Groundwater Monitoring Sampling and Analysis Plan Addendum

Cap Sante Marine
Anacortes, Washington
Ecology Consent Decree No. 9917

for
Washington State Department of Ecology on Behalf of Port of Anacortes

January 18, 2016

GeoEngineers
Earth Science + Technology

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File No. 5147-005-10

January 18, 2016

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INTRODUCTION

This document is being presented as an addendum to the Washington State Department of Ecology (Ecology) approved Groundwater Monitoring Sampling and Analysis Plan (SAP; GeoEngineers, 2014) for groundwater monitoring activities at the Cap Sante Marine Site (Site). The Site is located between 11th and 13th Streets east of Q Avenue in Anacortes, Washington (Figure 1). The Site is referred to in the Washington State Department of Ecology (Ecology) databases as Cap Sante Marine (Ecology Facility/Site Identification No. 67532227) and is subject to cleanup actions in accordance with Ecology Consent Decree No. 9917 (Consent Decree). Ecology is managing the Site as part of the Fidalgo and Padilla Bay component to the Puget Sound Initiative.

The Site includes portions of the Former Cap Sante Marine Lease Area and Fisherman's Work and Parking Area (see Figure 2) that have been environmentally impacted from historical uses of these areas. Residual contamination including gasoline- and diesel-range petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) exceeding Model Toxics Control Act (MCTA) cleanup levels remain in-place at the Site following implementation of Ecology's Cleanup Action Plan (CAP; Ecology, 2013). Engineering and institutional controls have been established at the Site to prevent human/terrestrial wildlife contact with this contamination. Between August 2014 and May 2015, four quarterly groundwater monitoring events were completed in accordance with the Ecology-approved SAP to evaluate whether residual contamination in soil was adversely effecting groundwater. No exceedances of the Site cleanup levels were measured.

At this time, Ecology is requiring that two additional rounds of groundwater monitoring be completed to further evaluate groundwater conditions at the Site.

The primary purpose of this document is to describe the additional groundwater monitoring activities that will be performed at the Site. This Addendum is intended to be used in conjunction with the Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HASP) included as appendices to the SAP. Additional groundwater monitoring activities are described below.

GROUNDWATER MONITORING PROGRAM

Groundwater monitoring will be performed at the Site to further evaluate groundwater conditions within and/or down gradient of areas in which concentrations of petroleum hydrocarbons and PAHs in soil exceed site-specific cleanup levels. Sample locations, procedures, frequency and chemical analysis for the additional groundwater monitoring are summarized in the following sections.

Detailed information regarding Site location, historical use, subsurface soil and groundwater conditions, and procedures and standards for quality assurance (QA) and quality control (QC) that will be implemented to produce chemical and field data that are representative, valid and accurate for use in evaluating the cleanup action effectiveness are presented in the SAP. Soil and groundwater cleanup levels established for the Site and a summary of previous cleanup actions are summarized in the CAP (Ecology, 2013).

Monitoring Well Network

Existing groundwater monitoring wells GEI-MW-6 and GEI-MW-7 will be used to evaluate groundwater conditions within and/or downgradient of residual soil contamination. Monitoring well GEI-MW-6 is

positioned downgradient of residual petroleum hydrocarbon and PAH contaminated soil located in the southwest corner of the Former Cap Sante Marine Lease Area. Monitoring well GEI-MW-7 is positioned at the shoreline within the area of residual petroleum hydrocarbon and PAH contaminated soil located in the eastern portion of the Fisherman's Work and Parking Area. Monitoring wells GEI-MW-6 and GEI-MW-7 are shown on Figure 2. Well construction details for GEI-MW-6 and GEI-MW-7 are summarized in Table 1. Monitoring well completion logs are presented in Appendix A.

Groundwater Sampling and Analysis

Groundwater samples will be collected from each monitoring well and analyzed for the chemical parameters identified in Table 2 to further evaluate the long-term effectiveness of the cleanup action implemented for the Site. Groundwater sampling procedures are summarized below.

Groundwater Sampling Procedure

Groundwater levels will be measured at each monitoring well location during each monitoring event to the nearest 0.01 foot prior to sampling using an electric water level indicator (e-tape). The water levels will be recorded relative to the surveyed casing rim elevations.

