in the leach field area have naturally degraded over time.

For purposes of this Work Plan, the source area of the PCE contamination is considered to be the septic system leach field near the southeast corner of Building 11.

2.2 Summary of Investigations and Remedial Actions Performed

A general timeline of the historical environmental investigations and their findings and remediation technologies implemented at the site is presented below.

Phase I ESA – April 2009

In April 2009, Brunswick Corporation, the former property owner, retained Stantec to complete the Phase I Environmental Site Assessment (ESA) in anticipation of the potential sale of the property. Based on a review of historical records about the property, the Phase I ESA Report identified the following Recognized Environmental Conditions (RECs) associated with the subject property:

- Wastewater discharges from the facility were originally directed to two septic systems with leach fields on the subject property. All wastewater from the facility went to the on-site septic systems from 1968 until at least 1987. Site buildings were gradually connected to the municipal sanitary sewer system between 1987 and 2005. Chemical waste constituents that may have been present in the wastewater discharges had the potential to migrate from the leach fields to subsurface soil and groundwater beneath the subject property.

- All stormwater catch basins and trench drains on the property discharged the collected stormwater to a series of three retention ponds along the southern boundary of the subject property. As such, there was a potential that chemical or petroleum contaminants that may have become entrained in stormwater runoff could have accumulated in sediments within the ponds or leached to underlying soil or groundwater.

- Ecology's underground storage tank (UST) database indicated that two USTs had been present on the subject property from 1964 until 1996. No other details about the location or fate of the tanks were located in records at the property or in files researched at the City of Arlington Fire Department. There was a potential that petroleum leaks or spills that may have resulted from the operation of the tank systems could potentially cause contamination of subsurface soil or groundwater.

Phase II ESA – June 2009

Brunswick directed Stantec to complete a Phase II ESA at the Site to further evaluate the potential presence or absence of impacted soil, sediment or groundwater associated with the RECs discussed above. Key findings of the Phase II ESA are summarized below:

<u>Former Underground Storage Tanks</u>. Bayliner personnel reported fuel USTs had been formerly located in the area just north of Building 11. Stantec also reviewed files pertaining to the former USTs at Ecology's Northwest Regional Office. Ecology's records indicated that one 5,000-gallon UST containing aviation gasoline and one 9,000-gallon UST containing Jet A fuel were removed in April 1989. No further documentation, such as results of soil sampling conducted at the time of the removal, was present in the Ecology files.

<u>Sampling of Soil, Groundwater and Pond Sediment</u>. In May 2009, soil borings were completed using a hollow-stem auger drilling rig at seven locations (B-1 through B-7) selected to evaluate potential impacts from the areas of concern identified as RECs in the Phase I report. Samples of soil and groundwater from each location were collected for laboratory analyses. To evaluate potential accumulations of contamination in the three on-site retention ponds, Stantec collected surface sediment samples from the bottom of each pond.

The Phase II ESA identified an area of shallow groundwater impacted with PCE at concentrations above the MTCA Method A Groundwater CUL. The highest reported concentration of PCE was 42 µg/L in the area of a former septic system leach field near the southeast corner of Building 11. The reported PCE concentration was 31 µg/L approximately 200 feet northwest in the presumed source area. The PCE concentration was 18 µg/L at the northern property boundary, approximately 800 feet in the presumed source area. Based on the data generated in this preliminary investigation, the lateral extent of PCE impact to the east and west appeared to be limited. No other VOCs were detected in the collected groundwater samples. No SVOCs were detected in any of the groundwater samples.

The analytical results did not identify any compounds in soil at concentrations exceeding Method A Soil CUL for Unrestricted Site Use. Based on results of the Phase II ESA, there was no evidence of impact from the former USTs, or from stormwater discharges to the on-site retention ponds. The presence of PCE in shallow groundwater was the only impact identified during the Phase II ESA that warranted further investigation.

Environmental Site Investigation – December 2009

Five groundwater monitoring wells (MW-1 through MW-5) were constructed to further characterize and confirm the Phase II findings. PCE was detected in groundwater at concentrations exceeding the MTCA Method A Groundwater CUL at MW-1 (near Building 11 in the south-center of the site) and at MW-4 (near the north-central perimeter of the facility). TCE was also detected in groundwater at MW-4. No VOCs were detected in groundwater at the other three well locations.

PCE was detected in soil at MW-1 and MW-4, at concentrations below the MTCA Method A Cleanup Level for residential soils. Consequently, further evaluation of PCE in soils at these locations was not warranted.

Additional Site Characterization – February-March 2010

To further delineate the extent of PCE impact in groundwater, the following additional investigations were conducted in February, March, and April 2010, with results presented in the April 2010 *Additional Site Characterization* report. In summary:

- Groundwater monitoring wells MW-6 and MW-7 were constructed on February 17, 2010.
- Temporary monitoring wells were installed on February 18, 2010 to facilitate groundwater sampling.
- Groundwater samples were collected on February 18, 2010 from monitoring wells MW-1 through MW-7 and from the temporary wells.
- Seven additional soil borings were completed as temporary wells on March 19, 2010, and groundwater samples were collected.

The results of the February-March 2010 groundwater sampling confirmed that the area of PCE-impacted groundwater was limited to a fairly narrow band between MW-1 and MW-4, with the highest PCE concentrations found in the area of Building 11 (MW-1) in the south-central portion of the property.

Soil Vapor Sampling – April 2010

In April 2010, two indoor air samples were collected in Building 11, and one indoor air sample each was collected from Buildings 4, 8, 10, 14, and 17. The samples were submitted to for analysis of selected VOCs by USEPA Method TO-15 (GC/MS SIM). PCE was not detected above the laboratory MRL of 0.21 $\mu g/m^3$ in four of the seven samples. PCE was detected in the two samples from Building 11 at concentrations that were below the proposed CUL established under MTCA Method B (0.42 µg/m³). The highest PCE concentration (1.2 µg/m³), reported for the sample from Building 14, is above the proposed Method B CUL of 0.42 µg/m³ for residential settings, but below the proposed Method C CUL of 4.2 µg/m³ for industrial settings.

Groundwater monitoring of the seven on-site monitoring wells continued on a regular basis throughout 2010 and most of 2011. Monitoring well MW-8 was completed on the north side of Building 11 on September 14, 2011.

In-situ Chemical Oxidation (ISCO) – May/June 2013

Between May 30 and June 6, 2013, Stantec oversaw in-situ chemical injection of RemOx® L ISCO reagent (RemOx®), a pre-mixed sodium permanganate ($NaMnO_4$) liquid solution at 12 injection points near the presumed PCE source at the southeast corner of Building 11. Nine points (IP-1 through 8 and IP- 11) were completed in the suspected source area (the former septic leach field) at the southeast corner of Building 11 and three points (IP-9, IP-10 and IP-12) were completed on the hydraulically downgradient (north) side of Building 11 (***Figure 3***). Approximately 680 gallons of sodium permanganate solution was injected at each injection point.

ISCO Reporting and Proposed Closure Strategy – March 2015

Fifteen months of post-injection groundwater monitoring of the 8 on-site monitoring wells was completed in September 2014. Results of the ISCO injection and monitoring were presented in the *In Situ Chemical Oxidation and Groundwater Monitoring Report* dated February 10, 2015. Based on the limited success of the ISCO program, Stantec proposed MNA with application of institutional controls as the most suitable closure strategy for the Site. The *Technical Memorandum* describing the proposed implementation of the MNA and institutional controls approach was presented to Ecology in March 2015.

2.3 Description of Current Site Conditions

The geologic and hydrologic conditions relevant to compliance monitoring and contingency monitoring are briefly summarized in the following sections.

2.3.1 Geology

The physiographic features and rock units of the Arlington area represent the end product of a complex geologic process. The glacially derived sands and gravels of Pleistocene age are the most recent deposits in the area, and various units of this group serve as the major aquifers in the area.

The Stillaguamish sand member is an outwash deposit which accumulated to a thickness of about 200 feet at a time when the melting ice temporarily blocked the river at the north end of Getchell Hill and caused the Stillaguamish drainage to pass southward through a spillway now followed by the Pilchuck River. The deposits are largely fine sand and clay but contain much coarser material towards the top and especially around the margin opposite points of tributary-stream debouchments. Review of well logs in the region confirms the presence of significant, discontinuous layers of clay within the sand aquifers.

According to the United States Geological Survey 7.5-minute topographic map for the Smokey Point, Washington quadrangle (1981), the Site is situated at an elevation of approximately 133 feet above mean sea level (MSL). The general topographic gradient in the vicinity is toward the northwest. The area to the north, south, and west is relatively flat and slopes downward slightly toward the Stillaguamish River, located approximately 1.4 miles to the northwest. However, an area of low hills rise steeply just to the east of the Site, reaching to ridges of up to 350 feet above MSL within less than one-half-mile.

The Site is underlain by Lynnwood loamy sand soils. Lynnwood soils have generally high infiltration rates and are considered to be well-drained to excessively-drained sands and gravels. The nearest surface water bodies are the Middle Fork of Quilceda Creek, approximately 0.4 miles south of the Site, and Portage Creek about 1.1 mile north of the Site. According to the U.S. Fish & Wildlife Service National Wetlands Mapper, the nearest identified wetland areas are approximately 0.75 of a mile southeast and 1.5 miles northwest of the Site.

Logged subsurface soils at the Site consist of fine-to-coarse-grain sand with traces of gravel. Similar soil conditions were noted at all depth intervals in all of the previous borings, with the only noticeable difference being slight variation in the amount of gravel. Well logs for the on-Site monitoring wells are presented in ***Appendix B***.

2.3.2 Groundwater

Top-of-casing elevations surveyed for each monitoring well have been used to determine the relative potentiometric surface elevation at each well location, the average hydraulic gradient across the Site, and the direction of groundwater flow. Groundwater flow direction has been toward the northwest, with the gradient ranging from 0.0018 feet per foot (ft/ft) in September 2013 to 0.0021 ft/ft in September 2014.

Water well logs, reviewed at the Ecology web site, identified approximately 136 wells within a 0.5 mile radius of the Site. The majority of the wells (60 wells) were located upgradient or cross-gradient from the Site. Of the 16 well logs from the downgradient quadrant, 15 are listed in the ¼ section directly northwest of the Site (T31N, R03E, Section 22, SE ¼ of the NW ¼). Fourteen of those are listed as resource protection wells (monitoring wells). One well is listed as a City of Arlington municipal water supply well, located approximately 1,500 feet north-northwest from the northwest corner of the Site. The well is reported to be 185 feet deep, with a screened interval between 151 and 181 feet bgs. According to the web site for the City of Arlington Department of Public Works, the well supplies 2 percent of the City's overall water supply.

The well construction log for the City of Arlington water supply well does not indicate the presence of a confining layer in the stratigraphy at the Site. However, a layer of fine sand with yellow clay was logged from 103 to 112 feet bgs and is interpreted to be an aquitard separating an upper and lower water bearing unit. This layer of sand and clay is below the shallow water bearing zone and above the well screen interval and lower water bearing unit. The continuity of this lower permeability layer is unknown.

Static water levels, recorded in well monitoring events since December 2009, ranged between 14 and 22 feet below ground surface (bgs). Variation in static water levels since December 2009 has been between 2 to 3 feet.

2.3.3 Contaminant Characteristics

The constituent of concern (COC) for the site is PCE. Because PCE is a relatively common contaminant, which has been the subject of many investigations, its behavior in the subsurface is well understood. The presence of in the various media has been defined at the Site.

PCE is a volatile organic constituent and its presence in soil vapor may account for some of the PCE found in groundwater, especially in areas upgradient and cross gradient of the sewer line. PCE in the vadose zone soil vapor travels by diffusion driven by a concentration gradient, which is independent of the groundwater flow direction. PCE in vapor form can partition into groundwater at locations that are not anticipated based on contaminant transport solely by groundwater flow. Concentrations of PCE in soil vapor decline with distance from the source area. When PCE partitions from soil vapor into groundwater, the result is generally low concentrations of PCE in groundwater.

PCE can break down in groundwater through reductive dechlorination by anaerobic bacteria, which can metabolize HVOCs by sequentially removing chlorine atoms until only ethane or ethane gas remains. PCE is reduced to TCE, then to DCE, then to vinyl chloride and finally to ethane or ethane with the removal of the final chlorine atom. This sequential dechlorination is performed by specific anaerobic bacteria populations, which must be present at the site in sufficient populations and must be in the correct geochemically reducing environment to break down PCE. The lack of any PCE breakdown products and the generally geochemically aerobic groundwater conditions at the site indicate that reductive dechlorination may not be occurring or is occurring at a rate that is too insignificant to detect by routine groundwater monitoring and analysis.

Based on the review of the historical reports, potential residual PCE contamination in soil is limited to a small area in the vicinity of the former septic tank drain field at the southeast corner of Building 11. However, even this small area of slightly elevated PCE concentrations likely no longer exists because the ISCO injection in this area has likely reduced these concentrations to less than the Method A CUL.

The PCE plume in groundwater with concentration above the Method A CUL of 5 μg/L extends approximately 600 feet northwest of the PCE source area at the southeast corner of Building 11. The central part of the plume with PCE concentrations up to 40 μg/L is confined to the footprint of Building 11. Based on the most recent groundwater data for the site, the downgradient extent of the plume does not extend to monitoring well MW-4 along the northern boundary of the former Bayliner property. Refer to ***Figure 5***.

2.3.4 Surface Water

The Site is a fully developed light industrial and storage facility. It is fully paved or covered by buildings with the exception of small landscaped areas and the three stormwater retention ponds. The parking area is drained by catch basins, which drain to the three retention ponds located along the southern boundary of the former Bayliner facility as shown in ***Figure 2***. Other than the stormwater retention ponds, there are no drainage ditches, intermittent streams, or other surface water features on the property.

3.0 Fate and Transport Modeling

At the request of the Ecology Site Manager, computer modeling was performed to evaluate the fate and transport of dissolved PCE in groundwater at the Site using EPA's BIOCHLOR screening model (Aziz and Newell, 2000). The modelling was performed to evaluate PCE concentrations in groundwater and the possibility of off-Site migration. The hydrogeologic conditions of the Site and the physical/chemical characteristics of PCE were used as the basis for simulating PCE concentrations downgradient from the source area at the Site. The model was calibrated to observed concentrations at a downgradient monitoring well (MW-4).

3.1 BIOCHLOR Model Selection

The selected groundwater flow model utilized for this study was BIOCHLOR Version 2.2 which is based on the Domenico (1997) analytical flow model. BIOCHLOR is programmed in the Microsoft Excel environment and is available from the EPA. The Domenico Model calculates the concentration of contaminant species at any point and time down gradient of a source area of known size and strength. The Domenico model has been successfully applied as a screening model at a wide range of Sites. The program is thoroughly documented, widely used by consultants, government agencies, and researchers, and is consistently accepted in regulatory proceedings. The Domenico model has particular application as a "conceptual" model where hypothetical or "worst case" conditions are investigated. By using conservative input assumptions, the Domenico model may be useful in providing quantitative fate and transport analyses.

The Domenico analytical model is based on the advection-dispersion partial-differential equation for organic contaminant transport processes in groundwater as described below.

$$\frac{\partial C}{\partial t} = D_x \frac{\partial^2 C}{\partial x^2} + D_y \frac{\partial^2 C}{\partial y^2} + D_z \frac{\partial^2 C}{\partial z^2} - v \frac{\partial C}{\partial x}$$

Where:

C = contaminant concentration (milligrams per liter ((mg/L))
t = time (day)
v = groundwater seepage velocity (feet/day)
x,y,z = coordinates to the three dimensions (feet)
Dx, Dy, Dz = dispersion coefficients for x,y,z dimensions, respectively (feet^2/day)

To incorporate a natural degradation factor, Domenico (1987) introduced a first order degradation rate constant to approximate the original analytical solution to the above equation. To evaluate transient plume behavior, the transient, centerline analytical solution derived by Domenico (1987) is applied. Under conditions of a continuous source and finite source dimensions with one-dimensional groundwater velocity, longitudinal, transverse, and vertical dispersion, and a first order degradation rate constant, the equation shown below represents the Domenico transient solution for the centerline concentration as a function of time:

$$C(x,0,0,t) = \frac{C_0}{2} \exp\left\{ \frac{x}{2\alpha_x} \left[1 - \left(1 + \frac{4\lambda \alpha_x}{v} \right)^{\frac{1}{2}} \right] \right\} \times \left\{ erfc \left[\frac{x - vt\left(1 + \frac{4\lambda \alpha_x}{v} \right)^{\frac{1}{2}}}{2(\alpha_x vt)^{\frac{1}{2}}} \right] \right\} \times erf\left[\frac{Y}{4(\alpha_y x)^{\frac{1}{2}}} \right] \times erf\left[\frac{Z}{4(\alpha_z x)^{\frac{1}{2}}} \right]$$

Where:

C = contaminant concentration (micrograms per liter ((µg/L))
t = time
(x,0,0) = plume centerline at a distance of x
C0 = steady state contaminant concentration in the source of the well (µg/L)
x = centerline distance between the downgradient well and source well (feet)
αx = longitudinal dispersivity (feet)
αy = transverse dispersivity (feet)
αz = vertical dispersivity (feet)
λ = degradation rate constant (1/day)
v = groundwater velocity (feet/day)
Y = source width (feet)
Z = source depth (feet)
erf = error function
erfc = complementary error function
exp = exponential function

In addition to its attributes of widespread use and acceptance, the Domenico model was also selected because of its versatile simulation features. The model is capable of simulating key chemical transport processes that reduce constituent concentrations during migration in groundwater such as advective transport, dispersion, decay, and sorption. This modeling effort used the advective, decay, and sorptive functions of the model.

3.2 Assumptions and Limitations

Assumptions used in this model include:

- Homogeneous aquifer properties,
- One dimensional groundwater flow,
- No change in groundwater flow direction and velocity,
- Contaminant concentration estimated at the centerline of the plume, and
- Molecular diffusion based on concentration gradient is neglected.

The major limitation of any analytical groundwater transport model is that steady, uniform, one dimensional groundwater flow is assumed. The Domenico model is primarily intended for use in unconsolidated aquifers with reasonably uniform physical and hydrogeologic properties. Despite these limitations, the Domenico model has been successfully applied as a screening model to actual data from contaminated sites.

3.3 Discussion of Input Parameters

In this analysis, the effects of advective transport, sorption, and first order decay were evaluated to determine the natural attenuation of PCE with distance from the highest observed value at the Site (presumed source area). The following presents the methodology used to derive each of the parameters used to conservatively estimate PCE concentration reduction during migration. A summary table of the input values, data sources and the model results is included as ***Table 3***. The BIOCHLOR input and output graphics are attached as ***Appendix C*** and ***Appendix D*** respectively.

