Data Summary Report
In Situ Solidification and Stabilization Pilot Study

USG Interiors Puyallup Site
Puyallup, Washington

Prepared for:

USG Corporation
550 West Adams Street
Chicago, Illinois 60661-3676

February 25, 2022

CDM Smith

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PUYALLUP, WASHINGTON

February 25, 2022

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Acronyms and Abbreviations

µg/L	micrograms per liter
ASARCO	American Smelter and Refining Company
ASTM	American Society of Testing and Materials International
CAP	Cleanup Action Plan
CDM Smith	CDM Smith Inc.
CDR	Conceptual Design Report
cm/s	centimeters per second
cy	cubic yard
DTL	Denver Treatability Laboratory
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ft bgs	feet below ground surface
FSH	ferrous sulfate heptahydrate
ICRI-ROW	Inter-County River Improvement Right-of-Way
ISS	in situ solidification and stabilization
mg/kg	milligrams per kilogram
MTCA	Washington State Model Toxics Control Act
OnSite	OnSite Environmental Inc.
PP	pocket penetrometer
ppm	parts per million
psi	pounds per square inch
SDL	semi-dynamic leaching
SOP	standard operating procedure
SPLP	synthetic precipitation leaching procedure
S/S	solidified/stabilized
UCS	unconfined compressive strength
USCS	Unified Soil Classification System
USGI	USG Interiors, LLC

Section 1

Introduction

This document presents the findings and evaluation of CDM Smith Inc.'s (CDM Smith) Puyallup pilot study to support in situ solidification/stabilization (ISS) of residual arsenic-impacted soil at both USG Interiors' (USGI) Puyallup site, located in Puyallup, Washington (site) and Highway 99 site, located in Milton, Washington. Because of similarities in subsurface conditions at both the Highway 99 and Puyallup sites, only one pilot study was conducted (at the Puyallup site) to collect data that will be used in designing the future remedial action at both sites.

CDM Smith Inc. completed this work on behalf of USGI in support of planned cleanup actions being performed under Washington State Department of Ecology (Ecology) Agreed Order No. DE 11098. This work was completed in general accordance with the Ecology-approved Work Plan In Situ Solidification and Stabilization Pilot Study (CDM Smith 2020a) for USGI's Puyallup site.

1.1 Site Location and Description

The USGI Puyallup site is adjacent to the Puyallup River and is generally located at 1005 River Road, as shown on **Figure 1**. USGI owns a 1.58 acre property at this location. The southern portion of the property, adjacent to River Road, is paved and used as a parking area by an adjacent used-car business. The remainder of the property is overgrown with trees, grasses, blackberries, and other vegetation. The northern portion of the property is prone to seasonal overbank flooding by the Puyallup River, as shown on **Figure 2,** and is part of the regulatory floodway from the Puyallup River (Zone AE). The Inter-County River Improvement Right-of-Way (ICRI-ROW), administered by Pierce County Public Works and Utilities, runs between the property and the Puyallup River to the north. A paved bike path is located on the ICRI-ROW and runs along the top of the south bank of the Puyallup River. USGI's property is bordered to the east and west by used-car dealerships—Market Place Auto and Bonney Lake Used Cars, respectively. Ecology defines the site as everywhere contamination has come to be located. Arsenic contamination extends off the USGI-owned property and has impacted properties to the north, east, and west. **Figure 3** shows an aerial view of the USGI property and adjacent properties.

Geologically, the site is located on the south bank of the lower Puyallup River within the Puyallup valley. Soils in the Puyallup valley consist of alluvium derived from the Puyallup River, underlain by glacial deposits. The Puyallup River alluvial deposits are consistent with alluvial deposits found worldwide and consist of three major types: overbank flood deposits, slack water deposits, and bar accretion deposits. It is important to note that these depositional processes are currently active.

Above the native sediments, the site is also underlain by fill associated with the backfilling of a 1985 remedial excavation and fill associated with early site development. The fill extends to depths ranging from 2 to 16 feet below ground surface (ft bgs). The fill is differentiated from alluvium by the presence of man-made debris and angular-to-subangular gravel. Minor quantities of recently deposited overbank flood deposits (poorly graded sand and silt) overlie the fill in portions of the site. This material was deposited during flood events that have occurred after the 1985 remedial excavation.

1.2 Background Information

Industrial waste from USGI's Tacoma mineral fiber insulation manufacturing plant was used to fill the Puyallup site (source material). At the time, USGI was using arsenic-bearing slag from American Smelter and Refining Company's (ASARCO) Tacoma smelter as manufacturing feedstock and was the source of arsenic contamination that exists in soil and groundwater today. The source material was largely removed in 1985. However, relatively high arsenic concentrations occur in soil below the clean fill, some of which is residual source material and some which leached from the original source material and redeposited on deeper soils. It appears to be a continuing source of groundwater contamination.

The selected remedy outlined in the Cleanup Action Plan (CAP) included treatment of groundwater by in situ application of ferrous iron and chemical oxidant via direct push borings and a trench (Ecology 2019). Treatment of vadose zone soils would occur via in situ soil solidification by injecting cement, bentonite, and iron reagents to a depth of approximately 16 ft bgs. In April 2020 the plan for cleanup was modified and presented in the Conceptual Design Report (CDR) (CDM Smith 2020b). This plan modified the original cleanup by increasing the lateral and vertical extent of the in situ solidification and stabilization (ISS), possibly eliminating in situ treatment of groundwater by ferrous iron and chemical oxidant injection.

As part of the CDR, a data gap assessment was performed to identify outstanding data needs for design of the ISS at the Puyallup site. The data gap assessment resulted in recommendations to complete geotechnical and additional bench scale treatability studies to further support the design of the ISS. The geotechnical field investigation and bench scale treatability study were performed in 2020 (CDM Smith 2021). Based on results from these studies, the recommended ISS mixture contains Portland cement (10 percent), bentonite (2 percent), a 4:1 ferrous sulfate heptahydrate (FSH) to arsenic molar ratio, and bulking sand (10 percent) by weight of soil treated.

1.3 Pilot Study Objectives and Scope of Work

The objective of the pilot study was to confirm the recommended ISS mix could meet project performance criteria when implemented at full scale and identify the mixing and injection methods prior to design. Several factors were evaluated during pilot testing that contribute to effectively stabilizing and solidifying the treatment zone, including:

- Methods for mixing and applying the reagents
- Means and methods for full scale implementation
- Auger mixing speeds
- Number of passes through the mixing column
- Mixing of additive and reagent products

- Injection rate of slurry
- Overlap of treatment columns
- Establishment of quality assurance sampling methods, procedures, and frequencies

The ISS pilot study included the following activities:

- Installing five ISS test columns by auger mixing while simultaneously injecting the ISS mix reagents through the targeted soil mixing zones. Each ISS test column was 3 feet in diameter with a target depth of 35 ft bgs.
- Collecting of wet mix samples at 5-foot intervals throughout each column. The wet samples were prepared in cylinders and allowed to cure.
- Conducting geotechnical and analytical testing of selected cured samples.
- Conducting leach testing of selected cured samples.

1.4 Pilot Study Performance Criteria

The performance criteria evaluated during the ISS pilot study included physical and leaching tests as follows:

1. Unconfined Compressive Strength (UCS) – UCS testing is used to measure the strength properties of treated material for either site reuse or land disposal (Barnett, et. al., 2009). For this ISS pilot study, the compressive strength of selected solidified/stabilized (S/S) samples were measured using the UCS American Society of Testing and Materials International (ASTM) Method D2166. The UCS performance criteria of the ISS pilot study is greater than or equal to 50 pounds per square inch (psi) Barnett, et. al., 2009).
2. Hydraulic Conductivity – S/S will reduce the hydraulic conductivity of the site soils and in turn the groundwater flow through the treated soil mass, thereby reducing contaminant transport. The estimated hydraulic conductivity of the site soils is approximately 1E-04 centimeters per second (cm/s), based on laboratory data collected from the pre-design investigation and previous studies. The hydraulic conductivity (ASTM D5084) performance criterion of the ISS pilot study is less than or equal to 1E-06 cm/s (Barnett, et. al., 2009).

3. Semi-Dynamic Leach (SDL) Testing – The SDL testing provides a measure of the amount of contaminants that can leach from the S/S-treated soil with respect to time and best represents site conditions. The results from the SDL were evaluated against the performance goal, which is the Model Toxics Control Act (MTCA) Method A groundwater cleanup level of 5 micrograms per liter (µg/L).

4. Synthetic Precipitation Leaching Procedure (SPLP) – SPLP, a fairly aggressive leaching test, provides another measure of the amount of contaminants that can leach from the S/S-treated soil. This test was predominantly used to compare results against data collected from past investigations.

Section 2

Field Pilot Activities and Observations

The ISS pilot study was conducted on the western side of the USGI Puyallup property, just south (upgradient) of the P3 well cluster (**Figure 4**). The location for the ISS pilot study was selected to target the area where soil exceeding 500 parts per million (ppm)[1] total arsenic was present.