Monitoring well GEI-MW-7 located within zone of tidal influence (i.e., 200 feet from the shoreline based on previous tidal studies) will be sampled within approximately one hour of the lowest daytime tide level to the extent practicable. Groundwater samples will be obtained using low-flow/low-turbidity sampling techniques to minimize the suspension of sediment in groundwater samples. Groundwater samples will be obtained using low-flow/low-turbidity sampling techniques to minimize the suspension of sediment in groundwater samples. Using a peristaltic pump and dedicated polyethylene tubing, groundwater will be pumped from the well at a rate not to exceed 0.5 liters per minute to minimize drawdown. A Horiba U-50 series water quality measuring unit (or equivalent) with flow-through-cell will be used to monitor the following water quality parameters during purging:

- Electrical conductivity (EC);
- Dissolved oxygen (DO);
- Acidity (pH);
- Total dissolved solids (TDS);
- Oxygen reduction potential (ORP);
- Turbidity;
- Salinity; and
- Temperature.

Water samples will be obtained after the measurements of these parameters vary by less than 10 percent on three consecutive attempts (i.e., indication of ambient groundwater conditions). Water samples will be placed in laboratory prepared containers following collection procedures outlined in QAPP (Appendix A of the SAP) and the stabilized field measurements documented on a field log.

Purge and decontamination water generated during groundwater sampling activities will be placed in labeled and sealed 30-gallon or 55-gallon drums. The drums will be temporarily stored at the Site in a secure location pending receipt of chemical analytical results and identification of an appropriate disposal facility. Incidental waste generated during sampling activities such as gloves, plastic sheeting, paper towels

and similar expended and discarded field supplies will be disposed of at a local trash receptacle or county disposal facility. Reusable sampling equipment that comes in contact with groundwater will be decontaminated before each use. Decontamination procedures for this equipment are described in the QAPP (Appendix A of the SAP).

Chemical Analysis

Water samples will be obtained from monitoring wells GEI-MW-6 and GEI-MW-7 will be submitted to an Ecology accredited laboratory for the following chemical analysis:

- Gasoline-range hydrocarbons using Ecology Method NWTPH-Gx;
- Diesel- and heavy oil-range hydrocarbons using Ecology Method NWTPH-Dx; and
- Polycyclic aromatic hydrocarbons (PAHs) using EPA Method 8270 SIM.

The schedule of analysis is summarized in Table 3. The groundwater samples will be kept cool prior to and during transport to the testing laboratory. Standard chain-of-custody procedures will be followed in transporting the samples to the testing laboratory. Sample containers, preservation and holding times for groundwater samples are summarized in Table 4.

To measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sampling techniques used by field personnel, a minimum of one duplicate sample will be collected during each monitoring event. Sample handling procedures, including labeling, container and preservation are described in the QAPP (Appendix A of the SAP).

Groundwater Monitoring Schedule

Groundwater will be monitored on a semi-annual basis over a one year period. During this monitoring period, sampling will be completed to evaluate “wet” season and “dry” season conditions. Semi-annual groundwater monitoring will be completed in August and February to be consistent with previous sampling events and to capture the months where contaminants exceeded the practical quantitation limit (PQL) but less than site cleanup levels. As requested by Ecology, additional groundwater monitoring events will be completed in February and August of 2017.

Further groundwater monitoring activities will be determined by Ecology based on the results of the additional groundwater monitoring and previously completed groundwater monitoring events.

Monitoring Well Decommissioning

Upon receipt of approval from Ecology that all compliance monitoring requirements have been met and the monitoring wells will no longer be used, monitoring wells GEI-MW-6 and GEI-MW-7 will be decommissioned by a well driller licensed in the State of Washington in accordance with Ecology requirements (WAC 173-160-460).

QUALITY ASSURANCE AND CONTROL

The quality assurance objective for technical data is to collect environmental monitoring data of known, acceptable, and documentable quality. The QA objectives established for the project are:

- Implement the procedures outlined in the QAPP for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting to facilitate consistency and thoroughness of data generated.
- Achieve the acceptable level of confidence and quality required so that data generated are scientifically valid and of known and documented quality. This will be performed by establishing criteria for precision, accuracy, representativeness, completeness, comparability, and by testing data against these criteria.

Specific QA/QC procedures and standards that will be implemented during the additional groundwater monitoring activities are presented in the QAPP (Appendix B of the SAP).

When sample analytical data are received from the analytical laboratory, they will undergo a QC review by the QA Leader. Quality control procedures for organic analysis are presented in Table 5. Under ideal conditions, the selected analytical method will provide reporting limits less than the cleanup levels presented in Table 1. However, the reporting limits presented in Table 1 are considered targets because several factors may influence final detection limits, including analytical procedures that may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect is that other analytes could be reported as undetected but at a value higher than a specified reporting limit. The laboratory will follow method specific quality control procedures, including an evaluation of method blanks, internal standards, calibrations, matrix spike/matrix spike duplicates (MS/MSD), laboratory control spikes/spike duplicates (LCS/LCSD), laboratory replicates or duplicates and/or surrogate spikes. Laboratory quality control will be reviewed by the QA Leader through a formal validation process to evaluate the quality of the data. Additional specifications and professional judgment by the QA Leader may be incorporated when appropriate data from specific matrices and field samples are available.