3.4 Advection

Darcy Velocity (V_D). The Darcy velocity, also known as the seepage velocity, is the advective velocity of groundwater in the aquifer. Darcy velocity is calculated via the following equation (Bouwer, 1978):

$$V_D = \frac{ki}{n_e}$$

Where,

k = hydraulic conductivity of aquifer (feet/day) = 187 feet/day (see below)
i = hydraulic gradient (feet/foot) = 1.2×10^{-3} feet/foot (see below)
n_e = effective porosity (unitless) = 0.22 (see below)

V_D = 187 feet/day * 1.2×10^{-3} feet/foot / 0.22 = 1 foot/day (373 feet/year)

<u>*Hydraulic Conductivity (k).*</u> A Site-specific pumping test was performed at monitoring well MW-1. The data from this test was used to estimate a hydraulic conductivity value of 0.013 feet/minute (19 feet/day or 6.6×10^{-3} centimeter per second (cm/sec)) which is on the low end of the literature range for clean sand (Aziz and Newell, 2000, Freeze and Cherry, 1979, Heath, 1983). To be conservative, the estimated hydraulic conductivity was multiplied by a factor of ten yielding a value of 6.6×10^{-2} cm/sec which is within the median literature range for clean sand.

<u>*Hydraulic Gradient (i).*</u> The horizontal hydraulic gradient was estimated based on groundwater elevations from wells MW-1, MW-2, and MW-4. These wells were chosen for the estimate based on their location within and downgradient from the source area. Groundwater gradient is locally represented by the plane defined by three points in space. The gradient of this plane was calculated for the three wells listed above based on groundwater elevation values from

September, 2013, November, 2013, June, 2014, and September, 2014. The average horizontal hydraulic gradient was calculated to be 1.2×10^{-3} feet/foot.

Effective Porosity (ne). Well logs for the Site indicate that the lithology of the aquifer is generally a fine to coarse grained sand. Literature values for effective porosity of medium sand range from 0.15 - 0.30 (Aziz and Newell, 2000). An effective porosity of 0.22 is estimated for the Site.

3.5 Dispersion

Dispersion refers to the process whereby dissolved phase contaminants may be spatially distributed longitudinally, transversely and vertically due to mechanical mixing and chemical diffusion. These processes contribute to the spatial distribution of the dissolved phase contaminant in the aquifer.

Fixed values used for longitudinal dispersivity (alpha x) in BIOCHLOR models are related to the estimated plume length. One method for estimating plume length based on alpha x was developed by Xu and Eckstein (1995) and is presented in the following equation:

Alpha x = $0.82*3.28*(\log(Lp/3.28))^{2.446}$

Where,

Alpha x = longitudinal dispersivity
Lp = Plume Length = 6

A plume length of 650 feet was estimated for the Site. Use of the Xu and Eckstein equation resulted in a value of alpha x of 21 feet.

Transverse and vertical dispersivity were estimated relative to longitudinal dispersivity at 1/10 times and 1/100 times the longitudinal dispersivity (Gelhar and others, 1992).

3.6 Adsorption

Dissolved constituents do not generally travel at the advective speed of the groundwater due to adsorption processes. Dissolved organics are absorbed from solution onto the aquifer matrix, thus slowing the movement of contaminants. Adsorption tends to slow the transport velocity of constituents dissolved in groundwater. When the average velocity of a dissolved constituent is less than the seepage velocity, the constituent is impeded with respect to groundwater flow. The coefficient of Retardation, R, is used to estimate the impeded constituent velocity. The coefficient of retardation is described by the following equation:

$$R = 1 + \frac{\rho_d K_d}{n_e} \quad \text{where: } k_d = k_{oc} * f_{oc}$$

Where,

ρ_d = bulk density of soil (kilograms/liter (kg/L)) = 1.6 kg/L (see below)
k_{oc} = organic carbon distribution coefficient (liters/kilogram (L/kg)) = 426 L/Kg (see below)
f_{oc} = organic carbon content of soil (unitless) = 0.0006 (see below)
n_e = effective porosity (unitless) = 0.22 (see above)

Based on the equation presented above and values discussed below, the estimated retardation factor for PCE at the Site is presented below.

R = 1+1.6 kg/L * 426 L/kg * 0.0006 / 0.22 = 2.86

This results in a contaminant flow velocity that would be anticipated to be 2.86 times slower than the advective groundwater flow velocity, for PCE at the Site.

Bulk density (ρd). Bulk density values for fine, medium, and coarse grained sand range from 1.37 to 1.81 kg/L with an average of 1.6 kg/L (Wiedemeier, 1998). The BIOCHLOR User's Manual notes that in most cases an estimated bulk density of 1.7 kg/L is used when estimating the coefficient of retardation (Aziz and others, 2000). A bulk density of 1.6 kg/L was used in estimating the coefficient of retardation for the Site.

Organic Carbon Distribution Coefficient (k_{oc}). The organic carbon distribution coefficient is a contaminant and temperature dependent parameter (Aziz and others, 2000). BIOCHLOR allows for the use of one coefficient of retardation value for all of the parameters modeled at the Site. Because PCE is the primary COC that has been detected in groundwater at the Site, a literature estimate for PCE was used. The BIOCHLOR User's Manual lists a value of 426 liter per kilogram (L/kg) but notes that there is a wide range of reported values (Aziz and others, 2000). Fetter (1999) listed a range of values from 204 to 2,630 L/kg. The BIOCHLOR default value (426 L/kg) was used in estimating the coefficient of retardation for the Site.

Organic Carbon Content of Soil (f_{oc}). The BIOCHLOR User's Manual recommends using a value of 1.0 x 10-3 when site specific values are not available (Aziz and others, 2000). Wiedemeier (1998) reported f_{oc} values for glaciofluvial sand that ranged from 0.00017 to 0.073 with a median value of 0.0006. To be conservative, a value of 0.0006 was used in estimating the coefficient of retardation for the Site.

3.7 Source Data

The highest observed value of PCE at the Site was 0.042 mg/L at the source area monitoring well MW-8. This value was used as the source area concentration in the model. The former septic leach field, MW-1 and MW-8 were assumed to represent the source area for the Site. The width of this area as measured perpendicular to the groundwater flow direction is approximately 100 feet. A source area width of 100 feet and depth of 10 feet were used in the model.

3.8 Biotransformation

The model includes a first order decay coefficient (λ) to account for degradation of COCs. The first order decay rate was the primary calibration parameter in the model. The plume decay rate for PCE was calibrated to the 2014 sampling results for PCE in the downgradient monitoring well MW-4 (0.004 mg/L). MW-4 is located approximately 700 feet downgradient from the source area well MW-1. A PCE plume decay rate of 0.6 yr-1 was found to match the calibration data for PCE and was used in the final calibrated model. ***Appendix C*** includes a plot of PCE concentration versus distance and includes the calibration data and the calibrated model output.

A PCE decay rate of 0.6 yr^{-1} fits the observed downgradient concentrations of PCE. Howard and others (1991) reported a range of half-life values for anaerobic degradation of PCE in groundwater of between 0.15 to 2.6 yr^{-1}. Aziz and others (2002) reported a range of field derived decay rate constants for PCE from 0.8 to 2.4 yr^{-1} with a median value of 1.1. The rates reported by Aziz and others 2002 were derived from sites with evidence of a significant electron donor. The authors recommend using a value lower than the minimum field derived rates for sites with low levels of electron donor. The calibrated value of 0.6 yr^{-1} is within the recommended range of less than 0.8 yr^{-1}.

Anaerobic dechlorination of PCE typically produces a series of daughter products: Trichloroethylene (TCE), cis-1,2-Dichloroethene (cis-1,2-DCE) and Vinyl Chloride (VC). TCE has been detected once in monitoring well MW-4. The predicted concentrations for these PCE daughter products do not match the generally, low or non-detected monitoring results for these parameters. The low levels and frequent lack of detected daughter products suggests that reductive dechlorination is not the only processes accounting for the natural attenuation of PCE at the Site.

The decay rate parameter can also be used to integrate processes other than biodegradation that are potentially removing contaminants from the dissolved phase including dispersion, dilution and volatilization. Aziz and others (2002) noted that decay rates calibrated to field data may overestimate biotransformation rates by combining the effects of biotransformation with the effects of lateral and vertical dispersion. Similarly, dispersion, dilution and volatilization may also provide significant natural attenuation over time. The Site-specific calibrated PCE decay rate is based upon a match to field data for PCE. However, the results should be used with an understanding that the first order decay rate may represent a combination of processes along with biotransformation.

3.9 Results and Discussion

When available, Site-specific data was used as input for the model. When Site-specific data was not available, conservative literature values were used. The complexities of the Site in combination with the screening nature of the one dimensional flow model necessitate simplifications. The model was calibrated to dissolved phase concentrations of PCE downgradient from the source area.

HVOCs are naturally attenuated in the environment through biologically mediated degradation. HVOCs are further reduced in groundwater by the processes of dilution, dispersion, and volatilization. While the decay rate parameter for PCE was used to calibrate the model, anaerobic biodegradation may not be the only or the primary mechanism limiting the extent of the plume.

Based upon the BIOCHLOR model, the extent of dissolved PCE in groundwater is simulated to be stable. The model predicts that the PCE plume (as defined by the extent of concentrations above 5 μg/L) reached a maximum length of approximately 600 feet within 12 years of the release. The property boundary is located approximately 810 feet downgradient from MW-8. The simulated PCE concentration at the property boundary is 3 μg/L which is less than the MTCA Method A CUL of 5 μg/L.

The model results are in accordance with the observed results. Groundwater collected at monitoring well MW-4, located approximately 600 feet down gradient of the source area had low concentrations of PCE (below the MTCA Method A CUL) during the first two years of monitoring but has been below the Method A CUL during the last two years of monitoring. Groundwater collected at monitoring well MW-7, located approximately 110 feet downgradient from MW-4 has exhibited PCE concentrations below laboratory reporting limits in each of the 10 sampling events completed at the Site.

4.0 COMPLIANCE CRITERIA AND MONITORING REQUIREMENTS

This section briefly summarizes the development of compliance criteria and defines the proposed methods of compliance monitoring in the context of MTCA requirements (WAC 173-340-410). The site-specific groundwater, soil vapor, and indoor air COCs, groundwater compliance criteria, and rationale for a containment strategy are described in the following sections.

4.1 Groundwater, Soil Vapor, and Indoor Air Constituents of Concern

The COC for groundwater, soil vapor, and indoor air at the site is PCE. To date, PCE's breakdown products, DCE and vinyl chloride have not been detected in groundwater samples. TCE was detected in MW-4 in the first round of groundwater sampling but has not been detected there or in any other well since that time. These breakdown products may be detected at the Site if PCE undergoes reductive dechlorination. These constituents are, therefore, potential COCs and will also be analyzed for during compliance monitoring events.

Groundwater samples will be analyzed for chlorinated VOCs associated with analytical method EPA Method 8260C.

4.2 Current Constituent of Concern Concentrations

Post-injection groundwater sampling results indicate the extent of the PCE plume is defined. The plume is stable, confined to the property, and concentrations are decreasing in the presumed source area.

Concentrations of PCE exceeding the MTCA Method A CUL were detected in MW-1 and MW-8. MW-1 is located at the southeast corner of Building 11 and is considered closest to the suspected source of the contamination. MW-8 is located on the north side of Building 11 and is considered the closest downgradient well. TCE was detected in MW-4 in December 2009 but has not been detected in MW-4 or any of the other on-Site wells sampled during any subsequent sampling.

In MW-1, the PCE concentrations ranged from 35 µg/L in the September 6, 2013 sampling round to 36.5 µg/L in the September 16, 2014 sampling round. In MW-8, the PCE concentration ranged from 34 µg/L in the September 6, 2013 sampling round to 42.4 µg/L in the September 16, 2014 sampling round.

PCE concentrations below the MTCA Method A CUL were detected in MW-4, located along the northern boundary of the Site, and in MW-5, located at the northwest corner of the Site during the post-injection monitoring. The PCE concentration in MW-4 ranged from 3.1 µg/L in the November 26, 2013 sampling round to 3.92 µg/L in the September 16, 2014 sampling round. In MW-5, PCE was detected at a concentration of 3.1 µg/L in the September 6, 2013 sampling round and has not been detected since.

PCE has never been detected in MW-2, MW-3, MW-6, or MW-7.

Cumulative analytical results from the groundwater sampling program since December 2009 are summarized in ***Table 1*** and are presented on ***Figure 4***.

Water quality parameters measured during post-injection monitoring and sampling are presented in ***Table 2***.

4.3 Compliance Criteria and Process for Assessing Compliance

The MTCA Method A CUL for PCE in groundwater will be used as the compliance criteria for the Site. Use of MTCA Method A CULs at the site is applicable and appropriate because there are a limited number of constituents of concern or "relatively few hazardous substances" as noted in footnote "a" in Table 720-1 in the MTCA Statue and Regulation revised in November 2007.

The proposed compliance monitoring well network consists of six monitoring wells shown in ***Figure 10***. The proposed network is designed to monitor the performance of the MNA containment remedy at the Site using data from two categories of wells: Compliance Wells and Performance Wells. Compliance wells consist of an Upgradient Well (MW-3), Downgradient Well (MW-4), and two Perimeter Wells (MW-2 and MW-6). Performance Wells consist of the two source area wells (MW-1 and MW-8). The compliance monitoring well network is discussed in more detail in ***Section 4***.

For wells in the compliance monitoring well network, the following process will be used to assess compliance and demonstrate the effectiveness of the containment remedy. Unless otherwise noted, this process will be used during the entire 2-year compliance monitoring period.

This Work Plan is based on a containment remedy for COCs within the PCE plume. Therefore, data from samples from the Performance Wells (MW-1 and MW-8) will be evaluated to determine if groundwater quality within the former source area of the plume is stable, improving, or degrading over time.

All the proposed compliance wells were last sampled on September 16, 2014. This sampling was performed to confirm that the concentration of PCE in groundwater samples from these proposed compliance monitoring wells was equal to or less than the compliance criteria i.e. the MTCA Method A CUL of 5 μg/L. PCE was detected in MW-4 at a concentration of 3.92 μg/L but was not detected in samples from any of the other proposed compliance monitoring wells. The PCE concentration in MW-4 has been steadily decreasing since regular monitoring was initiated in December 2009 suggesting that the PCE plume is shrinking.

If the PCE concentration in groundwater is greater than its compliance criteria in the Downgradient Well (MW-4), it will be considered an exceedance. The well will be re-sampled for confirmation within four weeks of receipt of laboratory results and the new sample will be tested for the constituent whose concentration exceeded compliance criteria. If the re-sample result is not an exceedance, the well will be considered in compliance and regularly scheduled monitoring will continue at the site. If the re-sample groundwater concentration confirms an exceedance, appropriate contingency actions will be discussed with the Ecology Site Manager.

4.4 Monitoring Types and Objectives

The proposed methods of compliance monitoring described in this plan are defined and placed in the context of the MTCA requirements for compliance monitoring (WAC 173-340-410). MTCA requirements for compliance monitoring consist of evaluation monitoring, protection monitoring, performance monitoring, and confimational monitoring.

4.4.1 Evaluation Monitoring

Additional evaluation monitoring will not be performed at the site. Because the Site has been the subject of six years of groundwater monitoring, the data requirements commonly filled by evaluation monitoring have been thoroughly addressed at the Site. Groundwater COCs and potential COCs have been identified and an existing monitoring well network and baseline chemical and hydrogeologic conditions have been well established by numerous investigations performed at the Site.

4.4.2 Protection Monitoring

According to MTCA requirements for compliance monitoring, the goal of protection monitoring is to confirm that human health and the environment are adequately protected during construction and the operational and maintenance period of the remedial action. The proposed remedy is a containment and MNA strategy that will not require additional subsurface construction activities.

The requirements for protection monitoring will therefore be met through field procedures established in this document and a site-specific health and safety plan (HASP) covering tasks associated with implementation of the groundwater remedial action, such as monitoring well installation, groundwater sampling, and disposal of investigation-derived waste (IDW).

4.4.3 Performance Monitoring

Performance monitoring conducted during previous environmental investigations at the Site has demonstrated that remedial actions have attained soil cleanup criteria at the points of compliance. Because groundwater samples from the Upgradient, Downgradient, and Perimeter Wells are already in compliance with MTCA Method A CULs for PCE, compliance monitoring will be used to ensure continued containment of the PCE plume.

4.4.4 Compliance Monitoring

The purpose of compliance or confirmational monitoring is to confirm the effectiveness of the containment remedy after cleanup levels have been met. For the purposes of the Work Plan, confirmational and compliance monitoring will be understood to have the same objective and will be referred to as Compliance Monitoring for the remainder of this document.

As noted in the previous section, groundwater samples from the Upgradient Well (MW-3), Downgradient or Sentinel Well (MW-4) and two Perimeter Wells (MW-2 and MW-6) are currently in compliance with MTCA Method A CUL for PCE. Two years of semi-annual compliance monitoring will be performed to confirm that the containment remedy continues to perform as intended and COC concentrations in samples from the two Performance Wells (MW-1 and MW-8) are stable or declining. In this context, compliance monitoring at the Site will address the effectiveness of the containment remedy by continuing to evaluate source area and downgradient groundwater quality trends and continued containment of the PCE plume.

5.0 COMPLIANCE MONITORING WELL NETWORK

5.1 Groundwater Monitoring

The compliance monitoring well network consists of the six monitoring wells shown on ***Figure 10***. Monitoring wells MW-1, MW-2, MW-3, and MW-4 were installed in December 2009. MW-6 was installed in February 2010. MW-8 was installed in September 2011. The wells are divided into four categories with distinct purposes, which are summarized below:

- **Upgradient Well** – MW-3 is located upgradient of the former septic system leach field and will be monitored to evaluate groundwater quality as it enters the property prior to flowing through the former PCE source area at the southeast corner of Building 11.
- **Source Area Wells** – Monitoring wells MW-1 and MW-8 are located in the immediate vicinity of the former septic system leach and will be monitored to track COC concentration trends that signal if groundwater quality within the PCE plume is stable, improving, or degrading over time.
- **Perimeter Wells** – Monitoring wells MW-2 and MW-6 are located along the west and east perimeters of the PCE plume respectively. These wells will be monitored to confirm that the plume is trending to the northwest following the general direction of groundwater movement. If PCE impacts are identified in MW-2, it would suggest that the groundwater direction is more to the west and the Conceptual Site Model would need to be revised.
- **Downgradient Well** – MW-4 is located just beyond the apparent leading edge of the PCE plume. MW-4 had PCE concentrations exceeding the Method A CUL until December 2010, however, PCE concentrations have been below the Method A CUL in the past 5 sampling rounds. MW-4 will be used to provide groundwater quality data to demonstrate that the PCE plume is stable or decreasing. MW-4 will also function as a "sentinel" well to indicate elevated concentrations of PCE and trigger contingency actions to prevent off-site migration of PCE to adjoining properties.

If PCE or other potential COCs are detected at concentrations greater than their applicable compliance criteria in samples from the non-source area wells or significantly increasing concentrations in the source area wells, environmental personnel with Brunswick and Stantec will enter into technical discussions with the Ecology Site Manager regarding an appropriate contingency response as presented in ***Section 8***.