2.1 Groundwater Monitoring

CDM Smith collected groundwater samples from three on-site monitoring wells just prior to and approximately 2 months after implementation of the pilot study to evaluate changes in groundwater conditions. Wells P3-1 and P3-2 (representative downgradient wells) and MW-1 (representative of an upgradient well) were sampled on September 17, 2021, to establish a baseline. Postpilot study groundwater samples were collected on December 2, 2021, to evaluate changes in arsenic concentrations and other conditions as a result of the pilot study activities. P3-1 and MW-1 are installed in the upper zone of the shallow aquifer and P3-2 is installed in the midzone of the shallow aquifer. **Figure 4** shows the well locations.

The wells were purged and sampled using a peristaltic pump with disposable tubing. The wells were purged at a rate of approximately 200 milliliters per minute. Physical parameters were monitored during purging using a YSI-brand multi parameter meter. The YSI meter was secured in a flow-through cell that was situated after the pump and before the purge water tubing discharge. Parameters measured during purging included pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity. The wells were purged until the physical parameter measurements stabilized.

Groundwater samples were collected by disconnecting the tubing from the flow-through cell and directly discharging the water into laboratory-supplied sample containers containing appropriate preservative, as applicable. Groundwater samples to be analyzed for dissolved arsenic were field filtered before placement into the sample bottle. Field filtering was accomplished by placing the tubing discharge over the inflow end of a 0.45-micron filter and discharging the filtered water directly into the sample bottle. Sample bottles were labeled, placed in a chilled cooler, and transported to OnSite Environmental, Inc., (OnSite) in Redmond, Washington, under chain-of-custody.

2.2 Pilot Study

Four separate contractors were used during the implementation of this pilot study: (1) ISS contractor – Keller, (2) land clearing contractor – KSR Excavating, (3) fencing contractor – Secoma Fencing, and (4) WHPacific, Inc. for site surveying. Keller provided a work plan submittal

[1] Parts per million (ppm) is approximately the same as milligrams per kilogram (mg/kg). Arsenic concentrations measured using an X-ray fluorescence device are reported in ppm and arsenic concentrations measured by the laboratory are reported in mg/kg. These units of measurement will be used interchangeably through this report. When speaking in general terms, ppm is used. The accurate term (ppm versus mg/kg) will be used in instances where the arsenic concentration was actually measured.

describing mixing means and methods, included in **Appendix A**. CDM Smith performed oversight during the pilot testing implementation; daily reports and photographs are provided in **Appendix B**. Daily reports provided by the ISS contractor are provided in **Appendix C**. A summary of the pilot study field activities are presented herein.

2.2.1 Site Preparation

2.2.1.1 Land Clearing and Stormwater and Erosion Control

Minor clearing and grubbing were performed on August 28, 2021, by KSR Excavating to access the proposed ISS pilot study location and staging area (**Figure 4**). A skid steer with multiple attachments and hand tools were used to perform minor grubbing of tall grasses/weeds and small tree removal (no greater than 1.5-inch in diameter and 10 feet tall). KSR Excavating also installed straw wattles downgradient of the ISS pilot study location as temporary erosion and sediment control measures. Land clearing and temporary erosion and sediment control photographs are provided in **Appendix B**.

2.2.1.2 Fence Removal/Temporary Site Security

Secoma Fencing removed approximately 100 feet of fencing along River Road and 200 feet of fencing along the site access on September 10, 2021. National Fencing, subcontracted by Keller, installed temporary fencing around the project site on September 10, 2021.

2.2.2 Mobilization

Keller began mobilization to the site on September 16, 2021, by installing a geosynthetic liner and rock ballast between the asphalt and the ISS pilot study area to prevent tracking soil and debris out of the site onto the asphalt. Additional gravel and rock were delivered to form a level working platform/pad for the ISS equipment.

WHPacific, Inc. surveyed and marked the five ISS column locations and multiple offsets on September 17, 2021.

Excess materials, mixing materials, and equipment, including the batch plant, were staged on the asphalt close to the ISS treatment area. The drill rig (Bauer BG-24 with 3-foot diameter single axis ISS tooling) was delivered to the site on September 20, 2021, with additional equipment/parts delivered over the next two days. The drill rig was fully assembled the morning of September 23, 2021.

WHPacific, Inc. surveyed and marked the five ISS column locations and multiple offsets on September 17, 2021.

2.2.3 Pilot Study Implementation

The ISS was completed using a 3-foot diameter auger to mix soil and reagents throughout the column length. The target depth for each column was 35 ft bgs. The treatment zone was mixed by advancing the auger at a controlled rate to ensure relatively complete mixing throughout the vertical column. The ISS reagents were added through an injection port located on the auger flights. As the augers advanced, the ISS reagent addition created treated "columns," each of which overlapped by approximately 10 percent of the column area to create a homogenous treated zone.

Five columns (ISS-1 through ISS-5) were installed in two groupings as shown in **Figure 5** (incorporated from the Keller work plan – **Appendix A**). The first grouping contained three overlapping columns with an admixture dosed to treat soil containing 550 ppm arsenic. The second grouping contained two overlapping columns with an admixture that assumed treatment of soil containing 850 ppm arsenic. This was accomplished by adjusting the amount of FSH in the admixture. The weights of all other components remained the same.

Columns ISS-1 and ISS-2 were installed on September 23, 2021. Columns ISS-3 through ISS-5 were installed on September 24, 2021.

2.2.3.1 Mix Design

The grout reagent mix consisted of:

- 10 percent by weight Portland cement
- 2 percent by weight bentonite
- 4:1 molar ratio of FSH to the arsenic concentration
- 10 percent by weight bulking sand

A premix of sand, cement, and water was delivered directly to the site in a cement truck from a local ready-mix plant (Corliss Resources). Once on site, bentonite slurry, which was premixed in the on-site batch plant, was pumped into the cement truck. Lastly, powdered FSH was mixed into the cement truck via the hatch at the top of the truck. The final mixture was allowed to fully mix in the cement truck prior to being pumped into the ISS columns.

2.2.3.2 ISS Implementation

According to Keller's work plan, wet soil mixing was the method used for ISS implementation. Wet soil mixing is a form of soil mixing where the reagent materials, which consist of neat cement, bentonite, admixtures, and sand, are mechanically mixed with in situ soils as a premixed grouted slurry. A 3-foot-diameter auger was used to mechanically mix the soil and slurry. As the tooling from the auger was advanced, the grouted slurry was pumped out the bottom of the mixing tool. By using the high torque of the drill rig to rotate the paddles, the tooling was advanced with a predetermined, controlled penetration rate to design tip elevation. Once the design tip elevation was reached, the grout reagent flow was reduced, and the tooling was withdrawn while still rotating to complete the mixing process. One vertical pass was used to calculate the mix design injection rate. An experienced drill rig operator used Keller's in-house data acquisition system and in-cab drill controls to control the penetration, withdrawal, and rotational rate of the drill rig along with matching the mud flow with predetermined parameters to deliver the specified material content.

The quality of the mix was measured by the grout density, which was measured electronically by the batch plant operator using a mass flow meter. As the grout specific gravity varied, penetration and withdrawal rates were controlled and adjusted to ensure adequate mixing of the soil.

Approximately 45 cubic yards of in situ soil was treated within the five treatment columns with an estimated density of 92 pounds per cubic foot. Excess "soilcrete" (surface return) was produced during the mixing process because of the volume increase from the introduction of grout mix. The excess surface return was contained with temporary soil berms around the column location. Keller estimated that there would be approximately 20 cubic yards (cy) of surface return (approximately 15–40 percent volume increase) that would need to be stockpiled on site for future removal. During the pilot study, there was only approximately 4 cy of surface return. This small amount of return was spread across the column locations following completion.

2.2.4 Deviations from Work Plan

- Refusal was encountered at ISS-4 at 31.9 ft bgs and ISS-5 at 32.8 ft bgs. It is believed to be due to wood, as there were wood fragments that floated up through the slurry, and there were pieces of wood found on the ISS tooling teeth upon retrieval.

- The flow rate on the pump used in the pilot study could not be adjusted. This would have been desirable when obstructions were encountered during drilling, which caused a slowdown in the drilling rate. This caused the grout mix to not be evenly injected into the column. The Wet Soil Mixing logs in **Appendix C** show the depth versus grout volume ratio. Because of the inconsistency in mixing in ISS-1 and ISS-2, it was determined that additional passes would be needed to fully mix the columns based on the quality control samples. ISS-3 had an additional four vertical passes and ISS-5 had an additional five vertical passes.

- The initial mix design assumed the same concentration of FSH would be added to all five columns based on the highest arsenic concentration seen in the composite samples during the bench scale study. In reality, the expected overall arsenic concentrations in each column would be lower because of variability of arsenic concentrations at various depths throughout each column. (Analytical testing of the samples collected at various depths from the treated columns confirmed this to be the case). Therefore, the first group of three columns used an addition of FSH that targeted 550 ppm arsenic, while the second group of two columns targeted 850 ppm arsenic (the originally assumed FSH addition) to evaluate potential cost savings of using a lesser amount of FSH during the full-scale implementation.