HEALTH AND SAFETY

Groundwater monitoring and sampling activities will be performed in accordance with the requirements of the Federal Occupational Safety and Health Act (29 CFR 1910, 1926). These regulations include requirements that workers are to be protected from exposure to contaminants. A Site HASP describing actions that will be taken to protect the health and safety of GeoEngineers, Inc.'s (GeoEngineers) personnel is provided in Appendix B of the SAP.

REPORTING

The results of the additional groundwater monitoring activities will be provided to Ecology following each of the monitoring events as part of the project progress reporting. After completion of the two additional rounds of groundwater monitoring, a Groundwater Monitoring Report summarizing the results of each additional semi-annual groundwater monitoring event will be submitted to Ecology for review. Data generated as part of the groundwater monitoring program will be submitted to Ecology in the format required by Environmental Information Management (EIM) Policy 840 following completion of data review and validation.

LIMITATIONS

This report has been prepared for the exclusive use of the Port of Anacortes, their authorized agents and regulatory agencies in their evaluation of the Cap Sante Marine Site in Anacortes, Washington. No other party may rely on the product of our services unless we agree in advance and in writing to such reliance.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. No warranty or other conditions express or implied should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

REFERENCES

GeoEngineers, Inc., "Groundwater Monitoring Sampling and Analysis Plan, Cap Sante Marine Site, Anacortes, Washington, Ecology Consent Decree No. 9917," GEI File No. 5147-005-10, prepared for the Washington State Department of Ecology on behalf of Port of Anacortes, May 30, 2014.

Washington State Department of Ecology (Ecology, 2013), "Cleanup Action Plan (CAP), Cap Sante Marine Site, Anacortes, Washington," by the Washington State Department of Ecology, Toxics Cleanup Program, Lacey, Washington, December 10, 2013.

TABLES

GeoEngineers

Table 1

Groundwater Monitoring Well Completion Data

Cap Sante Marine

Anacortes, Washington

Monitoring Well[1]	Date Installed	Installed By	Ecology Well Identification	Ground Surface Elevation (feet)	Top of Casing Elevation (feet)	Bottom of Casing Elevation (feet)	Total Well Depth (feet bgs)	Screen Interval (feet bgs)	Well Casing and Screen Specifications	Monitoring Well Coordinates Wahington State Planes (NAD 83)	
										Easting	Northing
GEI-MW-06	2/9/2015	GeoEngineers	BHM 145	12.80	12.5	-2.20	15	5 to 15	2-Inch Diameter Schedule 40 PVC Well Casing and Screen with 0.010-Inch Slot Width	1209694.387	556552.4204
GEI-MW-07	2/10/2015	GeoEngineers	BHM 146	12	11.7	-8.00	20	5 to 20	2-Inch Diameter Schedule 40 PVC Well Casing and Screen with 0.010-Inch Slot Width	1209845.159	556436.0145

Notes:

[1]Monitoring well locations are shown on Figure 2.

Borings were installed using hollow-stem auger (HAS) drilling methods.

Elevations referenced to Mean Lower Low Water (MLLW).