5.2 Possible Wells for Decommissioning

There are currently 8 on-site wells at the former Bayliner Marine facility. The proposed compliance well network will utilize 6 of these wells. Monitoring well MW-5 is located at the far northwest corner of the property and has only had one detectable concentration of PCE recorded on September 6, 2013. This concentration of 3.1 µg/L was below the Method A CUL of 5 µg/L. PCE has never been detected in MW-7, located in the north lane of 180th Street NE. Stantec proposes to maintain these wells for at least one year (after completion of the first compliance monitoring event) to ensure that additional sampling points are not required at the Site. If after one year, there are no contingency actions triggered as a result of monitoring, Stantec proposes that these wells be decommissioned to minimize possible impacts from surface sources to the uppermost aquifer at the Site.

Stantec personnel will notify the Ecology Site Manager of any planned well decommissioning work prior to initiating any on-site work. Stantec will request bids for the decommissioning work from well drillers licensed in the State of Washington and will oversee all well decommissioning, which will be performed in accordance with Ecology regulations found in WAC 173-160-460(2) for resource protection wells constructed in accordance with Ecology construction requirements.

6.0 COMPLIANCE MONITORING

As described in ***Section 5***, the compliance monitoring well network is intended for two years of semi-annual groundwater monitoring at the site. Monitoring data will determine if groundwater samples from compliance and performance monitoring wells at the site demonstrate continued containment of the PCE plume. In the event that concentrations greater than compliance criteria are detected in any of the compliance wells, the contingency plan will be triggered. If COC concentrations in either of the source area wells show a significant increase, the Ecology Site Manager will be contacted to discuss the appropriate response as described in ***Section 8***.

6.1 Groundwater Compliance Monitoring Plan Components

Groundwater compliance monitoring will consist of measuring the depth to groundwater (DTW), purging wells using low-flow purging techniques, measuring and recording primary geochemical parameters, sampling for groundwater COCs, and evaluating the analytical data and field measurements with respect to compliance criteria for triggering the contingency plan.

6.1.1 Groundwater Level Measurements

Prior to groundwater sampling, the DTW and total well depth will be measured at all compliance and performance monitoring wells to the nearest 0.01 foot using an electronic water level indicator. Water levels will be measured in all wells within a one hour interval to achieve a consistent data set representing groundwater elevation patterns at a point in time. The DTW data will be used to create groundwater elevation contour and flow direction maps for each monitoring event. ***Figures 6 through 9*** show groundwater elevation contours for each of the post-injection groundwater sampling events and confirm groundwater flow direction to the northwest.

The water level indicator will be decontaminated with distilled water prior to each use by spray rinsing the probe and any part of the cable that was in contact with groundwater. If the probe becomes visibly contaminated, a spray rinse using a solution of Liquinox™ and distilled water may be used, followed by a distilled water rinse. The DTW will be measured from the reference point (either the mark on the well casing or from the north side of the well casing) to the static water level inside the well casing. The DTW measurement will be recorded along with the time the measurement was made.

6.1.2 Well Purging and Sampling Parameters

Monitoring wells will be purged prior to sampling using a peristaltic pump, submersible pump, or equivalent, equipped with new, disposable tubing. Low-flow purging will be conducted in general accordance with procedures described in Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures (USEPA 1996).

Purging will be accomplished by starting the pump system at a low flow rate, (approximately 0.2 to 0.5 liters per minute) and slowly increasing the pumping rate. The water level in the well will be checked to maintain a drawdown of less than or equal to 0.33 feet (EPA, 1996). If drawdown is greater than 0.33 feet, the flow rate will be decreased. The goal of 0.33 feet or less of drawdown may be difficult to achieve at some locations due to low-permeability formations and may require adjustment based on site-specific conditions and personal experience. Purge water will be discharged through a flow cell for field parameter measurements and will be contained in 5-gallon buckets (or equivalent).

Primary geochemical indicators i.e. temperature, pH, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity will be measured and recorded during purging. DO and ORP measurements will be obtained but these parameters will not be used to determine stabilization. In addition, notes will be taken describing the appearance and/or odor of the water. Purging will be performed until field parameters stabilize to within the following ranges:

- pH ± 0.1 pH units
- Specific conductance ± 3 percent
- Turbidity ± 10 percent (when turbidity is greater than 10 NTUs)
- Temperature ± 0.1°C

To the extent possible, wells will not be purged to dryness. However, if a well exhibits very slow water level recovery and is purged to dryness, groundwater samples at that well will be collected upon sufficient recovery. Sufficient recovery is defined as recovery to at least 80% of original static water level prior to purging.

6.1.3 Groundwater Sampling Methods

Following purging, the sampling pump will be used to obtain groundwater samples following low-flow well sampling procedures. Groundwater samples will be collected into laboratory-cleaned, pre-labeled 40-milliliter (ml) volatile organic analysis (VOA) sample vials pre-preserved with hydrochloric acid.

Groundwater samples for HVOC analysis will be collected using the slowest pumping rate reasonably achievable with the sampling pump. To check for headspace, VOA vials will be capped, inverted, and checked for air bubbles. Each groundwater sample will be submitted for analysis of HVOCs using EPA Method 8260C. All samples will be handled and transported using standard Chain-of-Custody protocols and will remain in an iced cooler pending submittal to the analytical laboratory.

6.1.4 Sample Identification

All soil vapor and groundwater samples collected will be assigned a unique identification code based on a consistent sample designation scheme. A sample tracking record will be kept as each sample is collected.

Groundwater samples will be designated with unique alphanumeric sample identifiers (sample numbers) as follows:

BMF-MW-XX-T

Where:

BMF	Bayliner Marine Facility
MW	Monitoring Well
XX	Monitoring well number from series
T	Sample type 0 = primary field sample, 1 = field duplicate, 2 = trip blank, 3 = equipment blank

Sample numbers will be recorded in the field notebook, on sample container labels, and chain-of-custody forms. Other information recorded on the sample container label includes:

- Time and date of sample collection
- Initials of sampler(s)
- Laboratory analyses to be performed
- Preservatives used

6.1.5 Sample Handling

After collection, all samples will be placed in coolers with enough bagged ice to maintain an internal temperature of 4°C for the duration of the sampling and transportation to the laboratory. Samples will be delivered to ALS Laboratory Group (ALS) for analysis after each day of sampling following the procedures outlined in the previous section. ALS's address is:

ALS Laboratory Group
8620 Holly Drive
Suite 100
Everett, WA 981208
Contact: Mr. Rick Bagan, (425) 356-2600

6.1.6 Equipment Decontamination Procedures

Purging and sampling equipment that comes into direct contact with sample media, sample containers, or the inside of a probe or monitoring well will ideally be single-use, disposable equipment that is replaced between each sampling event, or will be dedicated equipment, assigned to and used at only one well or probe location. If non-dedicated, multiple-use sampling equipment is used for groundwater sampling or soil vapor sampling it will be decontaminated prior to use and between each sample location following the steps noted below:

1. Wash in a solution of Liquinox™ (or equivalent) and potable tap water;
2. Rinse with potable tap water; and
3. Spray-rinse with distilled or de-ionized water.

6.1.7 Disposal of Investigation Derived Waste

Monitoring well purge water and other Investigation Derived Waste (IDW) will be retained on-site in properly labeled DOT-approved steel drums pending characterization for disposal. Stantec personnel will coordinate characterization of drum contents and disposal according to established procedures. Disposal of well purge water will be coordinated with client representatives. Hazardous wastes will be managed per the requirements in *Dangerous Wastes Regulations*, Chapter 173-303 WAC. IDW will be manifested to a treatment, storage, and disposal (TSD) facility permitted to accept the material by a waste disposal subcontractor.

6.2 Compliance Monitoring Schedule

The compliance monitoring schedule is intended to provide two years of semi-annual sampling events (4 total) to ensure evaluation and demonstration of the continued effectiveness of the containment remedy and protection of potential surface water receptors. The two year monitoring schedule will supplement the 10 previous sampling events conducted between December 2009 and September 2014.

Compliance monitoring is designed to provide data that allow determination of whether COC concentrations exceed compliance criteria in the Downgradient Well. If this condition occurs, it would trigger a contingency process designed to bring the site groundwater back into compliance and reduce the possibility of off-site COC migration. If COC concentrations exceed compliance criteria in samples from the Perimeter Wells or the Upgradient Well, the results will be evaluated to determine the possible cause of the increase. Ecology will then be consulted regarding follow-up actions. Refer to ***Section 4.3*** for a description of the compliance evaluation process and ***Section 8.1*** for a discussion of how compliance monitoring results might trigger the contingency plan. Source area COCs concentrations will be tracked over time using samples from the Source Area Wells MW-1 and MW-8; however, exceedances of regulatory criteria are expected at this location and do not trigger the contingency process.

A comprehensive review of the groundwater monitoring data will be performed following the two-year compliance monitoring period. If those data demonstrate that groundwater at the site has remained in compliance throughout the monitoring events, that the containment remedy continues to be effective based on a review of analytical and groundwater flow data, and contingency monitoring has not otherwise been triggered, compliance monitoring will be discontinued at the site and an NFA determination will be requested from Ecology.

6.3 Compliance Monitoring Reporting Requirements

Upon completion of the compliance monitoring period, groundwater monitoring results will be presented in a *Final Cleanup Report*. This report will also include a copy of the restrictive covenant which will be required to restrict use of groundwater at the Site. The *Final Cleanup Report* will contain groundwater elevation measurements, laboratory data reports, and an evaluation of groundwater monitoring results compared to compliance criteria and other contingency plan triggers. The data from 8 years of regular monitoring will be used to demonstrate that the PCE plume is stable and that MNA will continue to be an effective means of long-term contaminant reduction. All analytical data will be uploaded to Ecology's Environmental Information Management (EIM) database for Ecology's review.

At the end of the two-year monitoring period a *Final Cleanup Report* will be prepared and submitted for Ecology's review. This report will summarize the results of the groundwater monitoring events for the compliance monitoring period and will include the following components:

- A summary of performance monitoring results with comparisons to compliance criteria and other contingency plan triggers;
- A summary of groundwater elevation data, including groundwater level elevation contour maps with groundwater flow directions arrows, and a discussion of any changes to groundwater flow velocity or direction; and,
- A discussion of significant findings and conclusions.

7.0 DATA EVALUATION AND MANAGEMENT

7.1 Data Validation

The results of the compliance monitoring are the final data that will be used to support an NFA determination. Accordingly, compliance monitoring analytical reports from the contracted laboratory will be accompanied by sufficient backup data and quality control (QC) results to enable reviewers to perform data review and validation. At a minimum, Stantec will review the laboratory reports for internal consistency, transmittal errors, and laboratory protocols. Data validation will typically include the following:

- Review of sample holding times;
- Verification of laboratory sample identification, Chain-of-Custody records, and proper analytical methods;
- Verification of attainment of specific reporting limits;
- Verification of the frequency of analysis of field duplicate, matrix spikes/matrix spike duplicates, and lab control samples;
- Verification of surrogate compound analysis performance and attainment of QC criteria; and,
- Verification that laboratory blanks are free of contaminants.

7.2 Data Management and Evaluation

Four semi-annual groundwater sampling events will be conducted during the two-year compliance monitoring period. All groundwater quality results will be managed in an electronic database and will also be submitted to Ecology's EIM database at the end of the monitoring period.

All analytical data from the soil and groundwater compliance monitoring activities described in ***Section 6*** will be subjected to the Level 1 internal data validation review described above. The results for each event will be tabulated and reported in the *Final Cleanup Report*. Data for each COC will be compared with previous results and compliance criteria described in ***Section 4***, and contingency plan triggers described in ***Section 8.***

8.0 CONTINGENCY PLAN

In this section, the processes by which the contingency plan is triggered and implemented are described. Compliance monitoring results are evaluated relative to criteria that determine whether implementation of the contingency plan is warranted. The contingency plan, once triggered, begins a set of predetermined steps designed to assess the stability and implications of the COC concentrations in the affected groundwater accompanied by an evaluation of available water quality and water elevation data to identify potential causal factors.

8.1 Contingency Plan Triggers

As described in ***Section 4*** compliance monitoring results will be evaluated relative to compliance criteria to confirm the continued effectiveness of the containment remedy at the Site.

The process for triggering the contingency plan and evaluating contingency monitoring is described in the following sections. The following indicators, based on analytical results in samples from the two of the four categories of compliance monitoring wells, will trigger the contingency plan at the site:

- Exceedance of compliance criteria in the Downgradient Well; and,
- Exceedance of compliance criteria in a Perimeter Well.

In addition, exceedances of compliance criteria in the two remaining categories of compliance monitoring wells do not trigger contingency plans; however, they are indicators that groundwater quality conditions at the Site require further evaluation. As a result, the two conditions noted below will warrant discussions with Ecology.

- Exceedance of compliance criteria in the Upgradient Well; and,
- Significantly increasing COC concentrations in either Source Area Well.

These two types of contingency plan triggers and two other conditions requiring further evaluation are described in the following sections.

8.1.1 Exceedance of Compliance Criteria in the Downgradient Well

Downgradient monitoring well MW-4 was most recently sampled on September 16, 2014 with a PCE concentration of 3.92 μg/L. The PCE concentration had been either ND or below the Method A CUL since December 2010 when the concentration was 7.7 μg/L.

The contingency plan will be implemented in the event that the PCE concentration in MW-4 is equal to or greater than its compliance criteria of 5 μg/L. The initial contingency step is to confirm the PCE concentration by re-sampling the well in which the exceedance was noted within four weeks of laboratory confirmation and the sample tested for the PCE concentration.

If the PCE concentration is confirmed to be in excess of compliance criteria concentration in the resampled well, quarterly contingency monitoring will be initiated as described in ***Section 8.2.1***. In addition, technical discussions will be initiated with Ecology regarding appropriate contingency actions to prevent off-Site groundwater impacts.

The appropriate contingency action will be based on the magnitude of PCE concentrations detected the Downgradient Well. Potential contingency actions that will be considered and evaluated are described in ***Section 8.2.2***.

8.1.2 Exceedance of Compliance Criteria in a Perimeter Well

Analytical results from the two Perimeter Wells (MW-2 and MW-6) in September 2014 indicated no detectable concentrations of PCE. Neither of these wells has had a detectable concentration of either PCE or TCE since monitoring began in December 2009.

As described in ***Section 4***, the contingency plan will be implemented in the event that PCE is detected in the either of the Perimeter Wells at a concentration greater than its compliance criteria of 5 μg/L. The initial contingency step is to confirm the PCE concentration by re-sampling the well within four weeks of laboratory confirmation and the sample tested for the PCE concentration.

If the PCE concentration is confirmed to be in excess of compliance criteria concentration in samples from either of the Perimeter Wells, Brunswick will immediately begin quarterly contingency monitoring as described in **Section 8.2.1**. In addition, Brunswick will schedule technical discussions with Ecology regarding what appropriate contingency actions are necessary.

The appropriate contingency action will be based on the magnitude of PCE concentrations detected in the sample(s). Potential contingency actions that will be considered and evaluated are described in **Section 8.2.2**.

8.1.3 Exceedance of Compliance Criteria in the Upgradient Well

Exceedance of compliance criteria in samples from the Upgradient Well (MW-3) does not automatically trigger contingency monitoring or a contingency action. However, upgradient groundwater data are important for evaluating the potential for off-Site sources and refinement of the Conceptual Site Model.

Analytical results from the most recent sampling event performed at the Upgradient Well in September 2014 indicated no detectable concentrations of PCE. MW-3 has not had a detectable concentration of either PCE or TCE since monitoring began in December 2009. If impacts to upgradient groundwater exceed the compliance criteria of 5 μg/L for PCE an appropriate response and potential appropriate contingency actions will be discussed with Ecology.

8.1.4 Significantly Increasing COC Concentrations in a Source Area Well

To provide greater protectiveness, Ecology will be informed and consulted for guidance in the event that PCE concentrations in groundwater samples from either of the Source Area Wells (MW-1 and MW-8) consecutively increase 50 percent from the previous sampling event for two consecutive sampling events. This condition will trigger an evaluation of the sampling results and potentially an increase in sampling frequency to quarterly until PCE concentrations either stabilize or decrease.

Limiting this concentration trend evaluation to the Source Area Well, which generally has elevated concentrations, is appropriate because very low PCE concentrations possible in other compliance monitoring wells could vary by more than the 50 percent criterion solely based on seasonal sample variability, laboratory variability, or other effects not related to actual water quality trends.

8.2 Contingency Plan Implementation

The intent of the contingency plan is to establish a framework for action in the event that the contingency plan is triggered based on the results of the compliance monitoring. The contingency plan will begin with contingency monitoring - a more intensive monitoring schedule intended to assess the stability of the PCE concentrations in the affected groundwater.

8.2.1 Contingency Monitoring

Triggering the contingency plan will result in quarterly contingency monitoring of the compliance monitoring well network. Quarterly monitoring of the compliance monitoring wells will begin with the goal of evaluating the stability of the PCE plume. The same wells, laboratory analyses, and field methods of the semiannual compliance monitoring will be used for quarterly contingency monitoring.

As part of the contingency monitoring, the potential cause of the PCE exceedance or increasing trend in PCE concentrations will be evaluated using the available water quality data, water level elevation data, and additional data collection, if necessary. Examples of potential causes may include a change in groundwater flow direction, changes in infiltration patterns or rates, disruptions to the subsurface resulting from construction activities, or leaching from residual contaminated soil.

The water quality and water elevation data sets will be reviewed for changes in the Site water balance, or other patterns that may suggest a potential source. In the event that contingency monitoring results in the need for a contingency action, this review will be used to assist in the development of a contingency action plan. Criteria for determining whether a contingency action is warranted are described below.

If contingency monitoring was triggered by an exceedance of the compliance criteria in samples from the Downgradient Well, quarterly contingency monitoring may be stopped when the PCE concentration is less than the compliance criteria for two consecutive quarters. At this point, the COC concentration will be considered stable and semiannual monitoring will resume.

8.2.2 Contingency Actions

In the event that a contingency action is necessary the process will begin with an evaluation of the conceptual hydrogeologic model of the Site and additional data collection may be necessary. Based on the review of groundwater quality and groundwater elevation and flow direction data obtained during the contingency monitoring a contingency investigation plan will be prepared and submitted to Ecology.

The goal of the contingency investigation plan will be to assess potential causes of the PCE increase and to determine the source and scope of the problem unless this information is already established. The contingency investigation will consist of additional or more frequent water level measurements or sampling additional monitoring wells depending on the nature of the groundwater exceedance or trend. The findings of the initial contingency investigation may lead to additional investigations to assess contaminant sources and migration routes and rates.

When the source and scope are sufficiently defined, a *Final Cleanup Report* will be prepared and submitted to Ecology discussing the results of the investigation, evaluating approaches for addressing the exceedance(s), and providing the rationale for the selection of the contingency action. Potential contingency action(s) may include physical containment of the source area or containment of the contaminated groundwater plume.