2.2.5 ISS Quality Control Sampling

Wet grab samples of the treated material were collected using a weighted double trap door sampler attached to the auger head. CDM Smith prepared 2-inch-diameter by 4-inch-tall cylinder and 3-inch-diameter by 6-inch-tall cylinder samples from three specific points between column overlaps. Each set of samples (A1, A2, and A3) represents an overlapping column mixture. Overlapping column mixing was captured by collecting samples once two columns were completed. ISS-1 and ISS-2 columns are represented by ISS-A1 samples, ISS-2 and ISS-3 columns are represented by ISS-A2 samples, and ISS-4 and ISS-5 columns are represented by ISS-A3 samples. At each sample collection location, samples were also collected at three depth intervals (shallow, mid-depth, and deep). A summary of the samples collect is summarized in **Table 2.1**.

Nine 2-by-4-foot cylinders and one 3-by -6-foot cylinder were collected at each depth interval for a total of 90 cylinders for the entire pilot study. The cylinders were allowed to cure for 3 days before sending to the laboratory for geotechnical and analytical testing.

2.2.6 Demobilization

Keller started demobilization following completion of the pilot study on September 24, 2021. The demobilization included decontamination of all required equipment, removal of all equipment from the site, and verification the site was restored. Demobilization was completed by October 1, 2021.

2.2.6.1 Decontamination

At the completion of each column, Keller decontaminated their equipment in accordance with the approved pilot study construction work plan. Equipment that contacted the waste material was thoroughly pressure washed at each boring location.

2.2.6.2 Site Restoration

Keller established a clean surface on top of the working platform/pad. There was no excess soil on the site. The working platform/pad with the gravel and rock piles was retained in place in preparation for the future full-scale efforts.

Secoma Fencing installed a new 50-foot-wide double gate on the River Road entrance into the Marketplace Auto parking lot and reinstalled fencing between the paved area and the unpaved portion of the site property on October 28, 2021.

2.2.7 Investigation-Derived Waste Management

The original intention was to stockpile excess material from ISS mixing and remove off-site once the material was stable. However, there was only an approximate 10-percent volume increase, or about 4 cubic yards. The excess material was spread out over the top of the column locations.

Section 3

Geotechnical and Chemical Laboratory Testing

3.1 Groundwater Chemistry Characterization

Groundwater samples collected during both sampling events were analyzed for the following:

- Total and dissolved arsenic (EPA [United States Environmental Protection Agency] Method 7060A)
- Alkalinity (SM [standard method] 2320B)
- Carbonate (SM 2320B)
- Bicarbonate (SM 2320B)
- Total suspended solids (SM 2540D)
- Total dissolved solids (SM 2450C)

3.2. ISS Quality Control Samples

The prepared mix cylinders were shipped to the CDM Smith Geotechnical Laboratory in Chelmsford, Massachusetts, for unconfined compression testing and permeability testing. Select samples were also shipped to the CDM Smith Treatability Laboratory located in Denver, Colorado, for SDL testing. The water samples collected as a part of the SDL testing were submitted to OnSite for analysis of dissolved arsenic. Select soil samples were also delivered to OnSite for SPLP and total arsenic analyses. Results of the testing are presented in **Section 4** of this report.

3.2.1 Physical Testing

The following physical tests were performed on solidified specimen cylinders:

- Pocket Penetrometer Readings – A total of 18 tests: 9 tests conducted after 1 day of curing and 9 tests conducted after 3 days of curing.
- Unconfined Compressive Strength (ASTM D2166) – A total of 27 tests: 9 tests conducted after 7 days of curing; 9 tests conducted after 14 days of curing; and 9 tests conducted after 28 days of curing.
- Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084) – A total of 9 tests were conducted on cylinders after 55 to 59 days of curing.

3.2.2 Arsenic Leaching Tests

Analytical testing was performed on the prepared S/S soil mixture samples to evaluate the potential leaching of arsenic. Two types of leaching tests were conducted: SPLP and SDL. The SPLP procedure is an aggressive single-point-in-time leaching test. The stated purpose of the SPLP test method is to evaluate leaching of soils by rain (precipitation) and to compare against results collected from previous investigations. The SPLP conditions (aggressive mixing and material grain reduction) are not representative of the in situ environment. The SDL leaching procedure is designed to evaluate the mass transfer rates (release rates) of inorganic analytes contained in a monolithic or compacted granular material as a function of leaching over time. The conditions of the SDL procedure better represent conditions at the site because: (1) treated material is in place and not subjected to artificial disaggregation, (2) the leaching solution (rainwater and/or surface water) is replaced in the environment periodically, and (3) aggressive mixing of the leaching solution and the treated soil is not a condition that will occur at the site.

Analytical testing methods and the laboratories responsible for conducting the analytical testing and evaluations are described in further detail in the following sections.

3.2.2.1 Synthetic Precipitation Leaching Procedure Testing

One soil mixture from each of the three columns sampled that met the project performance criteria for UCS was selected for arsenic leachate testing by the SPLP method. The following cylinders were selected for leachate testing:

- ISS-A1-C26 (20–23 ft bgs)
- ISS-A2-C46 (13–17 ft bgs)
- ISS-A3-C76 (17–20 ft bgs)

The SPLP leaching test was performed using EPA methods 1312/6020B. The solution ("synthetic precipitation") used for leaching was the method's extraction fluid #2 at a pH of 5.0 ±0.05 standard units. This solution was intended to represent rain in the western United States.

S/S samples were received by the OnSite laboratory as a 2-by-4-inch monolith molded in a cylinder. The molded materials were disaggregated to a size capable of passing through a 9.5 mm standard sieve (standard procedure for SPLP).

The leaching fluid was added to the disaggregated samples in a 4,000-milliliter polyethylene bottle and placed in a rotary tumbler for 18 hours (standard SPLP procedure). Measurement of pH was performed on each leachate before leaching and after the 18-hour tumbling period. The leachate was then filtered through a glassfiber filter and analyzed for dissolved arsenic by EPA Method 6020B.

3.2.2.2 Semi-Dynamic Leaching Tests

To determine leaching mechanisms, the potential of long-term leaching, and to calculate release rates, SDL tests were performed using a modified SW-846 method 1315 following CDM Smith's Denver Treatability Laboratory (DTL) standard operating procedure (SOP) 1-10, Semi-Dynamic Leaching Procedure for Amended Soils. This SOP is located in **Appendix D.** The selected cylinders (ISS-A1-C27, ISS-A2-C47, and ISS-A3-C77) were placed into a glass jar with a cap and synthetic rainwater (SW-846 Method 1312, western rainwater at pH 5.0) was added to the container. As with the SPLP method, this solution is intended to represent rainwater in the western United States. The treated-sample surface-area-to-water ratio was 1:10 (square centimeters to milliliters). On average, approximately 2,027 milliliters of the prepared synthetic rainwater was added to the container for each leaching period. The leachate was removed from the container and filtered through a 0.45-micron filter and replaced with fresh synthetic rainwater at the following time intervals, as detailed in DTL SOP 1-10 and modified from EPA SW-846 Method 1315 (**Appendix D**): 2 hours, 24 hours, 48 hours, 72 hours, 7 days, 14 days, 21 days, 28 days, and 42 days. Leachate samples were submitted to OnSite for analysis of dissolved arsenic.

Section 4

Summary of Laboratory Results

4.1 Groundwater Chemistry Characterization Results

The groundwater analytical results for wells P3-1, P3-2, and MW-1 are summarized in **Table 4.1** and the analytical laboratory report is included in **Appendix E**.

Concentrations of total suspended solids, total dissolved solids , total alkalinity, bicarbonate alkalinity, and carbonate alkalinity were essentially unchanged between sampling events and do not indicate probable compatibility issues with the proposed mix design. Total and dissolved arsenic concentrations at P3-2 and MW-1 were relatively unchanged between sampling events. The arsenic groundwater concentration at P3-1 was about 35-percent higher in the postpilot study sample than in the prepilot study sample. The significance and cause of this was not determined but is most likely a seasonal variation.

4.2 Solidified/Stabilized Sample Results

4.2.1 Pocket Penetrometer

Pocket penetrometer (PP) readings were performed on samples after 1 and 3 days of curing. The pocket penetrometer reading provides an indication of the unconfined compressive strength of the specimen. The strength corresponding to the maximum reading on the PP is greater than 62.5 psi. The results are presented in **Table 4.2** and a general summary is provided below:

- The PP readings for ISS-A1-C1 (0–3 ft bgs) after 1 day showed zero strength because of excess water and 30.6 psi on day 3. ISS-A1-C11 (10–13 ft bgs) was 24.3 psi after day 1 and exceeded the maximum reading (greater than 62.5 psi) on the PP on day 3. ISS-A1-C21 (20–23 ft bgs) exceeded the maximum reading on the PP for both the 1-day and 3-day readings.

- The average PP reading for ISS-A2 on day 1 for all depths was 28.2 psi and 48.6 psi for day 3.

- All PP readings from ISS-A3 samples exceeded the maximum reading on the PP on both the 1-day and 3-day readings.

4.2.2 Unconfined Compressive Strength

UCS tests were performed in accordance with ASTM D1633. Testing was performed on samples after 7, 14, and 28 days of curing. The UCS, density, and moisture content results from the laboratory tests are summarized in **Table 4.3** through **Table 4.5.** Laboratory test reports and photos are included in **Appendix F.** Plots of the results of the UCS tests for each composite sample are included in **Figure 6** through **Figure 16**. Photographs from the laboratory tests are included in **Appendix F**. The following subsections summarize the results from the laboratory testing for each mix.