bgs = below ground surface

NAD 83 = North American Datum 1983

PVC = polyvinyl chloride

Table 2

Method Analysis and Target Reporting Limits for Indicator Hazardous Substances

Cap Sante Marine

Anacortes, Washington

Constituent	CAS Number[1]	Analytical Method	Practical Quantification Limit[2] (PQL)	Groundwater Cleanup Level[3] (µg/L)
Petroleum Hydrocarbons				
Gasoline-Range	n/a	NWPTH-G	250	1,000
Diesel-Range	n/a	NWYPH-Dx	400	500
Heavy Oil-Range	n/a	NWYPH-Dx	400	500
Non-Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	83-32-9	EPA 8270-SIM	0.1	643
Acenaphthylene	208-96-8	EPA 8270-SIM	0.1	NE
Anthtracene	120-12-7	EPA 8270-SIM	0.1	25,900
Benzo(ghi)perylene	191-24- 2	EPA 8270-SIM	0.1	NE
Fluoranthene	206-44-0	EPA 8270-SIM	0.1	90
Fluorene	86-73-7	EPA 8270-SIM	0.1	3,460
Naphthalenes	1146-65-2 38072-94-5 91-57-6	EPA 8270-SIM	0.1	4,940
Phenanthrene	85-01-8	EPA 8270-SIM	0.1	NE
Pyrene	129-00-0	EPA 8270-SIM	0.1	2,590
Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)				
Benzo(a)anthracene	56-55-3	EPA 8270-SIM	0.01	see TEC
Chrysene	218-01-9	EPA 8270-SIM	0.01	see TEC
Benzo(b)fluoranthene	205-99-2	EPA 8270-SIM	0.01	see TEC
Benzo(k)fluoranthene	207-08-9	EPA 8270-SIM	0.01	see TEC
Benzo(a)pyrene	50-32-8	EPA 8270-SIM	0.01	see TEC
Indeno(1,2,3-cd)pyrene	193-39-5	EPA 8270-SIM	0.01	see TEC
Dibenz(a,h)anthracene	53-70-3	EPA 8270-SIM	0.01	see TEC
Total cPAHs (TEC)	n/a	n/a	n/a	0.100

Notes:

[1] Chemical Abstract Service (CAS) registry number.

[2] Practical Quantitation Limit (PQL) values from OnSite Environmental Inc. (OnSite) of Redmond, Washington.

[3] Groundwater cleanup levels referenced from the Cleanup Action Plan (Ecology, 2013).

µg/L = micrograms per liter

n/a = not applicable

TEC = toxicity equivalency concentration

Table 3

Groundwater Monitoring Sampling and Analysis Plan

Cap Sante Marine

Anacortes, Washington

Monitoring Well[1]	Petoleum Hydrocarbons			Polycyclic Aromatic Hydrocarbons (PAHs)
	Gasoline-Range	Diesel-Range	Heavy Oil-Range	
GEI-MW-06	X	X	X	X
GEI-MW-07[2]	X	X	X	X

Notes:

[1]Monitoring well locations are shown on Figure 2.

[2]A field duplicate sample will be obtained from this location during each monitoring event.

EPA = Environmental Protection Agency

Table 4

Sample Containers, Preservation and Holding Times

Cap Sante Marine

Anacortes, Washington

Parameter	Method	Minimum Sample Size	Container Size and Type	Sample Preservation Technique	Holding Time for Indicated Preservation Technique
Gasoline-Range Hydrocarbons	NWTPH-G	40 mL	Three 40mL glass vial (VOA)	Cool 4°C, HCl to pH < 2	14 days to extraction/analysis
Diesel- and Oil-Range Hydrocarbons	NWTPH-Dx	500mL	500mL amber glass with Teflon-lined lid	Cool 4°C, HCl to pH < 2	14 days to extraction 40 days from extraction to analysis
PAHs	EPA 8270/SIM	1L	1 Liter Amber Glass with Teflon - Lined Lid	Cool ≤ 6°C	7 Days to Extraction 40 Days for Extraction to Analysis

Notes:

EPA = Environmental Protection Agency

HCL = hycrochloric acid

L = liter

mL = milliliter

SIM = Selected Ion Mode

Table 5

Quality Control Procedures for Organic Analysis[1,2,3]