After consultation with and approval from Ecology, the contingency action will be implemented at the site and compliance monitoring will resume with a revised sampling schedule to be negotiated with Ecology.

9.0 REFERENCES

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TABLES

Table 1

Summary of Groundwater Monitoring Results

Former Bayliner Marine Facility - Arlington, Washington

Well/Borehole ID	Sample Collection Date	Total Depth of Well (feet)	Top of Casing Elev. (ft MSL)	Screened Int. (ft. bgs)		Screened Int. (ft. MSL)		Depth to GW (ft)	GW Elev. (ft. MSL)	Volatile Organic Compounds[1] (VOCs) in µg/L		
				Top	Bottom	Top	Bottom			Tetrachloroethene (PCE)	Trichloroethene (TCE)	All Remaining VOCs
B-1	5/20/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-2	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5	ND	ND
B-3	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.3	ND	ND
B-4	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**42**	ND	ND
B-5	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**31**	ND	ND
B-6	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**18**	ND	ND
B-7	5/21/2009	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-8	2/18/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-9	2/18/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-10	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-11	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-12	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-13	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-14 (16-20')[2]	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**45**	ND	ND
B-14 (30-34')[2]	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**40**	ND	ND
B-14 (44-48')[2]	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
B-15	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**40**	ND	ND
B-16 (18-22')[2]	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.9	ND	ND
B-16 (32-36')[2]	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**7.3**	ND	Ethylbenzene[3] = 3.4
B-16 (46-50')	3/19/2010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	ND	ND
MW-1	12/10/2009	29.95	129.42	15	30	114.42	99.42	18.89	110.53	**59**	ND	ND
	2/18/2010	29.95	129.42	15	30	114.42	99.42	16.71	112.71	**48**	ND	ND
	5/26/2010	29.95	129.42	15	30	114.42	99.42	16.51	112.91	**50**	ND	ND
	9/9/2010	29.95	129.42	15	30	114.42	99.42	19.22	110.2	**57**	ND	ND
	12/20/2010	29.95	129.42	15	30	114.42	99.42	17.28	112.14	**43**	ND	ND
	9/22/2011	30.10	129.42	15	30	114.42	99.42	16.53	112.89	**32**	ND	ND
	9/6/2013	30.10	129.42	15	30	114.42	99.42	17.05	112.37	**35**	ND	ND
	11/26/2013	30.10	129.42	15	30	114.42	99.42	18.28	111.14	**35**	ND	ND
	6/5/2014	30.10	129.42	15	30	114.42	99.42	13.72	115.7	**30.6**	ND	ND
	9/16/2014	30.10	129.42	15	30	114.42	99.42	18.10	111.32	**36.5**	ND	ND
MW-2	12/10/2009	27.25	129.68	15	30	114.68	99.68	20.02	109.66	ND	ND	ND
	2/18/2010	27.25	129.68	15	30	114.68	99.68	17.64	112.04	ND	ND	ND
	5/26/2010	27.25	129.68	15	30	114.68	99.68	17.41	112.27	ND	ND	ND
	9/9/2010	27.25	129.68	15	30	114.68	99.68	18.48	111.2	ND	ND	ND
	12/20/2010	27.25	129.68	15	30	114.68	99.68	18.49	111.19	ND	ND	ND
	9/22/2011	29.30	129.68	15	30	114.68	99.68	16.80	112.88	ND	ND	ND
	9/6/2013	29.30	129.68	15	30	114.68	99.68	17.40	112.28	ND	ND	ND
	11/26/2013	29.30	129.68	15	30	114.68	99.68	18.92	110.76	ND	ND	ND
	6/5/2014	29.30	129.68	15	30	114.68	99.68	14.63	115.05	ND	ND	ND
	9/16/2014	29.30	129.68	15	30	114.68	99.68	18.67	111.01	ND	ND	ND
MW-3	12/10/2009	24.30	129.90	10	25	119.90	104.90	16.89	113.01	ND	ND	ND
	2/18/2010	24.30	129.90	10	25	119.90	104.90	15.02	114.88	ND	ND	ND
	5/26/2010	24.30	129.90	10	25	119.90	104.90	14.85	115.05	ND	ND	ND
	9/9/2010	24.30	129.90	10	25	119.90	104.90	19.20	110.70	ND	ND	ND
	12/20/2010	24.30	129.90	10	25	119.90	104.90	15.28	114.62	ND	ND	ND
	9/22/2011	24.00	129.90	10	25	119.90	104.90	15.39	114.51	ND	ND	ND
	9/6/2013	24.00	129.90	10	25	119.90	104.90	15.89	114.01	ND	ND	ND
	11/26/2013	24.00	129.90	10	25	119.90	104.90	16.77	113.13	ND	ND	ND
	6/5/2014	24.00	129.90	10	25	119.90	104.90	12.24	117.66	ND	ND	ND
	9/16/2014	24.00	129.90	10	25	119.90	104.90	16.70	113.20	ND	ND	ND

Table 1
Summary of Groundwater Monitoring Results
Former Bayliner Marine Facility - Arlington, Washington

Well/Borehole ID	Sample Collection Date	Total Depth of Well (feet)	Top of Casing Elevation (ft. MSL)	Screened Int.		Screened Interval		Depth to Groundwater (feet)	Groundwater Elevation (ft. MSL)	Volatile Organic Compounds[1] (VOCs)		
				Top	Bottom	Top	Bottom			Tetrachloroethene (PCE)	Trichloroethene (TCE)	All Remaining VOCs
MW-4	12/10/2009	28.40	130.42	15	30	115.42	100.42	21.20	109.22	**13**	**16**	ND
	2/18/2010	28.40	130.42	15	30	115.42	100.42	18.55	111.87	**5.3**	ND	ND
	5/26/2010	28.40	130.42	15	30	115.42	100.42	18.24	112.18	**5**	ND	ND
	9/9/2010	28.40	130.42	15	30	115.42	100.42	19.79	110.63	**5.2**	ND	ND
	12/20/2010	28.40	130.42	15	30	115.42	100.42	19.62	110.80	**7.7**	ND	ND
	9/22/2011	28.60	130.42	15	30	115.42	100.42	17.10	113.32	2.4	ND	ND
	9/6/2013	28.60	130.42	15	30	115.42	100.42	17.74	112.68	ND	ND	ND
	11/26/2013	28.60	130.42	15	30	115.42	100.42	19.61	110.81	3.1	ND	ND
	6/5/2014	28.60	130.42	15	30	115.42	100.42	15.26	115.16	1.73	ND	ND
	9/16/2014	28.60	130.42	15	30	115.42	100.42	19.25	111.17	3.92	ND	ND
MW-5	12/10/2009	33.95	130.39	20	35	110.39	95.39	21.96	108.43	ND	ND	ND
	2/18/2010	33.95	130.39	20	35	110.39	95.39	19.45	110.94	ND	ND	ND
	5/26/2010	33.95	130.39	20	35	110.39	95.39	19.17	111.22	ND	ND	ND
	9/9/2010	33.95	130.39	20	35	110.39	95.39	20.50	109.89	ND	ND	ND
	12/20/2010	33.95	130.39	20	35	110.39	95.39	20.38	110.01	ND	ND	ND
	9/22/2011	33.80	130.39	20	35	110.39	95.39	17.91	112.48	ND	ND	ND
	9/6/2013	33.80	130.39	20	35	110.39	95.39	18.16	112.23	3.1	ND	ND
	11/26/2013	33.80	130.39	20	35	110.39	95.39	20.37	110.02	ND	ND	ND
	6/5/2014	33.80	130.39	20	35	110.39	95.39	16.36	114.03	ND	ND	ND
	9/16/2014	33.80	130.39	20	35	110.39	95.39	20.07	110.32	ND	ND	ND
MW-6	2/19/2010	25.00	130.39	15	25	114.59	104.59	16.68	113.71	ND	ND	ND
	5/26/2010	25.00	130.39	15	25	114.59	104.59	16.51	113.88	ND	ND	ND
	9/9/2010	25.00	130.39	15	25	114.59	104.59	19.21	111.18	ND	ND	ND
	12/20/2010	25.00	130.39	15	25	114.59	104.59	16.40	113.99	ND	ND	ND
	9/22/2011	25.20	130.39	15	25	114.59	104.59	16.42	113.97	ND	ND	ND
	9/6/2013	25.20	130.39	15	25	114.59	104.59	16.99	113.40	ND	ND	ND
	11/26/2013	25.20	130.39	15	25	114.59	104.59	17.85	112.54	ND	ND	ND
	6/5/2014	25.20	130.39	15	25	114.59	104.59	13.51	116.88	ND	ND	ND
	9/16/2014	25.20	130.39	15	25	114.59	104.59	17.92	112.47	ND	ND	ND
MW-7	2/19/2010	30.00	131.27	15	30	116.27	101.27	19.90	111.37	ND	ND	ND
	5/26/2010	30.00	131.27	15	30	116.27	101.27	19.61	111.66	ND	ND	ND
	9/9/2010	30.00	131.27	15	30	116.27	101.27	21.13	110.14	ND	ND	ND
	12/20/2010	30.00	131.27	15	30	116.27	101.27	20.89	110.38	ND	ND	ND
	9/22/2011	30.20	131.27	15	30	116.27	101.27	18.38	112.89	ND	ND	ND
	9/6/2013	30.20	131.27	15	30	116.27	101.27	18.85	112.42	ND	ND	ND
	11/26/2013	30.20	131.27	15	30	116.27	101.27	20.92	110.35	ND	ND	ND
	6/5/2014	30.20	131.27	15	30	116.27	101.27	16.62	114.65	ND	ND	ND
	9/16/2014	30.20	131.27	15	30	116.27	101.27	20.57	110.70	ND	ND	ND
MW-8	9/22/2011	26.70	NM	12	27	NM	NM	16.76	NM	**25**	ND	ND
	9/6/2013	26.70	NM	12	27	NM	NM	17.32	NM	**34**	ND	ND
	11/26/2013	26.70	NM	12	27	NM	NM	18.67	NM	**34**	ND	ND
	6/5/2014	26.70	NM	12	27	NM	NM	14.11	NM	**36.9**	ND	ND
	9/16/2014	26.70	NM	12	27	NM	NM	18.42	NM	**42.4**	ND	ND
MTCA Method A Cleanup Level										5	5	See comments

[1] = VOCs analyzed via United States Environmental Protection Agency Method 8260B
[2] = Discrete-depth groundwater samples were collected from borings B-14 and B-16. Groundwater samples collected by installing a temporary well casing in borehole with screened interval indicated by depths in parentheses.
[3] = MTCA Method A Cleanup Level for Ethylbenzene = 700 µg/L
ND = Non Detect at the laboratory's Reported Detection Limit; all reporting limits are below MTCA Method A Cleanup Level
NM = Not Measured
MTCA - Model Toxics Control Act
ft. bgs = feet below ground surface
ft. MSL = feet above mean sea level
(µg/L) = micrograms per liter

Table 2
Water Quality Parameters
Former Bayliner Marine Facility - Arlington, Washington

Well ID	Sample Date	Reading Time	Total Purge Volume (gallons)	Temperature (Degrees Celsius)	Electrical Conductivity (µmhos/cm)	Dissolved Oxygen (%)	pH (Standard Units)	ORP (mV)
MW-1	7/10/2013	NA	NA	19.94	0.005	114.0	6.44	163.6
	8/8/2013	NA	NA	20.26	0.160	135.0	7.42	35.5
	9/6/2013	14:33	2.5	12.22	0.067	79.4	6.81	491.3
	11/26/2013	14:35	2.5	11.74	0.241	83.9	6.29	157.7
	6/5/2014	14:15	3.0	11.76	3.576*	90.5	3.20	211.4
	9/16/2014	15:22	2.8	11.84	0.698	87.9	6.02	144.7
MW-2	7/10/2013	NA	NA	19.98	0.000	110.2	6.56	255.1
	8/8/2013	NA	NA	24.96	0.008	139.0	7.45	-12.0
	9/6/2013	13:23	2.2	13.39	0.079	66.1	5.90	153.7
	11/26/2013	10:53	2.5	12.08	0.274	68.7	6.22	154.0
	6/5/2014	12:37	2.7	13.25	4.206*	73.9	2.04	275.8
	9/16/2014	13:58	2.3	13.55	1.138	76.0	5.74	165.9
MW-3	7/10/2013	NA	NA	13.34	0.003	155.0	6.48	240.1
	8/8/2013	NA	NA	20.70	0.000	187.0	6.89	26.6
	9/6/2013	10:28	2.5	11.69	0.036	10.1	5.83	135.5
	11/26/2013	10:15	2.5	10.34	0.146	82.0	5.19	198.1
	6/5/2014	9:32	2.8	10.04	2.044*	92.7	4.57	191.6
	9/16/2014	9:15	1.3	NA	NA	NA	NA	NA
MW-4	9/6/2013	12:25	2.1	14.51	0.110	78.7	6.05	139.5
	11/26/2013	11:45	2.6	13.76	0.388	80.6	6.46	152.8
	6/5/2014	11:45	2.6	13.76	4.300*	84.4	2.21	254.1
	9/16/2014	12:36	2.6	13.76	1.182	86.4	6.15	162.9
MW-5	9/6/2013	12:52	2.3	14.54	0.079	87.3	6.48	109.1
	11/26/2013	14:26	2.0	14.31	0.275	95.1	6.57	155.1
	6/5/2014	14:26	3.3	13.32	4.423*	89.6	3.05	192.7
	9/16/2014	13:16	2.4	14.15	1.050	89.0	6.23	148.6
MW-6	9/6/2013	11:45	2.2	12.95	0.064	86.8	6.08	122.3
	11/26/2013	12:53	2.3	11.88	0.233	89.3	6.07	170.3
	6/5/2014	10:07	3.3	11.05	3.118*	91.3	4.88	178.6
	9/16/2014	10:13	2.4	11.39	0.849	90.5	7.02	135.5
MW-7	9/6/2013	11:10	2.5	14.24	0.103	76.2	5.82	144.4
	11/26/2013	12:20	2.2	14.03	0.319	44.0	6.25	158.9
	6/5/2014	10:47	3.0	11.28	2.265*	93.8	4.29	189.4
	9/16/2014	11:08	2.6	11.81	0.926	91.3	6.40	161.0
MW-8	7/10/2013	NA	NA	18.86	0.004	92.9	8.64	231.2
	8/8/2013	NA	NA	21.60	0.014	137.0	7.55	27.0
	9/6/2013	13:58	2.5	12.97	0.051	81.7	5.99	148.5
	11/26/2013	13:53	2.6	11.81	0.231	90.3	6.01	177.7
	6/5/2013	13:23	3.5	11.51	3.140*	82.6	1.47	306.6
	9/16/2014	14:34	2.5	12.11	0.685	81.0	5.84	166.0

NA = Not Analyzed, not available, or not applicable

ORP = Oxidation reduction potential

mV= Millivolts

µmhos/cm = micromhos per centimeter

* = Conductivity measured in milliSiemens per centimeter (mS/cm)

Dissolved oxygen, pH, ORP, electrical conductivity, and temperature measured using field monitoring equipment (such as Horiba Multi-Parameter Water Quality Meter)

Table 3
Summary of Model parameter, Sources and Results
Former Bayliner Facility
17825 59th Avenue NE
Arlington, Washington

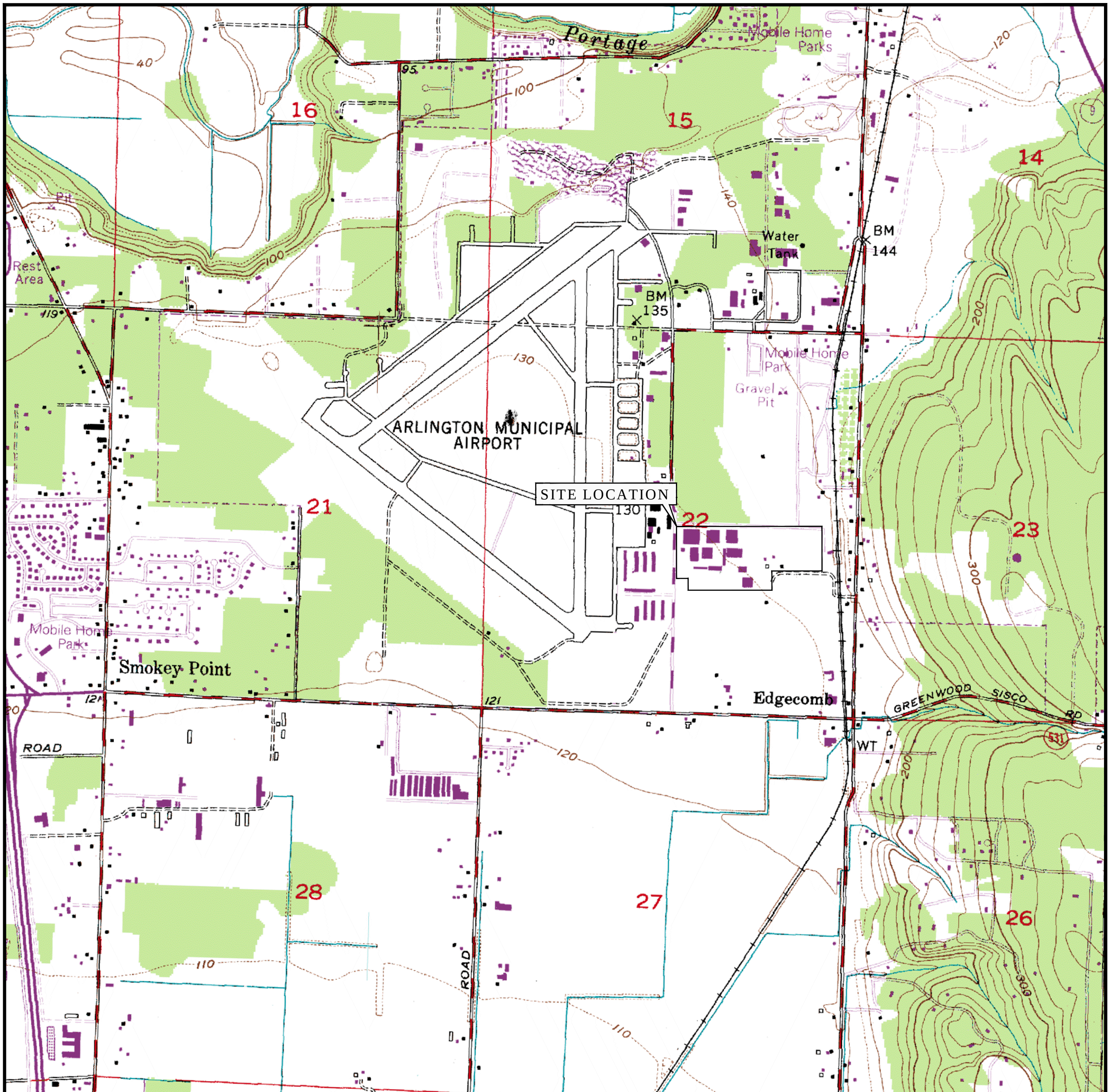
Parameter	Units	Value	Source
Advection			
Hydrualic Conductivity	cm/sec	6.61E-02	MW-1 Aq test * 10
Hydraulic Gradient	ft/ft	0.0012	2013-2014 Avg for MW-1, MW-2, and MW-4
Effective Porosity	na	0.22	Sand (Heath 1983)
Seepage Velocity	ft/yr	373	Calculated
Dispersion			
Alpha x	ft	21	Modified Xu and Eckstein est. plume length 650 ft.
Alpha y/Alpha x	na	0.1	Gelhar and others, 1992
Alpha z / Alpha x	na	1.00E-02	Gelhar and others, 1992
Adsorption			
Soil Bulk Density	kg/L	1.7	BIOCHLOR Default
Fraction Organic Carbon	na	6.00E-04	Median literature value for glaciofluvial sand (Wiedemeier 199
Partion Coefficient			
PCE	L/kg	426	BIOCHLOR Default
Retardation Factor	na	2.9	Calculated
Biotransformation			
Zone 1			
PCE > TCE	1/yr	0.6	Calibrated
General			
Simulation Time	yr	12	Stable
Modeled Area Width	ft	300	NA for centerline only model
Modeled Area Length	ft	810	Distance from MW-8 to property boundary
Zone 1 Length	ft	810	Equal to model length for one zone plume
Zone 2 Length	ft	0	NA for one zone plume
Source Data			
Source Thickness is Sat. Zone	ft	10	Estimate
Width	ft	100	Septic leach field, MW-1, and MW-8
Conc.			
PCE	mg/L	0.042	MW-8 Max (2014)
TCE	mg/L	0	ND
DCE	mg/L	0	ND
VC	mg/L	0	ND
ETH	mg/L	0	ND