4.2.2.1 ISS-A1

- Compressive strengths after 7 days of curing ranged from 19.7 psi (C2) to 53.5 psi (C22).
- Compressive strengths after 14 days of curing ranged from 25.3 psi (C3) to 61.3 psi (C23).
- Compressive strengths after 28 days of curing ranged from 39.6 psi (C4) to 91.8 psi (C24).

For all the samples collected, there was a consistent increase in strength with time of curing between 7 days to 28 days. The average compressive strength met the desired compressive strength after 28 days.

4.2.2.2 ISS-A2

- Compressive strengths after 7 days of curing ranged from 9.6 psi (C32) to 31.1 psi (C42).
- Compressive strengths after 14 days of curing ranged from 10.9 psi (C33) to 43.2 psi (C43).
- Compressive strengths after 28 days of curing ranged from 12.2 psi (C34) to 63.2 psi (C44).

For all the samples collected, there was a consistent increase in strength with time of curing between 7 days to 28 days; however, the average compressive strength did not meet the desired strength after 28 days.

4.2.2.3 ISS-A3

- Compressive strengths after 7 days of curing ranged from 106.6 psi (C62) to 138.2 psi (C82).
- Compressive strengths after 14 days of curing ranged from 155.9 psi (C73) to 171.4 psi (C83).
- Compressive strengths after 28 days of curing ranged from 197.9 psi (C74) to 223.3 psi (C84).

All cylinders reached the desired minimum 50 psi compressive strength after 28 days.

4.2.3 Hydraulic Conductivity

Hydraulic conductivity tests were performed in accordance with ASTM D5084. A summary of the results is presented in **Table 4.6.** Laboratory test reports and photos are included in **Appendix G**. The hydraulic conductivity measured in the lab ranged from 5.10E-07 cm/s (ISS-A3-C85) to 1.77E-05 cm/s (ISS-A2-C45) with an average of 3.76E-06 cm/s. All samples except for ISS-A2-C45 indicated that the hydraulic conductivity goal of 1.0E-06 cm/s or less was achieved.

4.2.4 Potential Leaching of Arsenic in Solidified/Stabilized Soil Mixtures

The results of the SPLP and SDL tests are discussed in the following sections. The laboratory reports are included in **Appendix H**.

4.2.4.1 SPLP Results for Arsenic in S/S Soil

Table 4.7 summarizes the results of the total arsenic in each of the S/S samples and the dissolved arsenic in the three SPLP leachates. The laboratory results are provided in **Appendix H.** The concentration of total arsenic in the S/S samples ranged from 93 to 180 mg/kg. Arsenic was nondetect (less than 5 µg/L) in the SPLP leachates for ISS-A1-C26 and ISS-A3-C76 and 5.3 µg/L in ISS-A2-C46. Because of the disaggregation and rotary tumbling, SPLP testing most likely overrepresents the amount the arsenic that would actually leach under the scenario of a full-scale ISS, but the results were favorable even for this aggressive test method.

4.2.4.2 SDL Results for Arsenic in S/S Soil

This section presents a summary of the results of the SDL testing on the S/S soil. **Table 4.8** summarizes the SDL results for the dissolved arsenic analysis performed by OnSite and the measurement parameters pH and oxidation-reduction potential performed at the DTL during this procedure. As shown in **Table 4.8**, dissolved arsenic was not detected above the reporting limit of 3.0 µg/L in SDL1 (ISS-A1) and ranged from nondetect (less than 3.0) to 4.4 µg/L in SDL3 (ISS-A3).

This pilot study showed that stabilization successfully bound the arsenic as indicated by the low leachate concentrations. **Appendix I** provides graphs of the log of the cumulative mass released versus the log of the leaching time for each of the tested samples. As shown, the coefficient of determinations (r^2) are excellent and range from 0.97 to 0.98. The resulting equations were used to predict leachate concentrations of dissolved arsenic at future time periods between 1 and 10 years at the interface between the treated soil and the aqueous phase (surface water). The concentrations for Year 1 through Year 10 were calculated to be less than the practical quantitation limit of (2 to 3.0 µg/L). These concentrations would decrease as the water at the interface migrates and mixes with additional surface or groundwater.

Section 5

Conclusions, Lessons Learned, and Recommendations

5.1 ISS Performance Conclusions

The objective of the pilot study was to confirm the recommended ISS mix from the bench scale tests could meet the project performance criteria when implemented at full scale. The following section presents the conclusions from the laboratory testing results.

- The 28-day cured strength criteria (50 psi) was achieved at two of the three columns (ISS-A1 and ISS-A3). The results of the pilot study indicate the selected mix design is capable of meeting the project performance criteria, but there was inconsistency observed in the 28-day results. The results ranged from 34 (ISS-A2) to 212 psi (ISS-A3), with an average UCS of 103 psi between all the samples tested. Despite variability in the results, they are still considered to be acceptable for the following reasons:
  - The 50 psi performance criteria was originally selected based on EPA guidance for future site redevelopment options. The future use of the Puyallup and Highway 99 site does not require redevelopment and therefore lower compressive strengths are acceptable as long as the mixed soils can demonstrate that they are the equivalent or better than existing in situ soil conditions.
  - Upon review of the soil boring data (collected during the geotechnical field investigation), existing soil conditions are variable, consisting of fill, gravel, sand, and silty sand ranging in density from very loose to dense. This soil profile results in equally variable in situ strengths that can range vertically from 15 to 80 psi. When comparing the existing soil information to the average 28-day cured strength of the ISS samples (103 psi), in situ strengths are improved following ISS treatment.
- In general, samples collected from columns ISS-A1 and ISS-A2 resulted in average 28-day compressive strengths ranging from 34 to 64 psi and were lower than the observed average at ISS-A3 of 212 psi. This may be attributed to many different factors such as variances in mixing approach, in situ conditions, and FSH dose. It is difficult to identify what the limiting factor(s) may be; however, it can be concluded that despite variances observed, the post-ISS treated soils improved the existing soil strengths at the site.
- The hydraulic conductivity measured in the lab ranged from 5.10E-07 cm/s (ISS-A3-C85) to 1.77E-05 cm/s (ISS-A2-C45). With the exception of one sample, the results indicated the performance criteria for hydraulic conductivity was met, and in most cases hydraulic conductivities were lower than the target maximum value of 1.0E-06 cm/s. This indicates that movement of groundwater through the ISS-mixed soil mass will be greatly reduced postsolidification.

- The leaching test method (SDL) used to determine the amount of hazardous contaminants that can leach from ISS treated soils met the MTCA Method A cleanup level performance goal of 5 µg/L or less.

- The pilot study evaluated two doses of FSH for arsenic concentrations at 550 ppm (ISS-A1 and ISS-A2) and 850 ppm (ISS-A3). The results of the SDL testing indicated there was little to no observed difference between the samples collected at columns dosed with FSH for 550 ppm or 850 ppm of arsenic. All samples met the MTCA Method A cleanup level performance goal of 5 µg/L or less.

5.2 Lessons Learned and Recommendations

Several factors that contribute to effectively stabilizing and solidifying the in situ soils were evaluated during the pilot study implementation for the future remedial action at both the Puyallup and Highway 99 sites. A summary of the lessons learned and future implementation recommendations are presented herein.

5.2.1 Mix Design

Based on the conclusions identified in Section 5.1, the mix designs identified during the bench scale study meet the project performance criteria to the extent required and can be implemented at full scale. Mix designs for the Puyallup and Highway 99 sites will consist of the following:

- Puyallup – Portland cement at a dosage rate of 10 percent by weight, bentonite at a dosage of 2 percent by weight, FSH at a molar ratio of 4:1 to the arsenic concentration, and a bulking sand at a dosage rate of 10 percent by weight.

- Highway 99 – Portland cement at a dosage rate of 13 percent by weight, bentonite at a dosage of 1 percent by weight, and FSH at a molar ratio of 4:1 to the arsenic concentration.

The recommended FSH dose of the mix design is determined based on an expected arsenic concentration. During the bench scale study, the expected arsenic concentration of 850 ppm was used for the FSH dose based on a limited volume of highly impacted soil samples collected in the field. For the pilot study, an FSH dose of 550 ppm was used to represent more of a high-end average arsenic concentration throughout the soil profile. Results from the pilot study indicated that treating an average concentration of 550 ppm total arsenic was just as effective as dosing for the smaller volume of highly impacted soils at 850 ppm arsenic. The recommended FSH dose for full scale implementation will be further evaluated during the project design phase based on the site model and existing sampling information collected at the site.

5.2.2 Soil Mixing Equipment and Application

ISS was completed using a 3-foot-diameter auger to homogenize soil throughout the column. The 3-foot-diameter auger was specifically selected based on the small scale of the pilot study. It was observed during the pilot study that the 3-foot diameter auger had difficulty advancing through some obstructions encountered. It is recommended that for future implementation a larger diameter auger (5-foot-diameter minimum) is used. This will reduce the number of columns required to fully treat the site and will also provide more torque/power when encountering difficult drilling conditions.