Cap Sante Marine
Anacortes, Washington

Quality Control Procedure	Frequency	Control Limit	Corrective Action
Instrument Quality Assurance/Quality Control			
Initial Calibration	Before sample analysis and when continuing calibration does not meet method requirements. See reference method(s) in Table 4.	See reference method(s) in Table 4.	Laboratory to recalibrate and reanalyze affect samples.
Continuing Calibration	Method-specific. See reference method(s) in Table 4.	Method–specific. See reference method(s) in Table 4.	Laboratory to recalibrate if correlation coefficient or response factor does not meet requirements.
Method Quality Assurance/Quality Control			
Holding Times	All samples.	See Table 4.	Laboratory to qualify results if holding times are exceeded. Data validator will use professional judgment to qualify results as estimated or reject data.
Method Detection Limits (MDL)	Update method detection limit studies annually.	See reference method(s) in Table 4.	Revise detection limits.
Method Blanks	One per sample batch or every 20 samples, whichever is more frequent, or when there is a change in reagents.	Analyte concentration ≤ PQL. Control limits are not applicable if sample concentrations are < MDL.	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware, or reagents, or analytical system. Re-digest and reanalyze affected samples.
Matrix Spikes (MS)	One per sample batch or every 20 samples, whichever is more frequent. Spiked with the same analytes at the same concentration as the laboratory control sample.	Compound and matrix specific, recovery should not exceed method or performance -based intra-laboratory control chart limits.	Laboratory to re-digest and reanalyze samples if analytical problems suspected. Matrix interferences should be assessed and explained in case narrative accompanying the data package.
Matrix Spike Duplicates (MSD)	One duplicate analysis with every sample batch or every 20 samples, whichever is more frequent. Use analytical replicates when samples are expected to contain target analytes. Use matrix spike duplicates when samples are not expected to contain target analytes.	Compound and matrix specific. Use intra-laboratory control chart results if sufficient data are available to generate control charts. Otherwise use analytical method default criteria.	Laboratory to re-digest and reanalyze samples if analytical problems are suspected, or to qualify the data if sample homogeneity problems are suspected and the project manager is consulted.
Surrogate Spikes (SS)	Added to every organics sample as specified in analytical protocol.	Compound specific, recovery should not exceed the control limits specified in the method or performance-based intra- laboratory control limits.	Follow corrective actions specified in analytical method.
Laboratory Control Samples (LCS)	One per analytical batch or every 20 samples, whichever is more frequent.	Compound specific, recovery should not exceed performance- based intra-laboratory control limits.	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then re-extract and reanalyze affected samples.
Certified or Standard Reference Material	Project specific requirement or at project manager's discretion.	Compound specific, recovery should be within accepted control or advisory limits.	Laboratory to re-extract and reanalyze samples if analytical problems suspected, or to qualify the data after consultation.
Field Quality Assurance/Quality Control			
Field Duplicates	One per sample monitoring event or every 10 samples, whichever is more frequent.	Project, matrix, and compound specific	Modify field sample homogenization procedures.
Field Blanks	At project manager's discretion	Analyte concentration ≤ PQL	Compare to method blank results to rule out laboratory contamination. Modify sample collection and equipment decontamination procedures. Qualify associated data.

Notes:

[1]Instrument and method QA/QC to monitor the performance of the instrument and sample preparation procedures are the responsibility of the analytical laboratory. When an instrument or method control limit is exceeded, the laboratory is responsible for correcting the problem and reanalyzing the samples.

[2]Instrument and method QA/QC results reported in the final data package should always meet control limits with a very small number of exceptions that apply to difficult analytes as specified by Environmental Protection Agency (EPA) Contract Laboratory Program (CLP). If instrument and method QA/QC procedures meet control limits, laboratory procedures are deemed to be adequate.

[3]Matrix and field QA/QC procedures monitor matrix effects, field procedures, and variability. Although poor analytical procedures may also result in poor spike recovery or duplicate results, the laboratory is not held responsible for meeting control limits for these QA/QC samples.