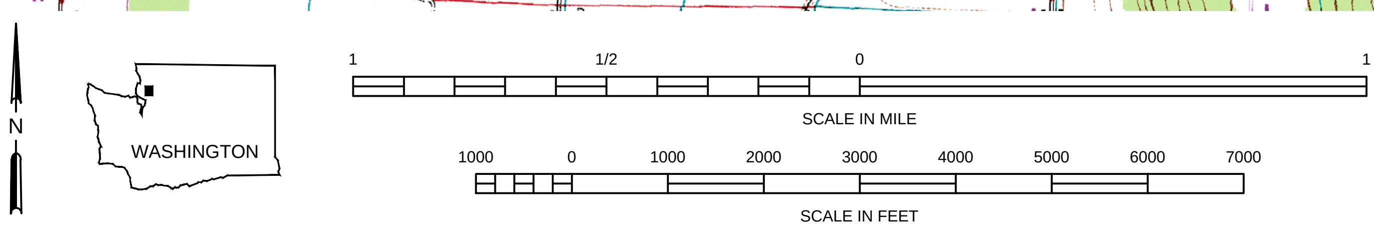
Table 3
Summary of Model parameter, Sources and Results
Former Bayliner Facility
17825 59th Avenue NE
Arlington, Washington

Parameter	Units	Value	Source
Field Data For Comparison			
Distance from Source (1)	ft	0	MW-8
Date Data Collected	yr	2014	
PCE Conc.	mg/L	0.042	MW-8 Max (2014)
TCE Conc.	mg/L	0	ND
DCE Conc.	mg/L	0	ND
VC Conc.	mg/L	0	ND
ETH Conc.	mg/L	0	ND
Distance from Source (2)	ft	700	MW-8 to MW-4
Date Data Collected	yr	2014	
PCE Conc.	mg/L	0.004	MW-4 in 2014
TCE Conc.	mg/L	0	ND
DCE Conc.	mg/L	0	ND
VC Conc.	mg/L	0	ND
ETH Conc.	mg/L	0	ND
Results			
Point of Compliance (POC)		Property Boundary	
Downgradient distance to POC	ft	810	
Simulated PCE at POC	mg/L	0.003	

Notes:
cm: centimeter
sec: second
ft: feet
na: not applicable
yr: year
kg/L: kilogram per liter
L/kg: liter per kilogram
mg/L: milogram per liter

FIGURES

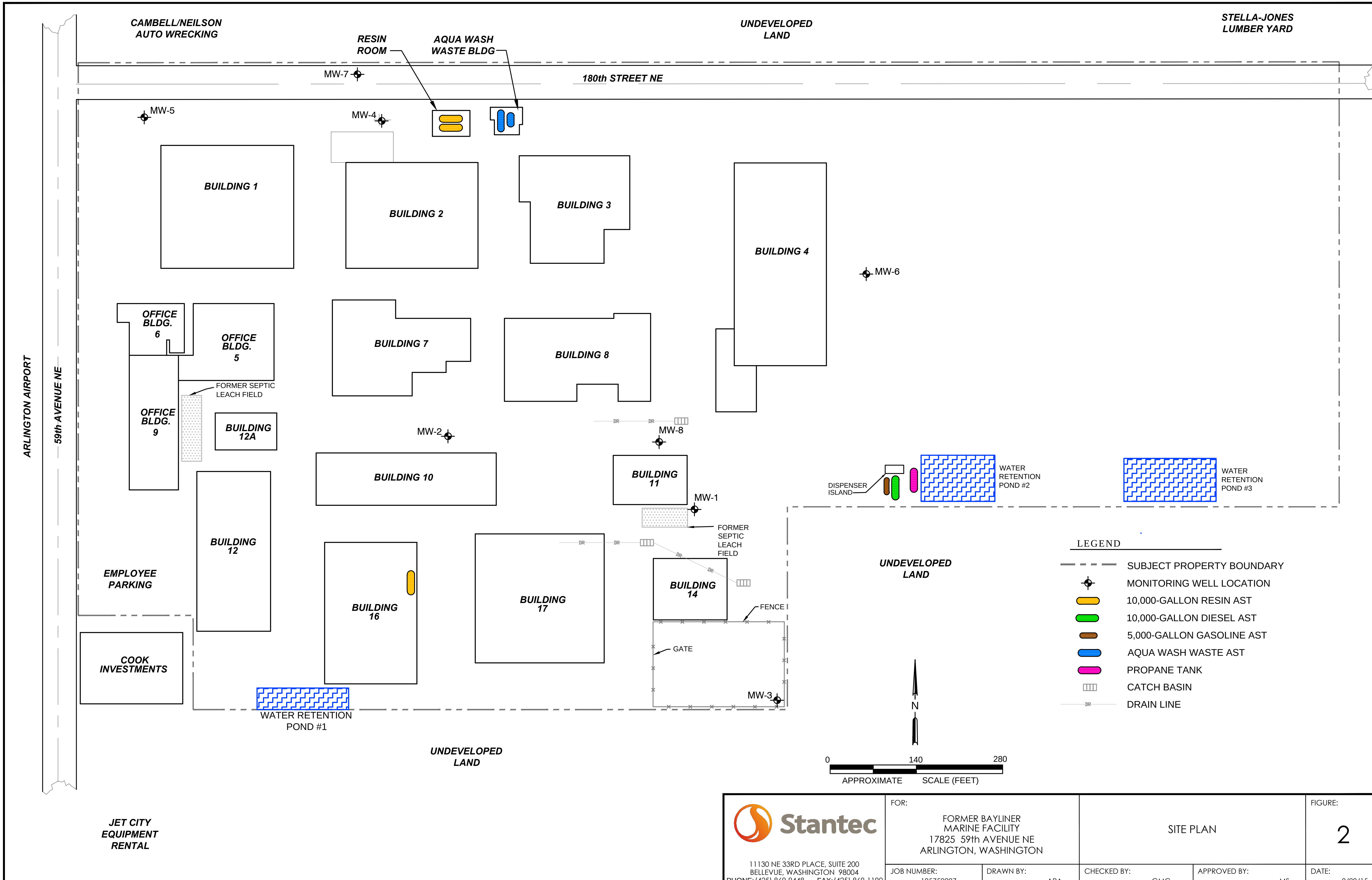




REFERENCE: WA Digital Raster Graphics(http://rocky2.ess.washington.edu/data/raster/drgclip/index.html)
7.5 Minute Series, NAD27 WA State Planes, N Zone,Trimmed
Block o48122b2; Downloaded September 2011

Stantec 11130 NE 33RD PLACE, SUITE 200 BELLEVUE, WASHINGTON 98004 PHONE: (425) 869-9448 FAX: (425) 869-1190	FOR: FORMER BAYLINER MARINE FACILITY 17825 59th AVENUE NE ARLINGTON, WASHINGTON		SITE LOCATION MAP		FIGURE: 1
	JOB NUMBER: 182602648	DRAWN BY: ARA	CHECKED BY: GMC	APPROVED BY: MS	DATE: 11/5/14

FILEPATH:C:\Users\AAndrews\Documents\traveling_folder\BaylinerMarine-SLM.dwg|AAndrews|Nov 13, 2014 at 21:33|Layout: F1



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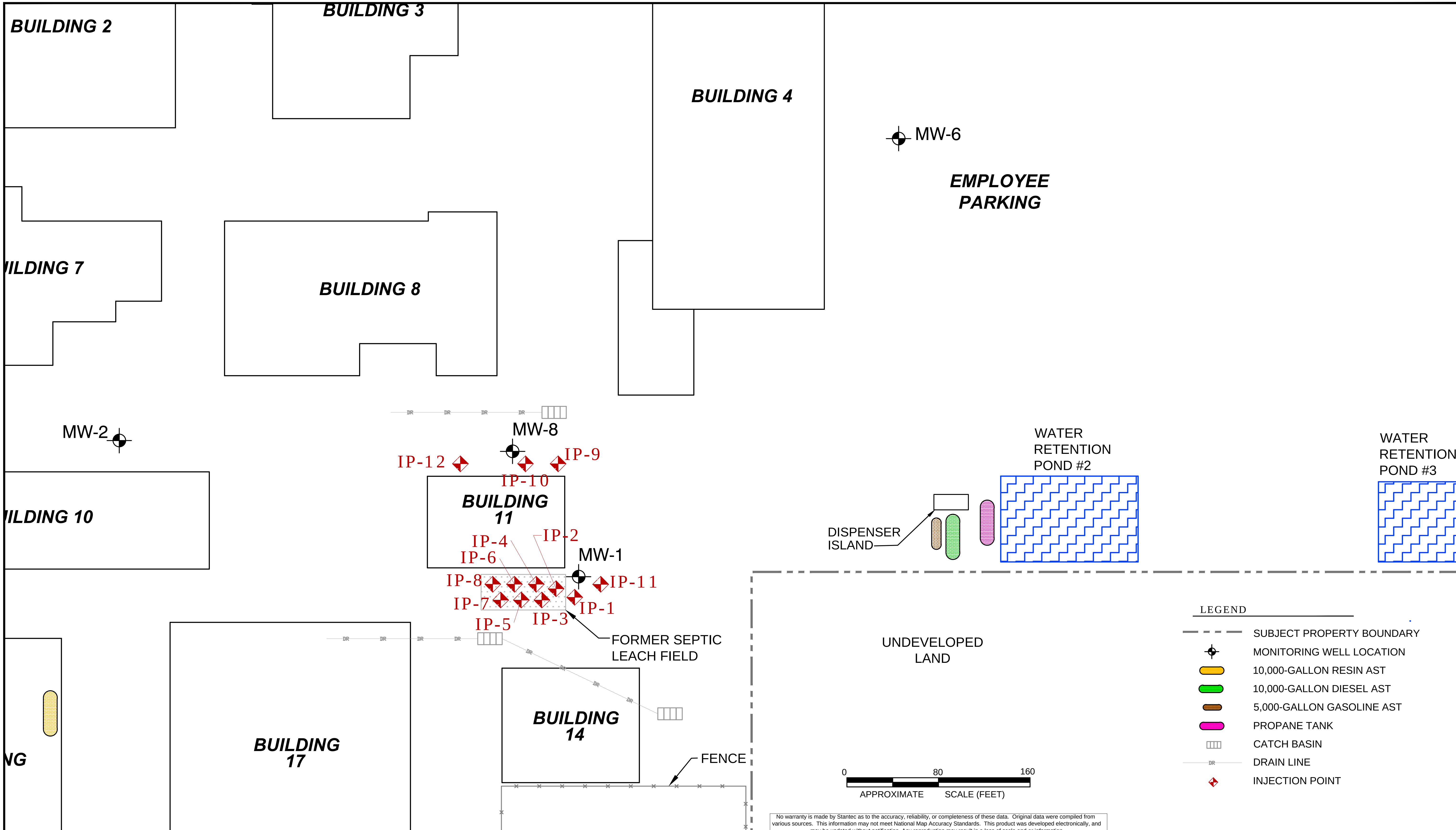

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FOR: FORMER BAYLINER MARINE FACILITY
17825 59th AVENUE NE
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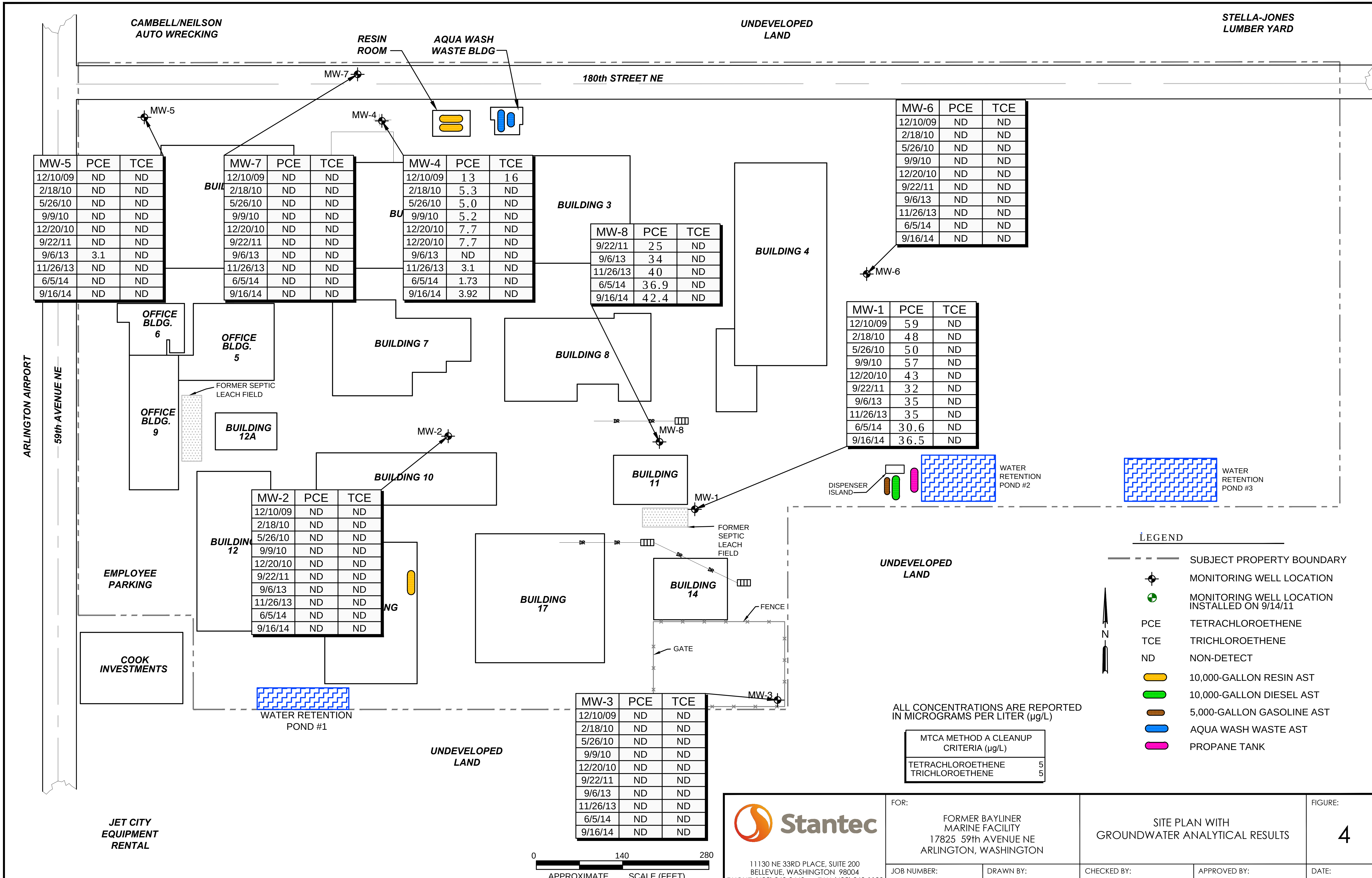
ISCO INJECTION POINTS

FIGURE: 3

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-isco_inj.dwg|AAndrews|Aug 28, 2015 at 7:57|Layout: F5-SP



MW-5	PCE	TCE
12/10/09	ND	ND
2/18/10	ND	ND
5/26/10	ND	ND
9/9/10	ND	ND
12/20/10	ND	ND
9/22/11	ND	ND
9/6/13	3.1	ND
11/26/13	ND	ND
6/5/14	ND	ND
9/16/14	ND	ND

MW-7	PCE	TCE
12/10/09	ND	ND
2/18/10	ND	ND
5/26/10	ND	ND
9/9/10	ND	ND
12/20/10	ND	ND
9/22/11	ND	ND
9/6/13	ND	ND
11/26/13	ND	ND
6/5/14	ND	ND
9/16/14	ND	ND

MW-4	PCE	TCE
12/10/09	13	16
2/18/10	5.3	ND
5/26/10	5.0	ND
9/9/10	5.2	ND
12/20/10	7.7	ND
12/20/10	7.7	ND
9/6/13	ND	ND
11/26/13	3.1	ND
6/5/14	1.73	ND
9/16/14	3.92	ND

MW-8	PCE	TCE
9/22/11	25	ND
9/6/13	34	ND
11/26/13	40	ND
6/5/14	36.9	ND
9/16/14	42.4	ND

MW-6	PCE	TCE
12/10/09	ND	ND
2/18/10	ND	ND
5/26/10	ND	ND
9/9/10	ND	ND
12/20/10	ND	ND
9/22/11	ND	ND
9/6/13	ND	ND
11/26/13	ND	ND
6/5/14	ND	ND
9/16/14	ND	ND

MW-1	PCE	TCE
12/10/09	59	ND
2/18/10	48	ND
5/26/10	50	ND
9/9/10	57	ND
12/20/10	43	ND
9/22/11	32	ND
9/6/13	35	ND
11/26/13	35	ND
6/5/14	30.6	ND
9/16/14	36.5	ND

MW-2	PCE	TCE
12/10/09	ND	ND
2/18/10	ND	ND
5/26/10	ND	ND
9/9/10	ND	ND
12/20/10	ND	ND
9/22/11	ND	ND
9/6/13	ND	ND
11/26/13	ND	ND
6/5/14	ND	ND
9/16/14	ND	ND