The drill rig was in control of the auger advancement based on a calculated injection rate of the slurry. The pump instrumentation controlling the flow of the slurry from the cement truck to the drill rig injection port was on a separate system that could not be adjusted in real time. During the pilot study there were times when the auger advancement was slowed because of obstructions or changes in soil condition. Whenever this happened, the injection rate of the grout could not be concurrently adjusted. It was observed that this resulted in variations within the soil-slurry mixture with respect to column depth. Because of these variations, the one-pass slurry injection/auger approach did not properly mix the columns. Multiple passes were required to properly homogenize and mix the columns vertically. It is recommended for future full-scale implementation that variable speed pumps be used to account for changes in drill speed, and drill rig operators should anticipate that multiple passes will be required to properly mix ISS columns vertically.

5.2.3 Slurry Preparation and Delivery

The slurry preparation and delivery for ISS projects is typically executed using a batch plant to premix the reagent slurry before pumping to the soil mixing equipment. For the Puyallup pilot study, a cement truck was used to premix the reagent slurry prior to pumping to the soil mixing equipment. This worked well on a small scale but would be difficult to execute at full scale production. Future limiting factors of the cement truck delivery methodology may be conflicts in delivery schedule and space for queueing trucks. Based on observations from the pilot study, silos may be placed on-site to contain the Portland cement, sand, bentonite and FSH in bulk quantities and a large-scale batch plant with instrumentation control should be established to mix and pump the slurry to the soil mixing equipment.

5.2.4 Sampling Methods, Procedures and Frequencies

Samples were collected during the pilot study at three respective depth intervals of the mixed columns at 60 percent of the columns installed. Samples were collected from discrete intervals using a detachable sampling bucket that adhered to the drilling auger. The sampling method used worked well in the field and will be recommended for future quality control sampling requirements. The sampling frequency will most likely be reduced to collect samples from three depth intervals of the mixed columns at a frequency closer to 25–30 percent of the total columns installed. This will continue to be evaluated during the design phase of the project.

5.2.5 Handling and Disposal of ISS Mixed Soils

Initial estimated quantities of the ISS mixed soils included swell volumes ranging from 30 to 60 percent the total mixed in situ volume. The total swell volumes observed during the pilot study resulted in less than a 10 percent volume increase of the mixed soils. For the full-scale implementation, this indicates that with proper site grading of the post-mixed soils, little to no ISS-mixed soils may need to be disposed off-site.

5.3 Closing

The conclusions and recommendations presented above do not indicate that any significant changes to the conceptual design approach and mix design presented during the bench scale study for Puyallup and Highway 99 will be required. Based on the results of the pilot study, the proposed extents and volumes of the treatment area will not change.

Section 6

References

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Tables

CDM Smith

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Table 2.1 Summary of Sample Collection

ISS Column Overlap	Sample ID	Depth (ft bgs)	Purpose
ISS-1/2	*ISS-A1-C1*	*0-3*	1-day and 3-day PP
	ISS-A1-C2	*0-3*	7-Day UCS
	ISS-A1-C3	*0-3*	14-Day UCS
	ISS-A1-C4	*0-3*	28-Day UCS
	ISS-A1-C5	*0-3*	Permeability
	ISS-A1-C6	*0-3*	SPLP
	ISS-A1-C7	*0-3*	SDL
	ISS-A1-C8	*0-3*	Extra
	ISS-A1-C9	*0-3*	Extra
	ISS-A1-C10	*0-3*	Extra
	ISS-A1-C11	*10-13*	1-day and 3-day PP
	ISS-A1-C12	*10-13*	7-Day UCS
	ISS-A1-C13	*10-13*	14-Day UCS
	ISS-A1-C14	*10-13*	28-Day UCS
	ISS-A1-C15	*10-13*	Permeability
	ISS-A1-C16	*10-13*	SPLP
	ISS-A1-C17	*10-13*	SDL
	ISS-A1-C18	*10-13*	Extra
	ISS-A1-C19	*10-13*	Extra
	ISS-A1-C20	*10-13*	Extra
	ISS-A1-C21	*20-23*	1-day and 3-day PP
	ISS-A1-C22	*20-23*	7-Day UCS
	ISS-A1-C23	*20-23*	14-Day UCS
	ISS-A1-C24	*20-23*	28-Day UCS
	ISS-A1-C25	*20-23*	Permeability
	ISS-A1-C26	*20-23*	SPLP
	ISS-A1-C27	*20-23*	SDL
	ISS-A1-C28	*20-23*	Extra
	ISS-A1-C29	*20-23*	Extra
	ISS-A1-C30	*20-23*	Extra

Table 2.1 Summary of Sample Collection

ISS Column Overlap	Sample ID	Depth (ft bgs)	Purpose
ISS-2/3	*ISS-A2-C31*	*3-7*	1-day and 3-day PP
	ISS-A2-C32	*3-7*	7-Day UCS
	ISS-A2-C33	*3-7*	14-Day UCS
	ISS-A2-C34	*3-7*	28-Day UCS
	ISS-A2-C35	*3-7*	Permeability
	ISS-A2-C36	*3-7*	SPLP
	ISS-A2-C37	*3-7*	SDL
	ISS-A2-C38	*3-7*	Extra
	ISS-A2-C39	*3-7*	Extra
	ISS-A2-C40	*3-7*	Extra
	ISS-A2-C41	*13-17*	1-day and 3-day PP
	ISS-A2-C42	*13-17*	7-Day UCS
	ISS-A2-C43	*13-17*	14-Day UCS
	ISS-A2-C44	*13-17*	28-Day UCS
	ISS-A2-C45	*13-17*	Permeability
	ISS-A2-C46	*13-17*	SPLP
	ISS-A2-C47	*13-17*	SDL
	ISS-A2-C48	*13-17*	Extra
	ISS-A2-C49	*13-17*	Extra
	ISS-A2-C50	*13-17*	Extra
	ISS-A2-C51	*23-27*	1-day and 3-day PP
	ISS-A2-C52	*23-27*	7-Day UCS
	ISS-A2-C53	*23-27*	14-Day UCS
	ISS-A2-C54	*23-27*	28-Day UCS
	ISS-A2-C55	*23-27*	Permeability
	ISS-A2-C56	*23-27*	SPLP
	ISS-A2-C57	*23-27*	SDL
	ISS-A2-C58	*23-27*	Extra
	ISS-A2-C59	*23-27*	Extra
	ISS-A2-C60	*23-27*	Extra

Table 2.1 Summary of Sample Collection

ISS Column Overlap	Sample ID	Depth (ft bgs)	Purpose
ISS-4/5	*ISS-A3-C61*	*7-10*	1-day and 3-day PP
	ISS-A3-C62	*7-10*	7-Day UCS
	ISS-A3-C63	*7-10*	14-Day UCS
	ISS-A3-C64	*7-10*	28-Day UCS
	ISS-A3-C65	*7-10*	Permeability
	ISS-A3-C66	*7-10*	SPLP
	ISS-A3-C67	*7-10*	SDL
	ISS-A3-C68	*7-10*	Extra
	ISS-A3-C69	*7-10*	Extra
	ISS-A3-C70	*7-10*	Extra
	ISS-A3-C71	*17-20*	1-day and 3-day PP
	ISS-A3-C72	*17-20*	7-Day UCS
	ISS-A3-C73	*17-20*	14-Day UCS
	ISS-A3-C74	*17-20*	28-Day UCS
	ISS-A3-C75	*17-20*	Permeability
	ISS-A3-C76	*17-20*	SPLP
	ISS-A3-C77	*17-20*	SDL
	ISS-A3-C78	*17-20*	Extra
	ISS-A3-C79	*17-20*	Extra
	ISS-A3-C80	*17-20*	Extra
	ISS-A3-C81	*27-30*	1-day and 3-day PP
	ISS-A3-C82	*27-30*	7-Day UCS
	ISS-A3-C83	*27-30*	14-Day UCS
	ISS-A3-C84	*27-30*	28-Day UCS
	ISS-A3-C85	*27-30*	Permeability
	ISS-A3-C86	*27-30*	SPLP
	ISS-A3-C87	*27-30*	SDL
	ISS-A3-C88	*27-30*	Extra
	ISS-A3-C89	*27-30*	Extra
	ISS-A3-C90	*27-30*	Extra

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Table 4.1 Groundwater Chemistry Characterization - Monitoring Wells

Analytical Method and Analyte	Unit	P3-1		P3-2		MW-1	
		9/17/2021	12/2/2021	9/17/2021	12/2/2021	9/17/2021	12/2/2021
SM 2540D/2540C							
TSS	mg/L	7	<4.0	<4.0	<4.0	<4.0	<4.0
TDS	mg/L	250	300	170	190	170	160
SM 2320B							
Total Alkalinity	mg CaCO3/L	160	170	82	96	86	70
Carbonate Alkalinity	mg CaCO3/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Bicarbonate Alkalinity	mg CaCO3/L	160	170	82	96	86	70
EPA 200.8							
Total Arsenic	µg/L	6,800	9,400	430	390	<3.3	<3.3
Dissolved Arsenic	µg/L	7,000	9,400	390	330	<3.0	<3.0

Notes:

TSS - Total Suspended Solids

TDS - Total Dissolved Solids

ND - None Detected

µg/L - micrograms per liter

mg/L milligrams per liter

mg CaCO3/L - milligrams per liter as calcium carbonate

< - not detected at or greater than the listed concentration

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Table 4.2 Summary of Pocket Penetrometer Test Results