MDL = method detection limit

PQL = practical quantification limit

FIGURES

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N
W E
S

2,000 0 2,000

Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps

Projection: NAD 1983 UTM Zone 10N

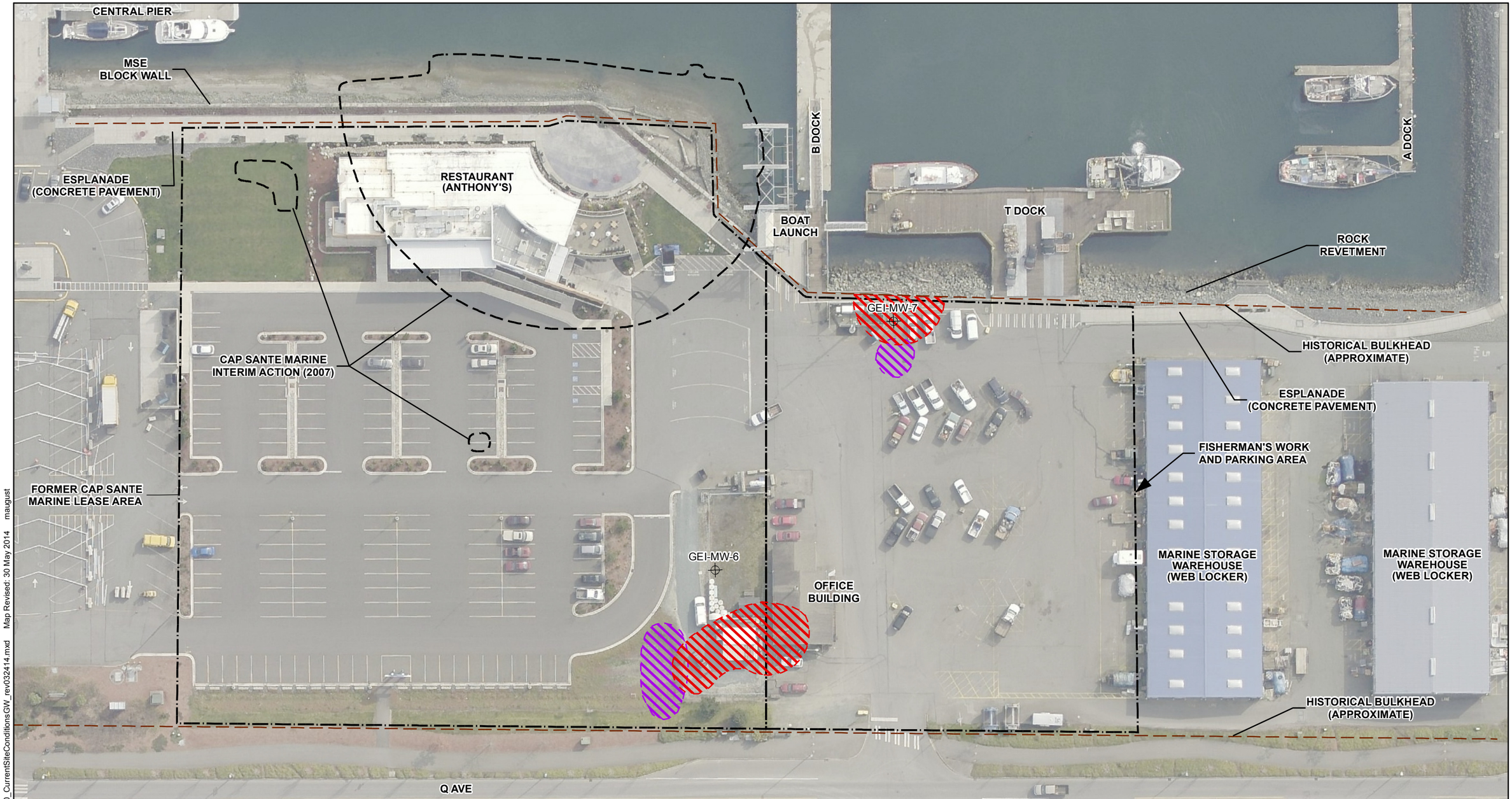
Vicinity Map

Cap Sante Marine Site
Anacortes, Washington

GeoEngineers

Figure 1

Path: \\sea\projects\5\5147005\GIS\5147005l0_VicinityMap.mxd Map Revised: 21 May 2014 cgonzales



Path: \\sea\projects\5\51470050\GIS\51470050_CurrentSiteConditionsGW_rev032414.mxd Map Revised: 30 May 2014 maugust

Data Source: Base aerial provided by the Port of Anacortes, March 2013. Skagit County GIS.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. Sampling locations in the vicinity of the areas identified to contain COCs exceeding site cleanup levels are shown on this figure.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

Monitoring Well Location

Areas With Contaminant of Concern (COCs) Exceeding Soil Cleanup Level

Approximate Area of TPH Exceedance in Soil

Approximate Area of PAH Exceedance in Soil

PAH - Polycyclic Aromatic Hydrocarbons

TPH - Petroleum Hydrocarbons (Gasoline, Diesel and/or Heavy Oil)

N E S W

60 0 60

Feet

Site Plan

Cap Sante Marine Site
Anacortes, Washington

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Figure 2

APPENDICES

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APPENDIX A
Monitoring Well Completion Logs