MW-3	PCE	TCE
12/10/09	ND	ND
2/18/10	ND	ND
5/26/10	ND	ND
9/9/10	ND	ND
12/20/10	ND	ND
9/22/11	ND	ND
9/6/13	ND	ND
11/26/13	ND	ND
6/5/14	ND	ND
9/16/14	ND	ND

LEGEND

- SUBJECT PROPERTY BOUNDARY
- MONITORING WELL LOCATION
- MONITORING WELL LOCATION INSTALLED ON 9/14/11
- PCE TETRACHLOROETHENE
- TCE TRICHLOROETHENE
- ND NON-DETECT
- 10,000-GALLON RESIN AST
- 10,000-GALLON DIESEL AST
- 5,000-GALLON GASOLINE AST
- AQUA WASH WASTE AST
- PROPANE TANK

ALL CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (µg/L)

MTCA METHOD A CLEANUP CRITERIA (µg/L)	
TETRACHLOROETHENE	5
TRICHLOROETHENE	5

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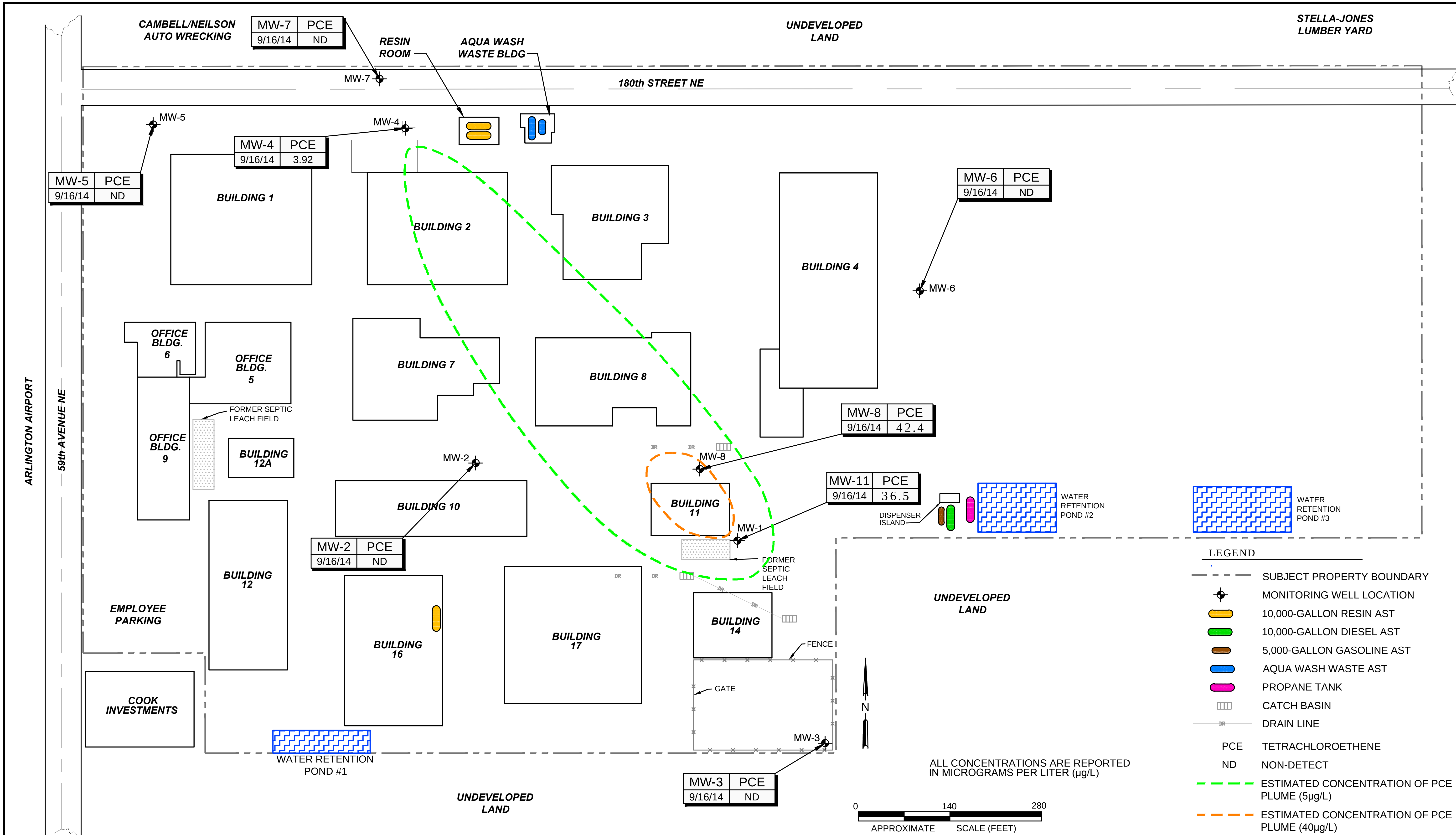
FOR: FORMER BAYLINER MARINE FACILITY
17825 59th AVENUE NE
ARLINGTON, WASHINGTON

SITE PLAN WITH GROUNDWATER ANALYTICAL RESULTS

FIGURE: 4

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 8:10|Layout: GWA



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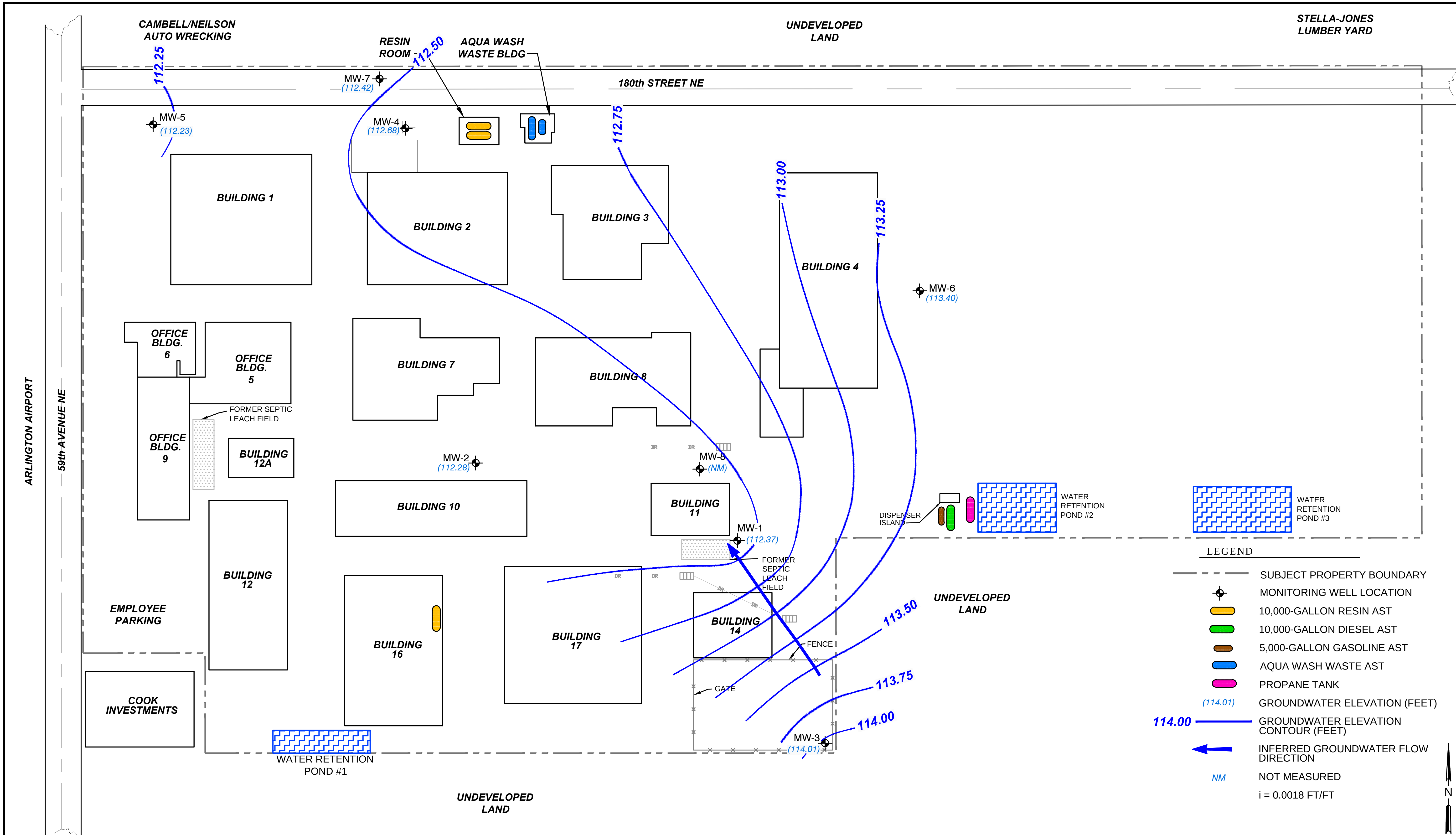
FORMER BAYLINER MARINE FACILITY
17825 59th AVENUE NE
ARLINGTON, WASHINGTON

PCE CONCENTRATIONS IN GROUNDWATER (µg/L) (SEPTEMBER 16, 2014)

FIGURE: 5

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 8:10|Layout: PCE GW



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FOR:
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17825 59th AVENUE NE
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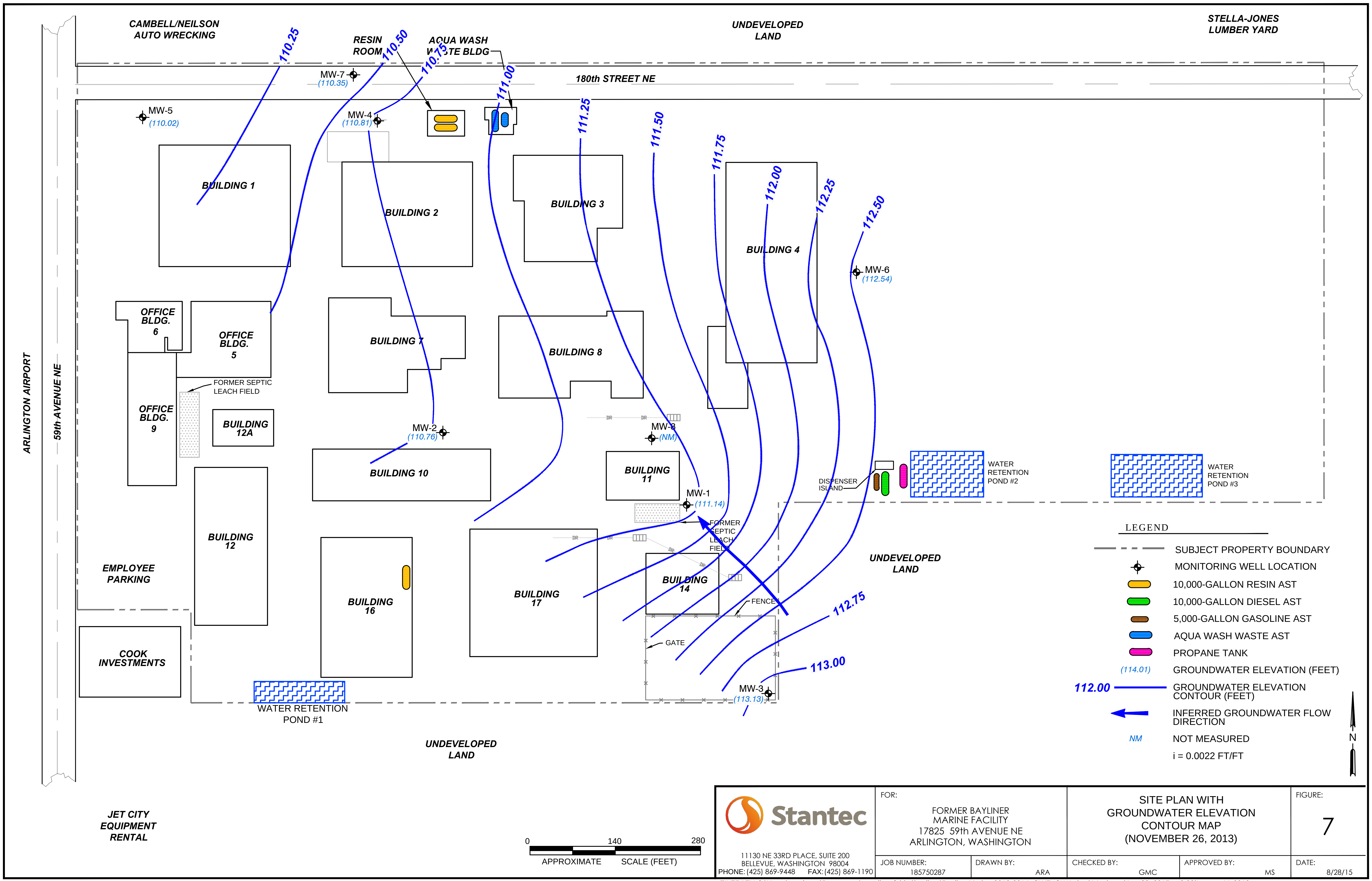
SITE PLAN WITH GROUNDWATER ELEVATION CONTOUR MAP (SEPTEMBER 6, 2013)

FIGURE: 6

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 8:08|Layout: 9-2013



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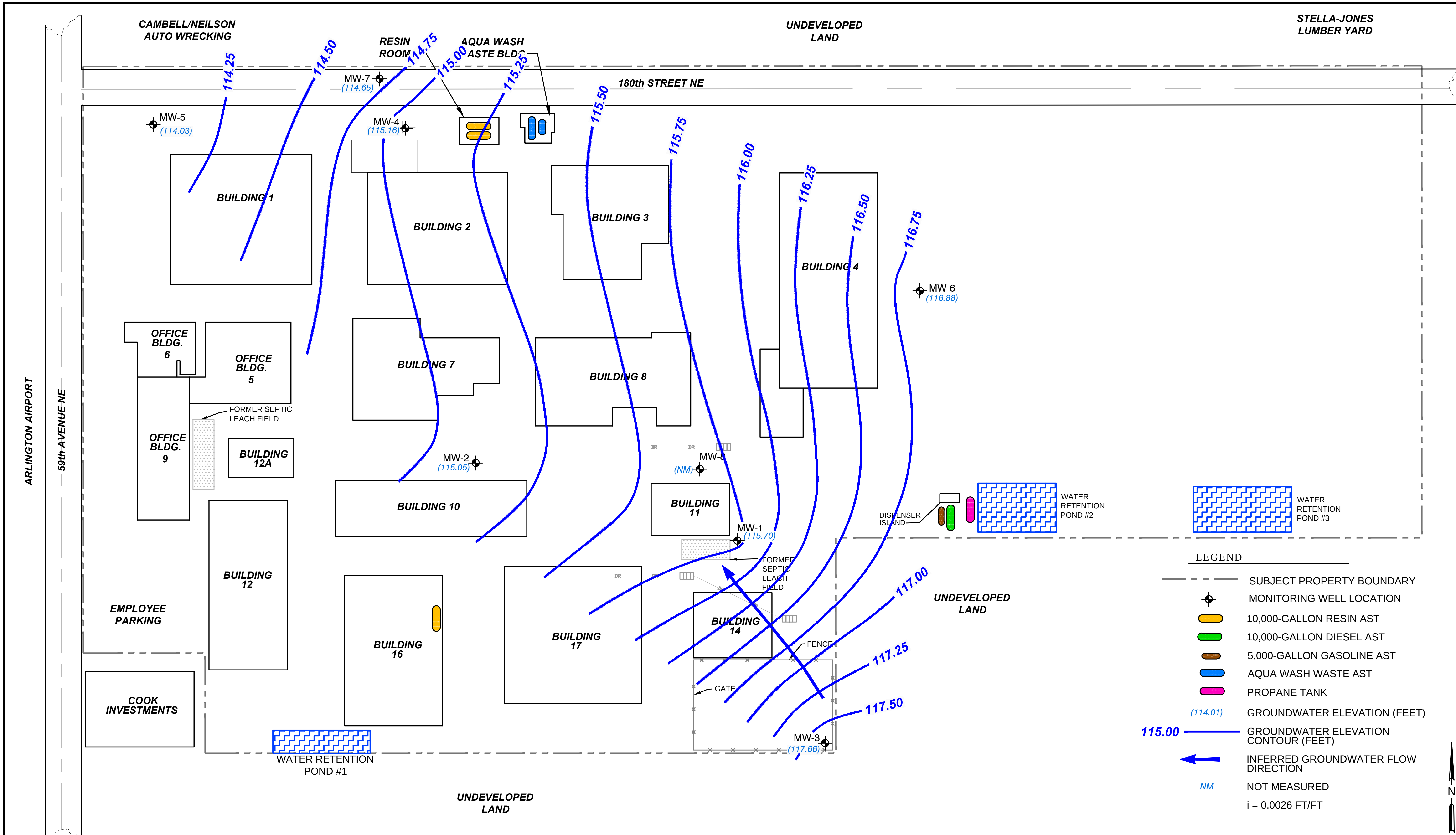

JET CITY EQUIPMENT RENTAL

0 140 280
APPROXIMATE SCALE (FEET)