Test ID	Targeted Arsenic Concentration	Depth (ft bgs)	Date Mixed	Sample	Pocket Penetrometer Reading 1 Day (psi)	Pocket Penetrometer Reading 3 Day (psi)
ISS-A1	550	0-3	9/23/2021	C1	0.0	30.6
		10-13	9/23/2021	C11	24.3	>62.5
		20-23	9/23/2021	C21	>62.5	>62.5
ISS-A2	550	3-7	9/24/2021	C31	10.4	20.8
		13-17	9/24/2021	C41	38.2	>62.5
		23-27	9/24/2021	C51	36.1	>62.5
ISS-A3	850	7-10	9/24/2021	C61	>62.5	>62.5
		17-20	9/24/2021	C71	>62.5	>62.5
		27-30	9/24/2021	C81	>62.5	>62.5

Notes:

ft bgs - feet below ground surface

psi - pounds per square inch

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Table 4.3 Summary of UCS Strength Test Results

Test ID	Targeted Arsenic Concentration (ppm)	Depth (ft bgs)	Date Mixed	UCS Testing [1]								
				7 Day Cure			14 Day Cure			28 Day Cure		
				Sample Mix	UCS Strength (psi)	UCS Strength Average (psi)	Sample Mix	UCS Strength (psi)	UCS Strength Average (psi)	Sample Mix	UCS Strength (psi)	UCS Strength Average (psi)
ISS-A1	550	0-3	9/23/2021	C2	19.7	35.4	C3	25.3	43.2	C4	39.6	64.8
		10-13	9/23/2021	C12	33.0		C13	43.0		C14	63.0	
		20-23	9/23/2021	C22	53.5		C23	61.3		C24	91.8	
ISS-A2	550	3-7	9/24/2021	C32	9.6	21.0	C33	10.9	25.5	C34	12.2	34.2
		13-17	9/24/2021	C42	31.1		C43	43.2		C44	63.2	
		23-27	9/24/2021	C52	22.3		C53	22.5		C54	27.3	
ISS-A3	850	7-10	9/24/2021	C62	106.6	121.8	C63	162.1	163.1	C64	215.8	212.3
		17-20	9/24/2021	C72	120.5		C73	155.9		C74	197.9	
		27-30	9/24/2021	C82	138.2		C83	171.4		C84	223.3	

Notes:

1. Unconfined compressive strength testing was conducted in accordance with ASTM D1633.

ft bgs - feet below ground surface

psi - pounds per square inch

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Table 4.4 Summary of Dry/Wet Bulk Density Test Results

			UCS Testing [1]														
			7 Day Cure					14 Day Cure					28 Day Cure				
Test ID	Depth (ft bgs)	Date Mixed	Sample Mix	Dry Bulk Density (pcf)	Dry Bulk Density Average (pcf)	Wet Bulk Density (pcf)	Wet Bulk Density Average (pcf)	Sample Mix	Dry Bulk Density (pcf)	Dry Bulk Density Average (pcf)	Wet Bulk Density (pcf)	Wet Bulk Density Average (pcf)	Sample Mix	Dry Bulk Density (pcf)	Dry Bulk Density Average (pcf)	Wet Bulk Density (pcf)	Wet Bulk Density Average (pcf)
ISS-A1	0-3	9/23/2021	C2	70.0	76.6	105.3	109.1	C3	69.7	74.0	105.3	107.2	C4	71.0	79.3	106.4	110.8
	10-13	9/23/2021	C12	78.8		109.7		C13	69.7		105.3		C14	81.9		112.6	
	20-23	9/23/2021	C22	81.1		112.3		C23	82.6		111.1		C124	84.9		113.5	
ISS-A2	3-7	9/24/2021	C32	81.1	85.4	112.3	115.1	C33	82.6	85.8	114.4	115.9	C34	82.8	86.0	113.7	115.5
	13-17	9/24/2021	C42	86.2		115.5		C43	85.6		115.1		C44	86.8		115.9	
	23-27	9/24/2021	C52	88.8		117.5		C53	89.3		118.3		C54	88.5		117.0	
ISS-A3	7-10	9/24/2021	C62	87.9	89.3	116.4	117.3	C63	87.5	88.8	116.0	116.5	C64	89.1	89.8	117.1	117.5
	17-20	9/24/2021	C72	90.4		117.5		C73	91.0		117.6		C74	91.2		118.2	
	27-30	9/24/2021	C82	89.7		118.0		C83	88.0		116.0		C84	89.2		117.1	

Notes:

1. Unconfined compressive strength testing was conducted in accordance with ASTM D1633.

pcf - pounds per cubic foot

ft bgs - feet below ground surface

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Table 4.5 Summary of Moisture Content Results

Test ID	Depth (ft bgs)	Date Mixed	UCS Testing [1]								
			7 Day Cure			14 Day Cure			28 Day Cure		
			Sample Mix	Moisture Content (%)	Average Moisture Content (%)	Sample Mix	Moisture Content (%)	Average Moisture Content (%)	Sample Mix	Moisture Content (%)	Average Moisture Content (%)
ISS-A1	0-3	9/23/2021	C2	50.5	42.7	C3	51.0	45.5	C4	49.9	40.4
	10-13	9/23/2021	C12	39.2		C13	51.0		C14	37.5	
	20-23	9/23/2021	C22	38.5		C23	34.4		C124	33.7	
ISS-A2	3-7	9/24/2021	C32	38.5	35.0	C33	38.5	35.1	C34	37.3	34.3
	13-17	9/24/2021	C42	34.0		C43	34.4		C44	33.5	
	23-27	9/24/2021	C52	32.4		C53	32.5		C54	32.2	
ISS-A3	7-10	9/24/2021	C62	32.5	31.4	C63	32.5	31.2	C64	31.5	30.8
	17-20	9/24/2021	C72	30.0		C73	29.3		C74	29.6	
	27-30	9/24/2021	C82	31.6		C83	31.8		C84	31.2	

Notes:

1. Unconfined compressive strength testing was conducted in accordance with ASTM D1633.

ft bgs- feet below ground surface

% - percent

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Table 4.6 Summary of Hydraulic Conductivity Test Results

Test ID	Depth (ft bgs)	Date Mixed	Sample Mix	Hydraulic Conductivity [1] (cm/s)
ISS-A1	0-3	9/23/2021	C5	2.36E-06
	10-13	9/23/2021	C15	3.86E-06
	20-23	9/23/2021	C25	1.82E-06
ISS-A2	3-7	9/24/2021	C35	3.57E-06
	13-17	9/24/2021	C45	1.77E-05
	23-27	9/24/2021	C55	1.03E-06
ISS-A3	7-10	9/24/2021	C65	4.45E-07
	17-20	9/24/2021	C75	2.93E-06
	27-30	9/24/2021	C85	5.10E-07

Notes:

1. Hydraulic Conductivity testing was conducted in accordance with ASTM D5084.

ft bgs - feet below ground surface
cm/s - centimeter per second

Table 4.7 Total Arsenic in S/S Composite Soils and SPLP Leachate Results

Mix Designation	Depth (ft bgs)	Date Leached/ Sampled	Solids Results	SPLP Leaching Data
			Arsenic [1]	SPLP Arsenic Result[2]
			(ppm)	(ppm)
ISS-A1-C10	0-3	11/18/2021	96	-
ISS-A1-C20	10-13	11/18/2021	110	-
ISS-A1-C26	20-23	10/28/2021	-	<0.005
ISS-A1-C30	20-23	11/18/2021	93	-
ISS-A2-C40	3-7	11/18/2021	100	-
ISS-A2-C46	13-17	10/28/2021	-	0.0053
ISS-A2-C50	13-17	11/18/2021	130	-
ISS-A2-C60	23-27	11/18/2021	140	-
ISS-A3-C70	7-10	11/18/2021	170	-
ISS-A3-C76	17-20	10/28/2021	-	<0.005
ISS-A3-C80	17-20	11/18/2021	170	-
ISS-A3-C90	27-30	11/18/2021	180	-

Notes:
1.Performed in accordance with EPA Method 6010D
2.Performed in accordance with EPA Method 1312/6020B
ppm - parts per million
SPLP - Synthetic Precipitation Leaching Procedure