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

GeoEngineers

FIGURE C-1

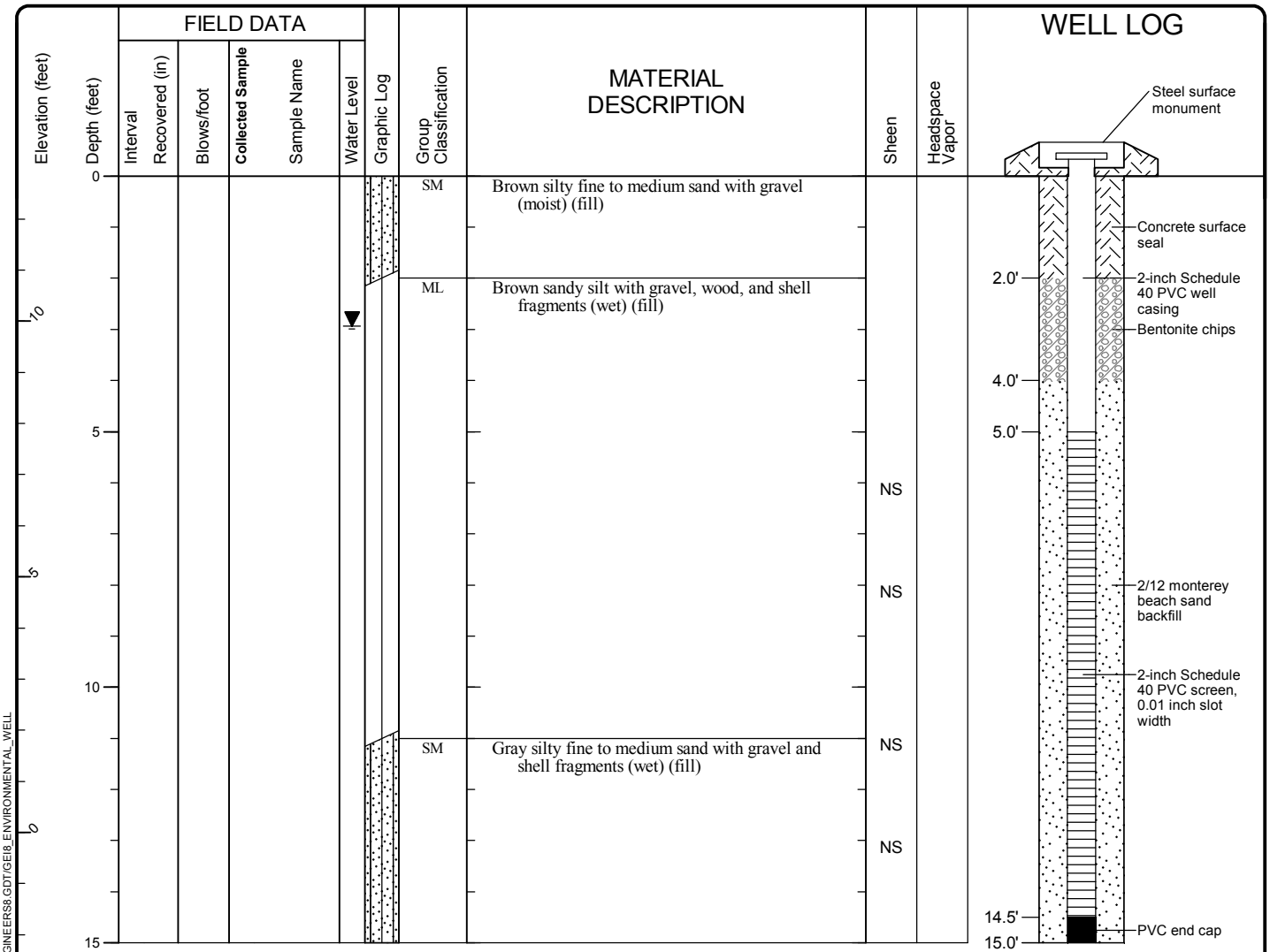
Drilled	Start	End	Total Depth (ft)	Logged By	Checked By	Driller	Drilling Method
	2/9/2012	2/9/2012	15	AJ	RST	Cascade Drilling, LP	Hollow Stem Auger

Hammer Data	N/A	Drilling Equipment	CME 75
Surface Elevation (ft) Vertical Datum	12.8 MLLW	Top of Casing Elevation (ft)	12.5
Easting (X) Northing (Y)	1209694.387 556552.4204	Horizontal Datum	NAD83

Licensing agency well number: **BHM145**
A 2 (in) well was installed on 2/9/2012 to a depth of 15 (ft).

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
2/9/2012	2.9	9.58

Notes: Air knife from 0 to 5 feet. No samples obtained, soil descriptions based on drill cuttings. PID malfunction - No head space vapor readings.



Note: See Figure B-1 for explanation of symbols.

Log of Monitoring Well GEI-MW-6

GeoEngineers

Project:	Former Shell Oil Tank Farm
Project Location:	Anacortes, Washington
Project Number:	5147-012-02

Figure C-2
Sheet 1 of 1

Seattle: Date:4/5/12 Path:C:\USERS\TNASH\DESKTOP\5147012202.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_ENVIRONMENTAL_WELL