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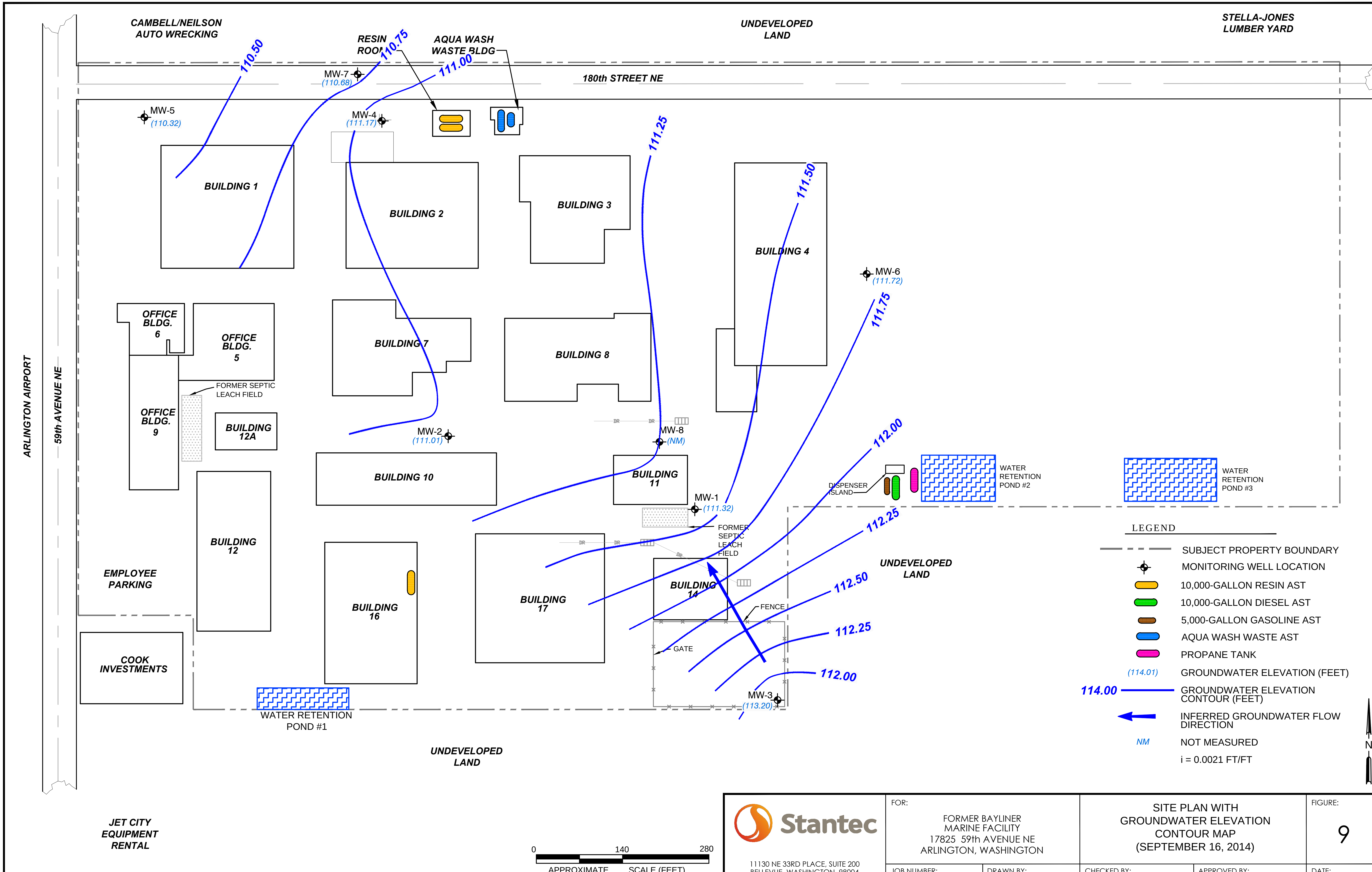
FOR: FORMER BAYLINER MARINE FACILITY 17825 59th AVENUE NE ARLINGTON, WASHINGTON		SITE PLAN WITH GROUNDWATER ELEVATION CONTOUR MAP (JUNE 5, 2014)		FIGURE: 8
JOB NUMBER: 185750287	DRAWN BY: ARA	CHECKED BY: GMC	APPROVED BY: MS	DATE: 8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 8:09|Layout: 6-2014



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17825 59th AVENUE NE
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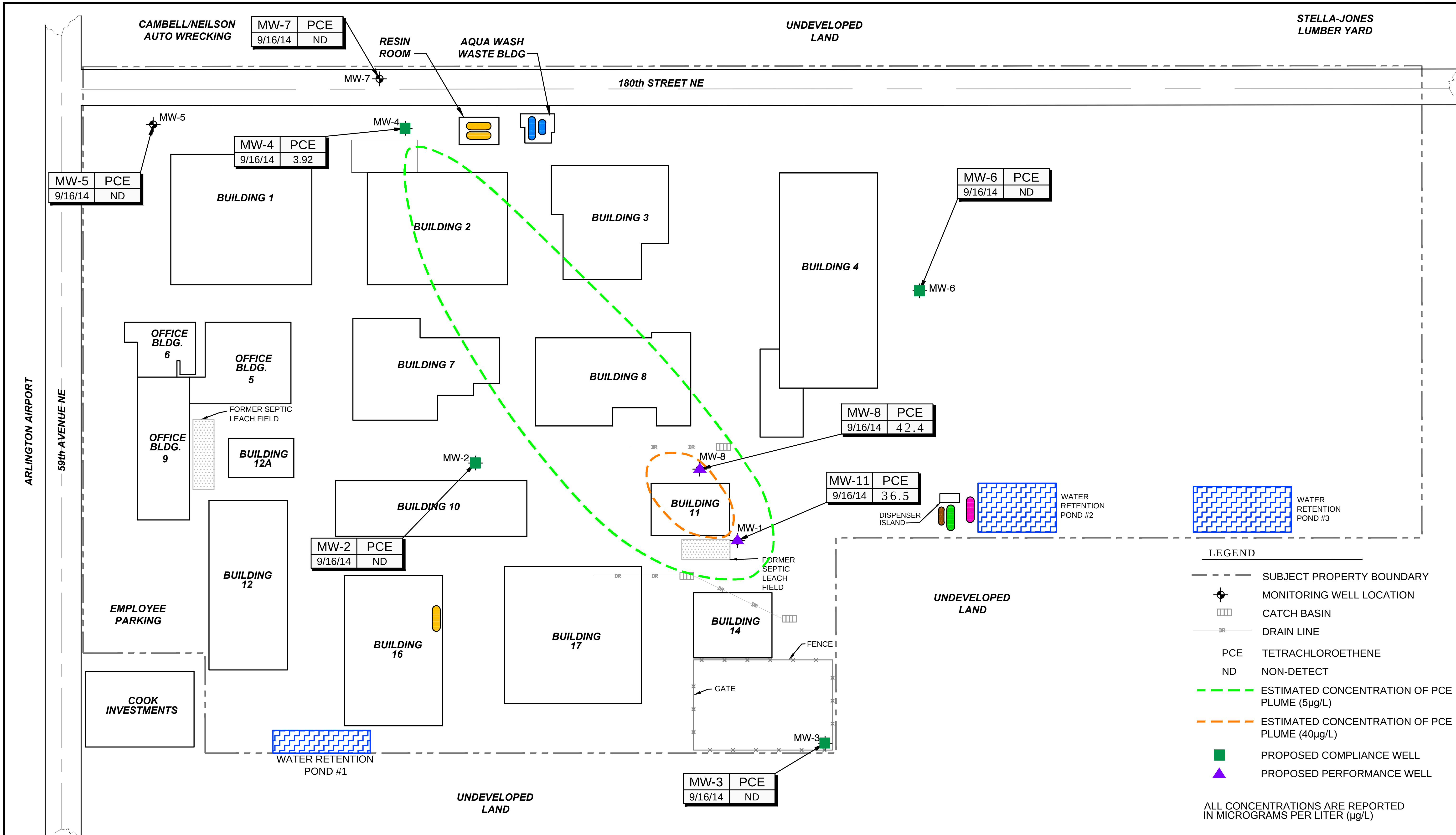
SITE PLAN WITH GROUNDWATER ELEVATION CONTOUR MAP (SEPTEMBER 16, 2014)

FIGURE: 9

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 8:09|Layout: 9-2014



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FOR:
FORMER BAYLINER MARINE FACILITY
17825 59th AVENUE NE
ARLINGTON, WASHINGTON

PROPOSED COMPLIANCE MONITORING WELL NETWORK

FIGURE: 10

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
185750287	ARA	GMC	MS	8/28/15

FILEPATH:C:\Users\aandrews\Documents\traveling_folder\bayliner\BaylinerMarine-2013-2014_GWE_GWA.dwg|AAndrews|Aug 28, 2015 at 10:01|Layout: PROPOSED

Appendix A ECOLOGY OPINION LETTER (JUNE 1, 2015)

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

June 1, 2015

Mr. David Selig
Brunswick Corporation
1 N Field Ct
Lake Forest, IL 60045-4810

Re: Opinion Pursuant to WAC 173-340-515(5) on Proposed Closure Strategy for the Following Hazardous Waste Site:

- **Name:** US Marine Bayliner Marine
- **Address:** 17825 59th Ave NE, Arlington, WA 98223
- **Facility/Site No.:** 51332889
- **VCP No.:** NW2270
- **Cleanup Site No.:** 4208

Dear Mr. Selig:

Thank you for submitting documents regarding your proposed closure strategy for the US Marine Bayliner Marine (Site) for review by the Washington State Department of Ecology (Ecology) under the Voluntary Cleanup Program (VCP). Ecology appreciates your initiative in pursuing this administrative option for cleaning up hazardous waste sites under the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

This letter constitutes an advisory opinion regarding a review of submitted documents/reports pursuant to requirements of MTCA and its implementing regulations, Chapter 70.105D RCW and Chapter 173-340 WAC, for characterizing and addressing the following release at the Site:

- Tetrachloroethylene (PCE) in ground water.

Ecology is providing this advisory opinion under the specific authority of RCW 70.105D.030(1)(i) and WAC 173-340-515(5).

This opinion does not resolve a person's liability to the state under MTCA or protect a person from contribution claims by third parties for matters addressed by the opinion. The state does not have the authority to settle with any person potentially liable under MTCA except in accordance with RCW 70.105D.040(4). The opinion is advisory only and not binding on Ecology.

Ecology's Toxics Cleanup Program has reviewed the following information regarding your proposed closure strategy:

1. *Remedial Investigation and Feasibility Study Former US Marine / Bayliner Marine*, dated April 12, 2011, prepared by Stantec Consulting Services Inc.

2. *Work-Plan for In-Situ Chemical Oxidation Former US Marine / Bayliner Marine*, dated September 24, 2012, prepared by Stantec Consulting Corporation.

3. *In Situ Chemical Oxidation and Ground Water Monitoring Report US Marine / Bayliner Marine*, dated February 10, 2015, prepared by Stantec Consulting Corporation.

4. *Technical Memorandum – Proposed Closure Strategy US Marine / Bayliner Marine,* dated March 12, 2015, prepared by Stantec Consulting Corporation.

The reports listed above will be kept in the Central Files of the Northwest Regional Office of Ecology (NWRO) for review by appointment only. Appointments can be made by calling the NWRO resource contact at (425) 649-7239 or sending an email to: nwro_public_request@ecy.wa.gov.

The Site is defined by the extent of contamination caused by the following release:

- PCE in ground water.

Based on a review of supporting documentation listed above, pursuant to **requirements contained in MTCA and its implementing regulations, Chapter 70.105D RCW and Chapter 173-340 WAC, for characterizing and addressing the following release(s) at the Site, Ecology has determined:**

- Ecology has received and reviewed your Technical Memorandum – Proposed Closure Strategy.

- The proposed closure strategy includes monitored natural attenuation (MNA) and institutional controls in the form of an Environmental Covenant.

- Ecology notes that the normally expected degradation products of PCE including trichloroethene (TCE), cis/trans isomers of dichloroethene (DCE) and vinyl chloride (VC) have not been observed at concentrations above laboratory reporting limits at any time with the exception of 16 μg/L of TCE in monitoring well MW-4 in 2009. This suggests that conditions for reductive dechlorination of PCE in ground water may not be optimal on the Site.

- Ecology also notes that post in-situ chemical oxidation (ISCO) injections, concentrations of PCE in monitoring well MW-8 steadily increased from 34 μg/L to 42 μg/L and concentrations of PCE in MW-1 appears to have stabilized at 31 to 36 μg/L. Additional ground water monitoring and evaluation will be necessary to demonstrate natural attenuation is occurring.

- Conditional points of compliance will be established with monitoring wells MW-2, MW-3, MW-4, and MW-6. Monitoring wells MW-1 and MW-8 within the PCE plume will be performance wells.

- Please develop a *detailed* work plan for MNA which will include use of EPA's BIOCHLOR natural attenuation screening model *and* Ecology's Guidance on Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation (July 2005 Publication No. 05-09-091).

- Ecology requires a stand-alone comprehensive Final Cleanup Report for Sites requiring Institutional Controls.

- For all Sites where an Institutional Control is necessary, Ecology's Northwest Regional Office requires an additional document: Environmental Covenant Checklist. An outline for this document is included as Enclosure A.

This opinion does not represent a determination by Ecology that a proposed remedial action will be sufficient to characterize and address the specified contamination at the Site or that no further remedial action will be required at the Site upon completion of the proposed remedial action. To obtain either of these opinions, you must submit appropriate documentation to Ecology and request such an opinion under the VCP. **This letter also does not provide an opinion regarding the sufficiency of any other remedial action proposed for or conducted at the Site.**

Please note that this opinion is based solely on the information contained in the documents listed above. Therefore, if any of the information contained in those documents is materially false or misleading, then this opinion will automatically be rendered null and void.

The state, Ecology, and its officers and employees make no guarantees or assurances by providing this opinion, and no cause of action against the state, Ecology, its officers or employees may arise from any act or omission in providing this opinion.

Again, Ecology appreciates your initiative in conducting independent remedial action and requesting technical consultation under the VCP. As the cleanup of the Site progresses, you may request additional consultative services under the VCP, including assistance in identifying applicable regulatory requirements and opinions regarding whether remedial actions proposed for or conducted at the Site meet those requirements.

If you have any questions regarding this opinion, please contact me at (425) 649-4446 or by email damy461@ecy.wa.gov.

Sincerely,

Dale Myers
Site Manager
Toxics Cleanup Program

Enclosure: A – Environmental Covenant Checklist

cc: Greg McCormick, Stantec Consulting Corporation

Enclosure A

Environmental Covenant Checklist

Environmental Covenant Checklist

Include following elements:

- Site discovery and regulatory status (**fully describe sites cleanup history and provide a description of previous interim actions and identify if they were approved by Ecology**)
- Site and property location/definition (*define actual MTCA site location relative to property or study area*)
- Physiographic setting/topography
- Provide copies of:
  Vicinity Map (*preferably with topography*)
  Property/Site Map (*preferably with topography*)
  Legal description of property, present owner and operator
- Past site uses and facilities
- Current site use and facilities
- Proposed or potential future site uses
- Zoning
- Utilities, water supply (describe how they do or do not impact the site)
- Contaminants of Concern
- Identify Potential sources of site contamination
- Potential sources of contamination from neighboring properties (*discuss nearby sources if known)*
- Figure – Soil investigation data points
- Figure – Surface water/groundwater investigation data points/depths
- Figure – Cross section with ground water information
- Figure- Boring/ Well logs
- Figure- Ground water elevation data
- Describe Natural Resources and Ecological Receptors
- Provide description of the contaminations proximity to surface water and groundwater based upon the investigation
- Figures – Cross sections showing soil contamination with depth
- Figures – Plan views showing soil contamination across site (*relative to releases if known*)
- Figures – Cross section showing ground water contamination with depth (*if appropriate*)
- Figures – Plan views showing ground water contamination in each aquifer
- Tables – All of the analytical data against final cleanup levels (*exceedances highlighted)*
- Figures – Plan view and vertical sections of areas meeting MTCA cleanup levels

SELECTION AND DESCRIPTION OF CLEANUP ALTERNATIVES (Outline)
(Here is where distinct alternatives are established and described only – no comparison. Some text is useful, but the bulk of the description is best put into a table with accompanying figures.)

MTCA requires:

- *A reasonable number and type of alternatives*
- *Alternatives that protect human health and the environment by eliminating, reducing, or otherwise controlling risks*
- *Alternatives that have the standard point of compliance for all affected media, unless they are not technically possible or are disproportionately costly for the benefit obtained.*
- *At least one permanent cleanup action alternative, unless it is not technically possible or is disproportionately costly for the benefit obtained.)*

(Ecology expectations for cleanup (WAC 173-340-370) should also be considered in formulating the alternatives, even though these expectations are not explicit evaluation criterion.)

DETAILED EVALUATION OF ALTERNATIVES (Outline)
(Best put into tabular format with numerical values for weighting criteria, important to have figure showing cost versus environment benefit for disproportionate cost analysis.)

A cleanup action must meet these minimum requirements [WAC 173-340-360(2)(a)]:

Threshold requirements

- *Protect human health and the environment*
- *Comply with cleanup standards*
- *Comply with applicable state and federal laws*
- *Provide for compliance monitoring*

Other requirements

- *Use permanent solutions to the maximum extent practicable*
- *Provide for a reasonable restoration time frame*
- *Consider public concerns*

Project-specific requirements

- *Engineering criteria established for the specific project, as appropriate)*

- **Describe Comparison with Threshold Criteria** (*Determine if alternatives meet threshold requirements. Only alternatives that meet these requirements advance to the next stage of comparison)*

- **Comparison with "Use Permanent Solutions to the Maximum Extent Practicable" (PMEP) Criterion** *(Ecology prefers permanent solutions, which are essentially those in which cleanup standards can be met without further action at the site.)*

  Procedure

  A. *The alternatives are compared with the evaluation criteria listed below. The comparison may be quantitative or qualitative and require the use of best professional judgment.* ***However, at this time Ecology's northwest regional office favors a quantitative analysis. Quantitative factors should be applied to both weighting of the evaluation criteria and to the ranking of alternatives for each criterion. The basis for the criteria weighting and the alternative rankings should be clearly explained and supported.***

  B. *The most practicable permanent alternative is the baseline against which other alternatives are compared. The results of the comparison are best displayed in a graph which shows relative environmental benefit on one axis and cost on another.*

  Evaluation Criteria
  (Following are the required comparison criteria for the DCA. Cost is not listed since it is an obvious criterion)

  Protectiveness
  Permanence
  Effectiveness over the long term
  Management of short-term risks
  Technical and administrative implementability

- **Comparison with "Reasonable Restoration Time Frame" Criterion**

Potential Risk *(How risky is the existing situation based on type, extent and toxicity of contamination, and sensitivity of surrounding land uses now and in the future.)*
Practicality of Achieving Shorter Time Frame
Availability of Alternate Water Supplies
Likely Effectiveness and Reliability of Institutional Controls
Ability to Control and Monitor Contaminant Migration
Potential for Contaminant Degradation Over time
Provide copy of monitoring plan
Consultant Signature and LHG stamp

Appendix B WELL LOGS

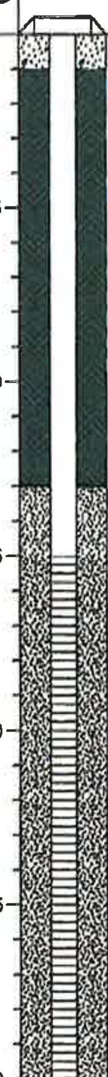
PROJECT: **Bayliner Marine**
LOCATION: **17825 59th Avenue NE, Arlington, WA**
PROJECT NUMBER: **190402025.200.0002**

WELL / PROBEHOLE / BOREHOLE NO: **MW-1**

DATE: STARTED **12/9/2009** COMPLETED: **12/9/2009**	NORTHING (ft):
TIME: STARTED COMPLETED:	EASTING (ft):
DRILLING COMPANY: **Cascade Drilling Inc.**	LATITUDE:
DRILLING EQUIPMENT: **CME 75**	LONGITUDE:
DRILLING METHOD: **Hollow Stem Auger**	GROUND ELEV (ft):
SAMPLING EQUIPMENT: **Split Spoon**	TOC ELEV (ft): **129.42**
	INITIAL DTW (ft): **25 12/9/09**
	BOREHOLE DEPTH (ft): **30.0**
	STATIC DTW (ft): **N/A**
	WELL DEPTH (ft): **30**
	WELL CASING DIAM. (in): **2**
	BOREHOLE DIAM. (in): **6.25**
	LOGGED BY: **ACZ**
	CHECKED BY: **RRS**