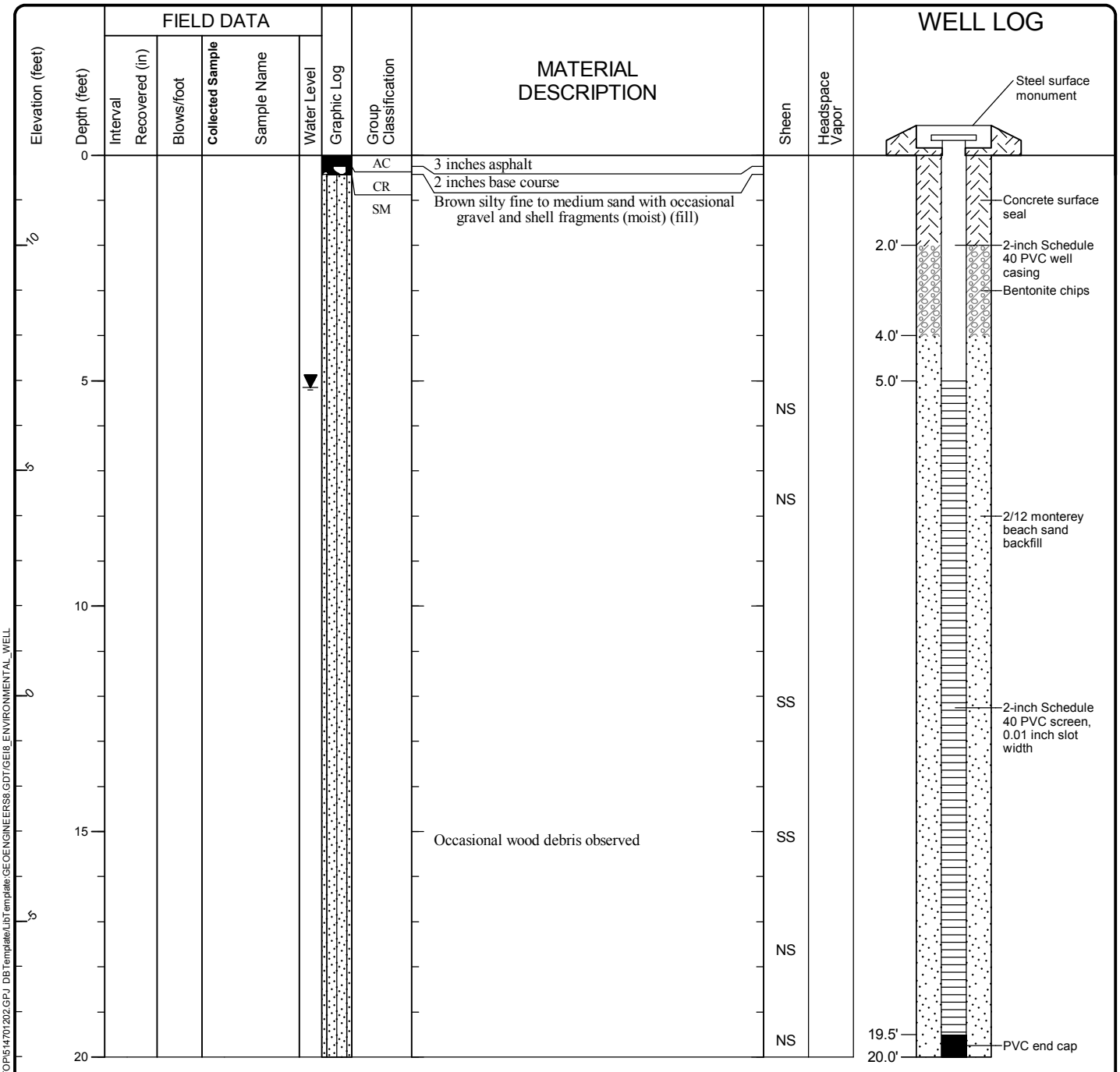
Drilled Start	End	Total Depth (ft)	Logged By / Checked By	Driller	Drilling Method
2/10/2012	2/10/2012	20	AJ / RST	Cascade Drilling, LP	Hollow Stem Auger

Hammer Data	N/A	Drilling Equipment	CME 75
Surface Elevation (ft) Vertical Datum	12.0 MLLW	Top of Casing Elevation (ft)	11.7
Easting (X) Northing (Y)	1209845.159 556436.0145	Horizontal Datum	NAD83

Licensing agency well number: **BHM147**
A 2 (in) well was installed on 2/10/2012 to a depth of 20 (ft).

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
3/6/2012	5.2	6.50

Notes: Air knife from 0 to 5 feet. No samples obtained, soil descriptions based on drill cuttings. PID malfunction - No head space vapor readings.



Note: See Figure B-1 for explanation of symbols.

Log of Monitoring Well GEI-MW-7

GeoEngineers

Project: Former Shell Oil Tank Farm
Project Location: Anacortes, Washington
Project Number: 5147-012-02

Figure C-3
Sheet 1 of 1

Seattle: Date:4/5/12 Path:C:\USERS\TNASH\DESKTOP\5147012202.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_ENVIRONMENTAL_WELL

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