Time & Depth (feet)	USCS	Description	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)
0		Concrete				
		Fill Material				
	SW	SW; Sand, fine to medium grained, < 5% coarse sand, brown, damp, no odor, no staining, medium dense				
09 00 5			09 00 MW-1-5		13 12 13	0.0
09 05 10	SW	SW; Sand, fine to coarse grained, < 5% gravel, brown, damp, no odor, no staining, medium dense	09 05 MW-1-10		10 12 14	0.0
09 12 15			09 12 MW-1-15		14 19 20	0.0
09 18 20	SW	SW; Sand, fine to coarse grained, brown, moist, no odor, no staining, very dense	09 18 MW-1-20*		50 for 6	0.0
09 23 25	SW	SW; Sand, fine to coarse grained, brown, saturated, no odor, no staining, very dense	09 23 MW-1-25		50 for 6	0.0
30		Hole terminated at 30 feet.				
		* - Sample submitted for analysis.				
35						

Well Construction



GEO FORM 304 STANTEC037 GWM INSTALL - BRUNSICK - ARLINGTON, WA.GPJ SECOR037.GDT 12/18/09

PROJECT: **Bayliner Marine**	WELL / PROBEHOLE / BOREHOLE NO:
LOCATION: **17825 59th Avenue NE, Arlington, WA**	**MW-2**
PROJECT NUMBER: **190402025.200.0002**	PAGE 1 OF 1
DATE: STARTED **12/9/2009** COMPLETED: **12/9/2009**	NORTHING (ft): / EASTING (ft):
TIME: STARTED COMPLETED:	LATITUDE: / LONGITUDE:
DRILLING COMPANY: **Cascade Drilling Inc.**	GROUND ELEV (ft): / TOC ELEV (ft): **129.68**
DRILLING EQUIPMENT: **CME 75**	INITIAL DTW (ft): **25 12/9/09** / BOREHOLE DEPTH (ft): **30.0**
DRILLING METHOD: **Hollow Stem Auger**	STATIC DTW (ft): **N/A** / WELL DEPTH (ft): **30**
SAMPLING EQUIPMENT: **Split Spoon**	WELL CASING DIAM. (in): **2** / BOREHOLE DIAM. (in): **6.25**
	LOGGED BY: **ACZ** / CHECKED BY: **RRS**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)	Depth (feet)	Well Construction
			Concrete							
			Fill Material							
		SW	SW; Sand, fine to coarse grained, < 5% gravel, brown, damp, no odor, no staining, medium dense to dense							
11 15 5				X	11 15 MW-2-5		10 12 12	0.0	5	
11 26 10				X	11 26 MW-2-10		10 14 19	0.0	10	
11 39 15				X	11 39 MW-2-15		50 for 6 19 20	0.0	15	
11 43 20		SW	SW; Sand, fine to coarse grained, brown, moist, no odor, no staining, very dense	X	11 43 MW-2-20*		32 50 for 4	0.0	20	
11 48 25		SW	SW; Sand, fine to coarse grained, brown, saturated, no odor, no staining, very dense	X	11 48 MW-2-25		50 for 5	0.0	▽ 25	
30			Hole terminated at 30 feet.						30	
			* - Sample submitted for analysis.							
35									35	

GEO FORM 304 STANTEC037 GWM INSTALL - BRUNSICK - ARLINGTON, WA.GPJ SECOR037.GDT 12/18/09

PROJECT: **Bayliner Marine**
LOCATION: **17825 59th Avenue NE, Arlington, WA**
PROJECT NUMBER: **190402025.200.0002**

WELL / PROBEHOLE / BOREHOLE NO:
MW-3

Stantec

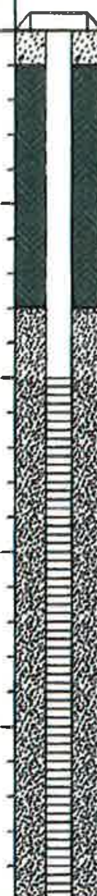
DATE: STARTED **12/8/2009** COMPLETED: **12/8/2009**
TIME: STARTED COMPLETED:
DRILLING COMPANY: **Cascade Drilling Inc.**
DRILLING EQUIPMENT: **CME 75**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING EQUIPMENT: **Split Spoon**

NORTHING (ft):
LATITUDE:
GROUND ELEV (ft):
INITIAL DTW (ft): **20 12/9/09**
STATIC DTW (ft): **N/A**
WELL CASING DIAM. (in): **2**
LOGGED BY: **ACZ**

EASTING (ft):
LONGITUDE:
TOC ELEV (ft): **129.90**
BOREHOLE DEPTH (ft): **25.0**
WELL DEPTH (ft): **25**
BOREHOLE DIAM. (in): **6.25**
CHECKED BY: **RRS**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)	Depth (feet)
			Topsoil						
		SW	SW; Sand, fine to coarse grained, < 5% gravel, brown, damp, no odor, no staining, dense						
14 01 5		SW	SW; Sand, fine to medium grained, reddish brown to brown, damp, no odor, no staining, dense to very dense	X	14 01 MW-3-5		27 50 for 4	0.0	5
14 15 10		SW	SW; Sand, fine to coarse grained, <5% gravel, brown, damp, no odor, no staining, very dense	X	14 15 MW-3-10		20 27 30	0.0	10
14 19 15		SW	SW; Sand, fine to coarse grained, brown to dark brown, moist to wet, no odor, no staining, very dense	X	14 19 MW-3-15*		50 for 5	0.0	15
14 24 20		SW	SW; Sand, fine to coarse grained, <5% gravel, brown, saturated, no odor, no staining, very dense	X	14 24 MW-3-20		50 for 5	0.0	∇ 20
14 33 25			Hole terminated at 25 feet.						25
			* - Sample submitted for analysis.						
30									30
35									35

Well Construction



PROJECT: **Bayliner Marine**
LOCATION: **17825 59th Avenue NE, Arlington, WA**
PROJECT NUMBER: **190402025.200.0002**

WELL / PROBEHOLE / BOREHOLE NO: **MW-4**

Stantec

DATE: STARTED **12/9/2009** COMPLETED: **12/9/2009**	NORTHING (ft):	EASTING (ft):
TIME: STARTED COMPLETED:	LATITUDE:	LONGITUDE:
DRILLING COMPANY: **Cascade Drilling Inc.**	GROUND ELEV (ft):	TOC ELEV (ft): **130.42**
DRILLING EQUIPMENT: **CME 75**	INITIAL DTW (ft): **25 12/9/09**	BOREHOLE DEPTH (ft): **30.0**
DRILLING METHOD: **Hollow Stem Auger**	STATIC DTW (ft): **N/A**	WELL DEPTH (ft): **30**
SAMPLING EQUIPMENT: **Split Spoon**	WELL CASING DIAM. (in): **2**	BOREHOLE DIAM. (in): **6.25**
	LOGGED BY: **ACZ**	CHECKED BY: **RRS**

Time & Depth (feet)	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)	Depth (feet)
0		Asphalt						
		Fill Material						
	SW	SW; Sand, fine to coarse grained, <15% gravel, grayish brown, damp, no odor, no staining, medium dense						
13 25 5			X	13 46 MW-4-5		12 12 14	0.0	5
13 45 10			X	13 50 MW-4-10		14 17 18	0.0	10
13 50 15	SW	SW; Sand, fine to coarse grained, <25% gravel, grayish brown, damp, no odor, no staining, very dense	X	13 55 MW-4-15		31 50 for 4	0.0	15
14 01 20	SW	SW; Sand, fine to medium grained, brown to dark brown, moist to wet, no odor, no staining, very dense	X	14 01 MW-4-20*		50 for 5	0.0	20
14 09 25	SW	SW; Sand, fine to medium grained, brown to dark brown, saturated, no odor, no staining, very dense	X	14 09 MW-4-25		50 for 5	0.0	∇ 25
30		Hole terminated at 30 feet.						30
		* - Sample submitted for analysis.						
35								35

Well Construction

GEO FORM 304 STANTEC037 GWM INSTALL - BRUNSWICK - ARLINGTON, WA.GPJ SECOR037.GDT 12/18/09

PROJECT: **Bayliner Marine**
LOCATION: **17825 59th Avenue NE, Arlington, WA**
PROJECT NUMBER: **190402025.200.0002**

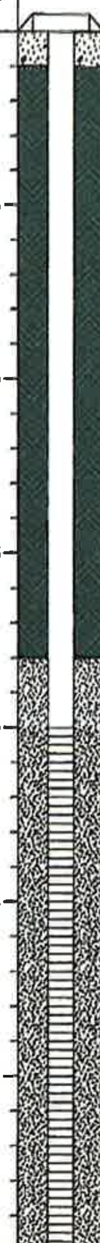
WELL / PROBEHOLE / BOREHOLE NO:
MW-5

Stantec

DATE: STARTED **12/8/2009** COMPLETED: **12/8/2009**	NORTHING (ft):
TIME: STARTED COMPLETED:	EASTING (ft):
DRILLING COMPANY: **Cascade Drilling Inc.**	LATITUDE:
DRILLING EQUIPMENT: **CME 75**	LONGITUDE:
DRILLING METHOD: **Hollow Stem Auger**	GROUND ELEV (ft):
SAMPLING EQUIPMENT: **Split Spoon**	TOC ELEV (ft): **130.39**
	INITIAL DTW (ft): **30 12/9/09**
	BOREHOLE DEPTH (ft): **35.0**
	STATIC DTW (ft): **N/A**
	WELL DEPTH (ft): **35**
	WELL CASING DIAM. (in): **2**
	BOREHOLE DIAM. (in): **6.25**
	LOGGED BY: **ACZ**
	CHECKED BY: **RRS**

Time & Depth (feet)	Graphic Log	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (ppm)	Depth (feet)
0			Topsoil						0
		SW	SW; Sand, fine to coarse grained, brown, damp, no odor, no staining, dense						
11 00 5				X	11 00 MW-5-5*		12 18 24	6.9	5
11 11 10		SW	SW; Sand, fine to coarse grained, <5% gravel, brown, damp, no odor, no staining, very dense	X	11 11 MW-5-10		50 for 6	2.4	10
11 24 15		SW	SW; Sand, fine to coarse grained, brown, moist, no odor, no staining, very dense	X	11 24 MW-5-15		50 for 4	0.9	15
11 31 20		SW	SW; Sand, fine to medium grained, brown, damp to moist, no odor, no staining, very dense	X	11 31 MW-5-20*		22 30 35	0.0	20
11 42 25		SW	SW; Sand, fine to coarse grained, brown, wet, no odor, no staining, very dense	X	11 42 MW-5-25		50 for 6	0.0	25
30		SW	SW; Sand, fine to coarse grained, brown, saturated, no odor, no staining, very dense						∇ 30
35			Hole terminated at 35 feet.						35
			* - Submitted for labaratory analysis.						

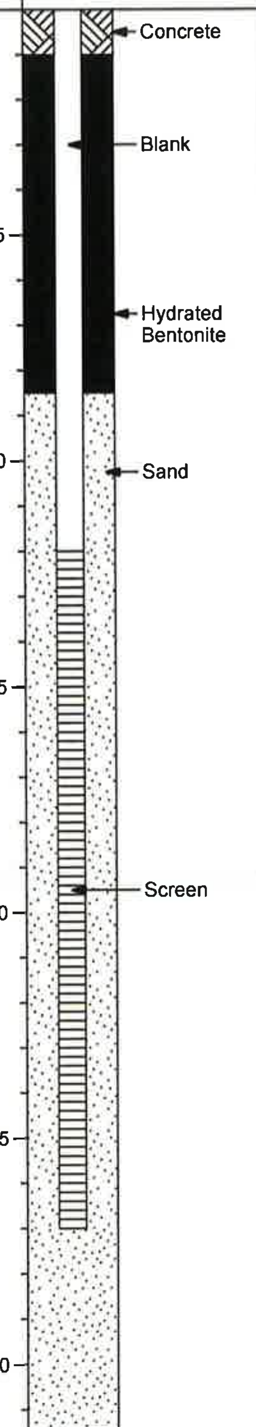
Well Construction



PROJECT: **Bayliner Marine - Brunskick-Arlington**	WELL / PROBEHOLE / BOREHOLE NO: **MW-8**
LOCATION: **17825 59th Avenue NE, Arlington WA**	PAGE 1 OF 1
PROJECT NUMBER: **190402126**	

DRILLING: STARTED **9/13/11** COMPLETED: **9/13/11**	NORTHING (ft):	EASTING (ft):	
INSTALLATION: STARTED **9/13/11** COMPLETED: **9/13/11**	LATITUDE:	LONGITUDE:	
DRILLING COMPANY: **EDI**	GROUND ELEV (ft):	TOC ELEV (ft):	
DRILLING EQUIPMENT: **Hollow Stem Auger**	INITIAL DTW (ft): **18**	BOREHOLE DEPTH (ft): **31.5**	
DRILLING METHOD:	STATIC DTW (ft): **Not Measured**	WELL DEPTH (ft): **30**	
SAMPLING EQUIPMENT:	WELL CASING DIAMETER (in): **4**	BOREHOLE DIAMETER (in): **8**	
	LOGGED BY: **A. Donnell**	CHECKED BY:	

Time & Depth (feet)	USCS	Description	Sample	Time Sample ID	Measured Recov. (feet)	Blow Count	Headspace PID (units)	Depth (feet)
0		CONCRETE						
	SW	**SAND LENSE OF GRAVEL**; SW; brown red; fine-grained; moist; hit a large rock at 2.5'				3/6" 5/6" 6/6" 11		
5							3.1	5
	SW	**SAND**; SW; gray; medium-grained; medium dense; moist				5/6" 12/6" 14/6" 26		
10	SPG	**SAND WITH GRAVEL**; SPG; gray; medium-grained; medium dense to dense; moist to wet					2.5	10
						10/6" 13/6" 18/6" 31		
15							1.1	15
						6/6" 10/6" 14/6" 24		
20	SP	**SAND**; SP; gray; medium-grained; medium dense; saturated					1.1	20
						10/6" 21/6" 38/6" 59		
25	SP	**SAND LITTLE GRAVEL**; SP; gray; medium-grained; very dense; saturated					1.5	25
	SW	**SAND**; SW; gray; fine-grained; very dense; saturated				14/6" 27/6" 34/6" 61		
30							1.1	30
		Borehole terminated at 31.5 feet.						



Appendix C BIOCHLOR INPUT PARAMETERS

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Former Bayliner
Arlington, WA
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 0.02 → 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes O

1. ADVECTION

Seepage Velocity*	Vs	373.0	(ft/yr)
or			
Hydraulic Conductivity	K	6.6E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.22	(-)

2. DISPERSION

Alpha x*	21	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	1.6	(kg/L)
FractionOrganicCarbon, foc	6.0E-4	(-)

Partition Coefficient

	Koc		R	
PCE	426	(L/kg)	2.86	(-)
TCE		(L/kg)		(-)
DCE		(L/kg)		(-)
VC		(L/kg)		(-)
ETH		(L/kg)		(-)

Common R (used in model)* = 2.86

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.600	0.40	0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	20	(yr)
Modeled Area Width*	300	(ft)
Modeled Area Length*	810	(ft)
Zone 1 Length*	810	(ft)
Zone 2 Length*	0	(ft)

L W Zone 2=

6. SOURCE DATA TYPE: Continuous Single Planar

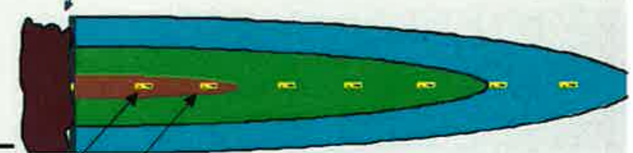
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Width* (ft) Y1: 100

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.042	0
TCE		0
DCE		0
VC		0
ETH		0

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.042	.004									
TCE Conc. (mg/L)	.0	.0									
DCE Conc. (mg/L)	.0	.0									
VC Conc. (mg/L)	0.0	.0									
ETH Conc. (mg/L)	0.0	.0									
Distance from Source (ft)	0	700									
Date Data Collected	1998										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | SEE | Restore | Paste | RESET

Appendix D BIOCHLOR GROUNDWATER MODELING RESULTS

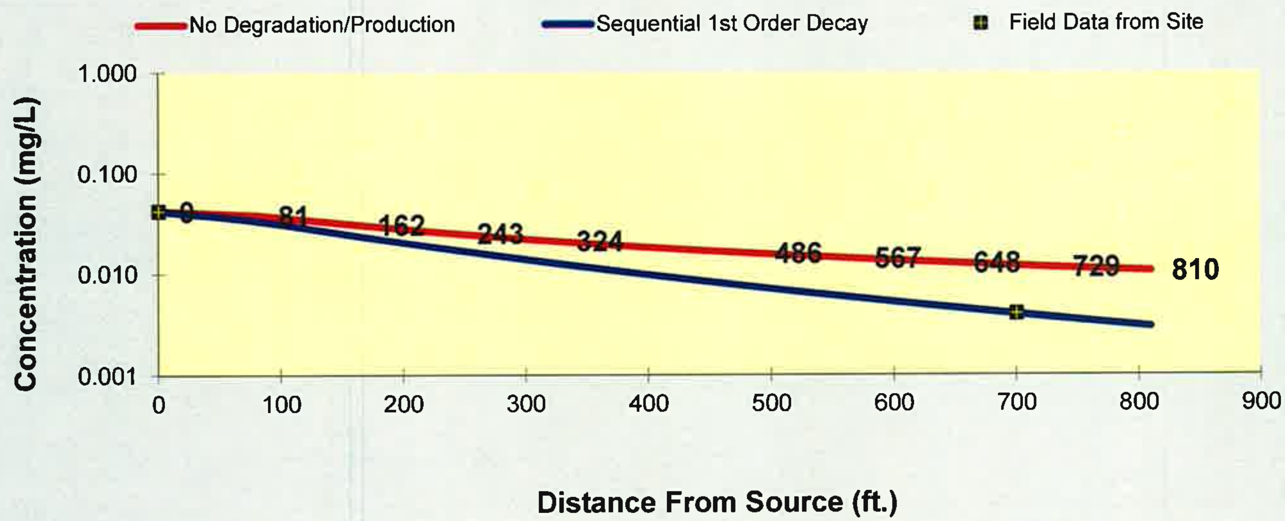
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

PCE	0	81	162	243	324	405	486	567	648	729	810
No Degradation	0.042	0.038	0.031	0.025	0.021	0.018	0.016	0.014	0.013	0.012	0.011
Biotransformation	0.0420	0.034	0.024	0.017	0.013	0.010	0.007	0.006	0.005	0.004	0.003

Monitoring Well Locations (ft)

	0	700									
Field Data from Site	0.042	0.004									



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time:
20.0 Years
Log ⟺ Linear

Return to Input
To All
To Array