Table 4.8 Semi-Dynamic Leach Testing Results

Column	Sample ID	Depth (ft bgs)	Date Leachate Sampled	Cummulative Leaching Time	SDL Arsenic Result	pH	ORP	Observations
					µg/L	su	mv	
ISS-A1	SDL1	20-23	10/25/2021	2-hour	<3.0	11.62	231.3	
			10/26/2021	24 hour	<3.0	11.53	212.6	Slight Flaking of the surface
			10/27/2021	48 hour	<3.0	11.64	219.4	Sediment observation, minimal
			10/28/2021	72 hour	<3.0	11.40	209.5	no increased in sediment
			11/1/2021	7 days	<3.0	11.48	213.7	
			11/8/2021	14 days	<3.0	11.67	223.6	
			11/15/2021	21 days	<3.0	11.29	218.7	
			11/22/2021	28 days	<3.0	11.14	211.4	
			12/6/2021	42 days	<3.0	11.28	209.7	
ISS-A2	SDL2	13-17	10/25/2021	2-hour	<3.0	11.31	220.3	
			10/26/2021	24 hour	<3.0	11.24	225.4	Slight Flaking of the surface
			10/27/2021	48 hour	<3.0	10.96	231.6	Sediment observation, minimal
			10/28/2021	72 hour	**3.2**	11.04	227.3	no increased in sediment
			11/1/2021	7 days	**3.4**	11.09	218.6	
			11/8/2021	14 days	**3.8**	11.22	211.5	
			11/15/2021	21 days	**3.6**	11.21	223.4	
			11/22/2021	28 days	**3.8**	11.08	221.6	
			12/6/2021	42 days	**3.4**	11.42	231.3	
ISS-A3	SDL3	17-20	10/25/2021	2-hour	<3.0	11.31	223.7	
			10/26/2021	24 hour	<3.0	11.33	217.5	Slight Flaking of the surface
			10/27/2021	48 hour	<3.0	11.29	212.0	Sediment observation, minimal
			10/28/2021	72 hour	<3.0	11.51	218.4	no increased in sediment
			11/1/2021	7 days	<3.0	11.42	219.6	
			11/8/2021	14 days	**3.4**	11.61	233.4	
			11/15/2021	21 days	**3.9**	11.21	228.6	
			11/22/2021	28 days	**3.9**	11.08	208.9	
			12/6/2021	42 days	**4.4**	11.10	215.4	

Figures

Site
Puyallup River
N Levee Rd E
N Levee Rd
River Rd
167
Industrial Pkwy
85th Ave E
59th St E
7th St NW
Valley Ave
12th Ave Ct NW
Peach Park Ln NW
12th Ave NW
11th Ave NW
10th Ave NW
9th Ave NW
8th Ave NW
7th Ave NW
5th Ave NW
4th Ave NW
3rd Ave NW
17th St NW
15th St NW
14th St NW
13th Ct NW
11th St NW
9th St NW
16th St NW
13th St NW
17th St Pl NW
18th St Pl NW
Wilson Dr
8th St NW
12th St NW
13th Pl NW
W Stewart Ave
N
1" = 500'
250
0
500

National Flood Hazard Layer FIRMette

FEMA

122°18'46"W 47°12'21"N

122°18'9"W 47°11'57"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

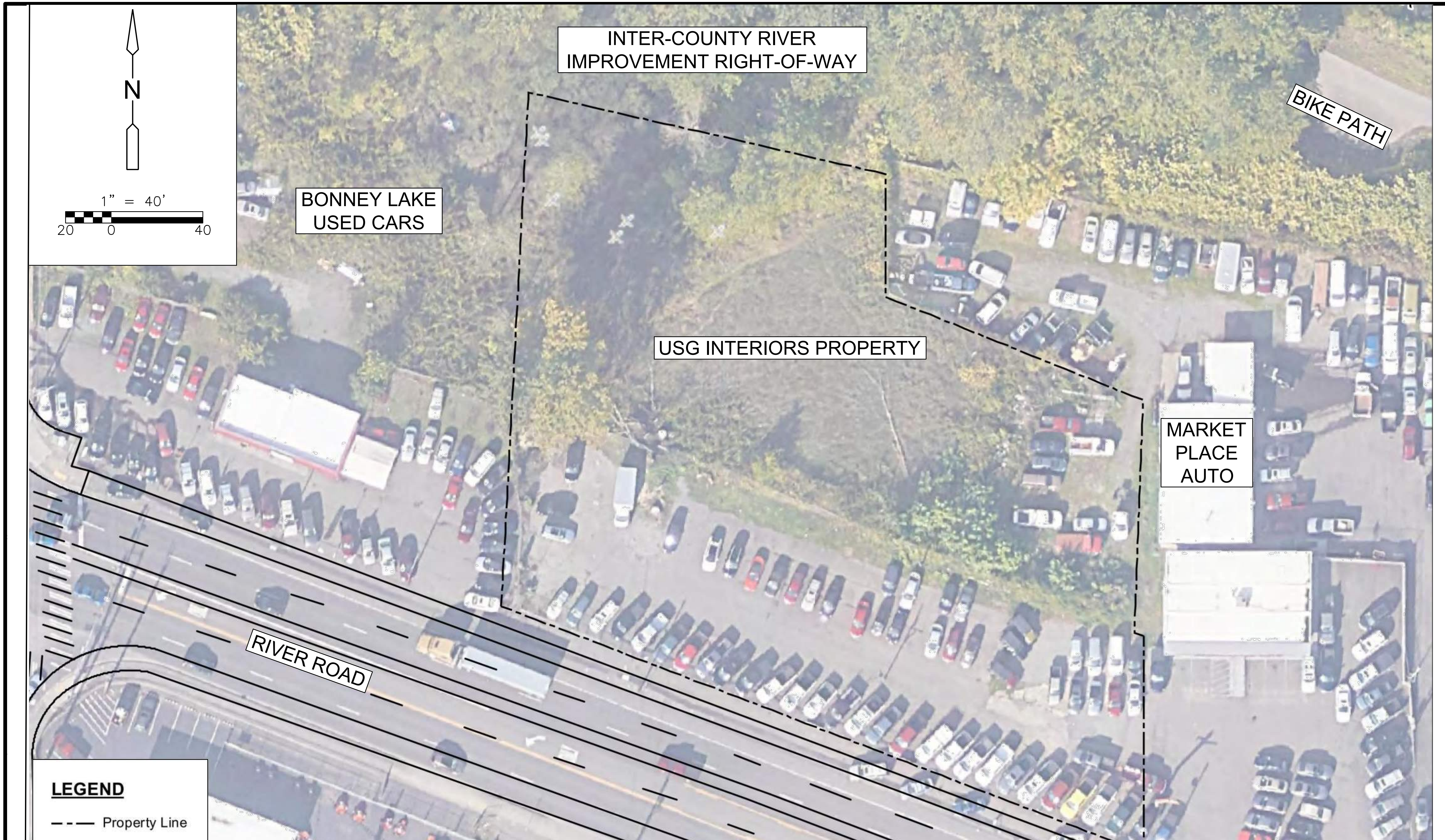
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/7/2022 at 1:04 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

CDM Smith

USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

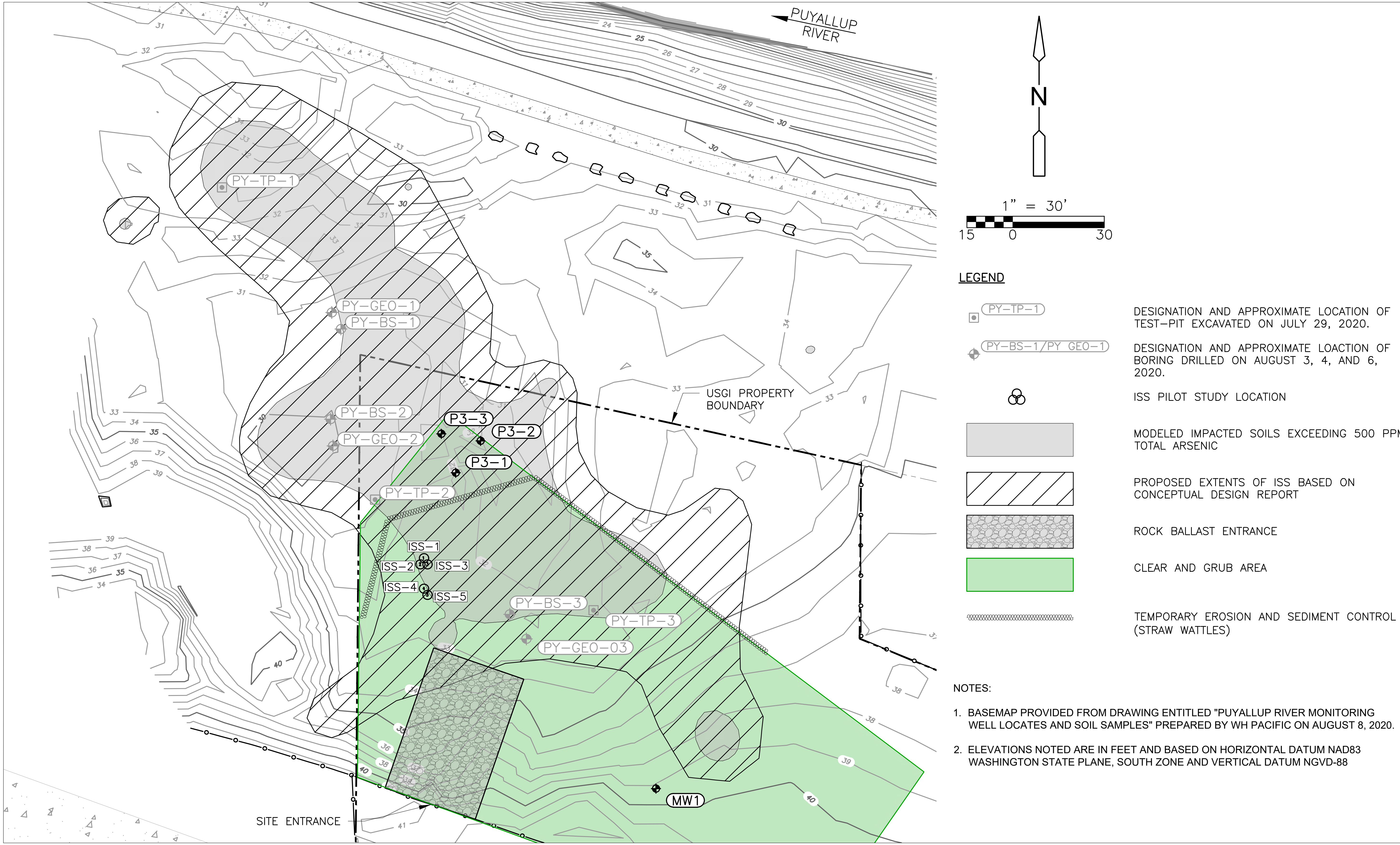
FIGURE 2
FEMA FLOOD HAZARD MAP



CDM Smith

USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 3
SITE AND VICINITY MAP



NOTES:

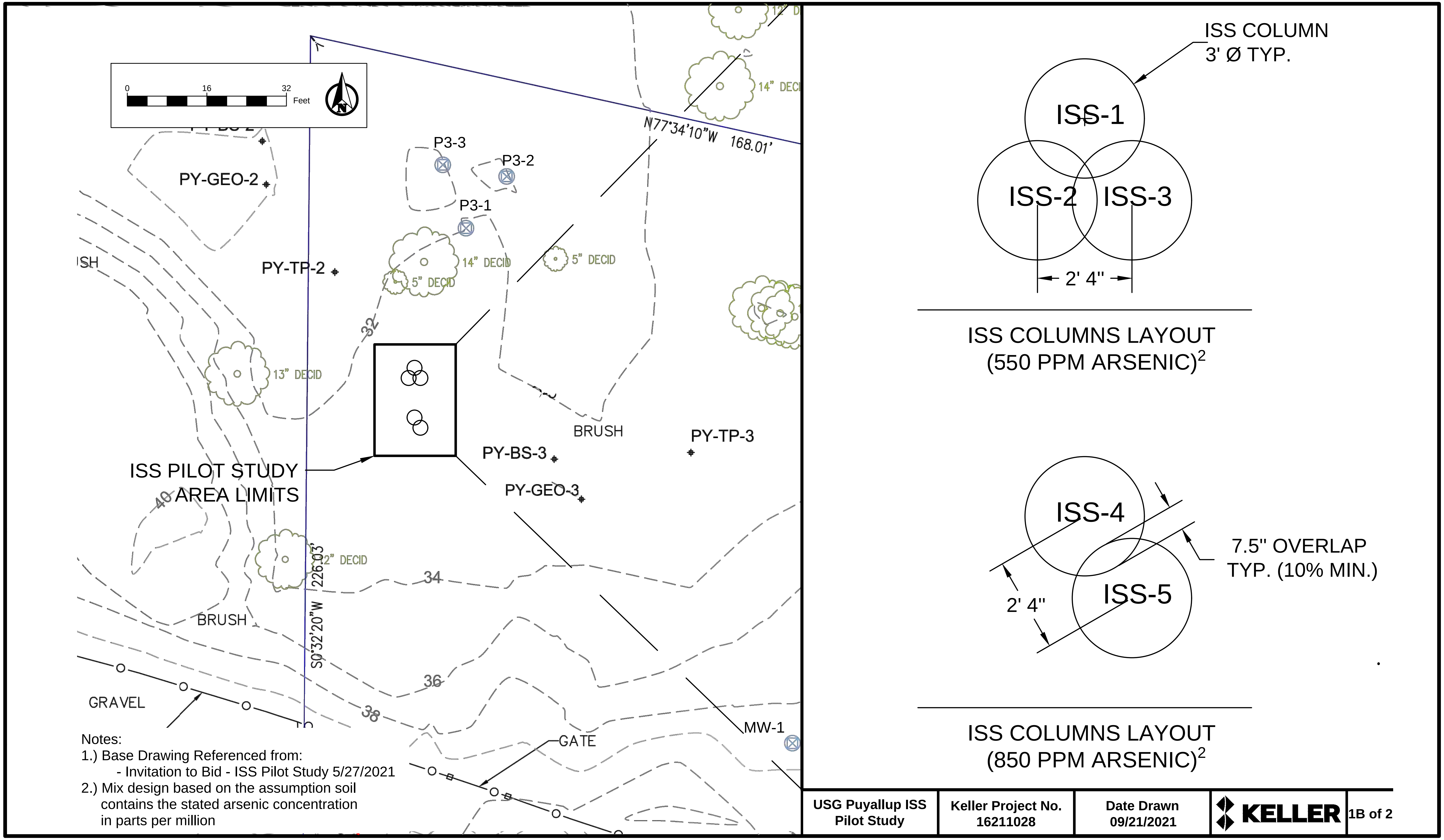
1. BASEMAP PROVIDED FROM DRAWING ENTITLED "PUYALLUP RIVER MONITORING WELL LOCATES AND SOIL SAMPLES" PREPARED BY WH PACIFIC ON AUGUST 8, 2020.
2. ELEVATIONS NOTED ARE IN FEET AND BASED ON HORIZONTAL DATUM NAD83 WASHINGTON STATE PLANE, SOUTH ZONE AND VERTICAL DATUM NGVD-88

C:\pw_pl1\thomastj\d2199292\Figure 4 (2022).dwg SAVED: 1/11/22 PRINTED: 1/11/22 BY: THOMASTJ

CDM Smith

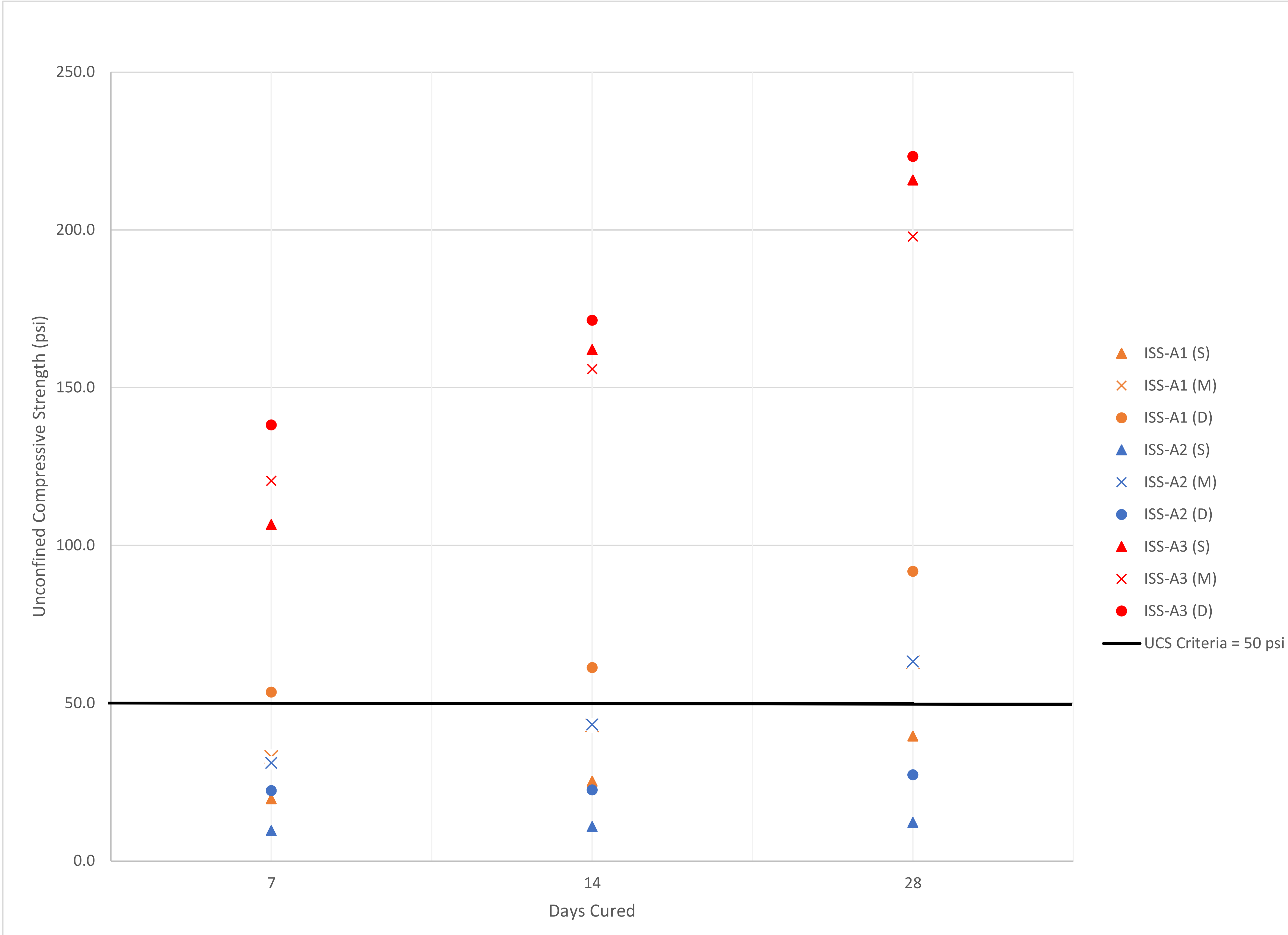
USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE NO. 4
ISS PILOT STUDY LOCATION MAP



USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

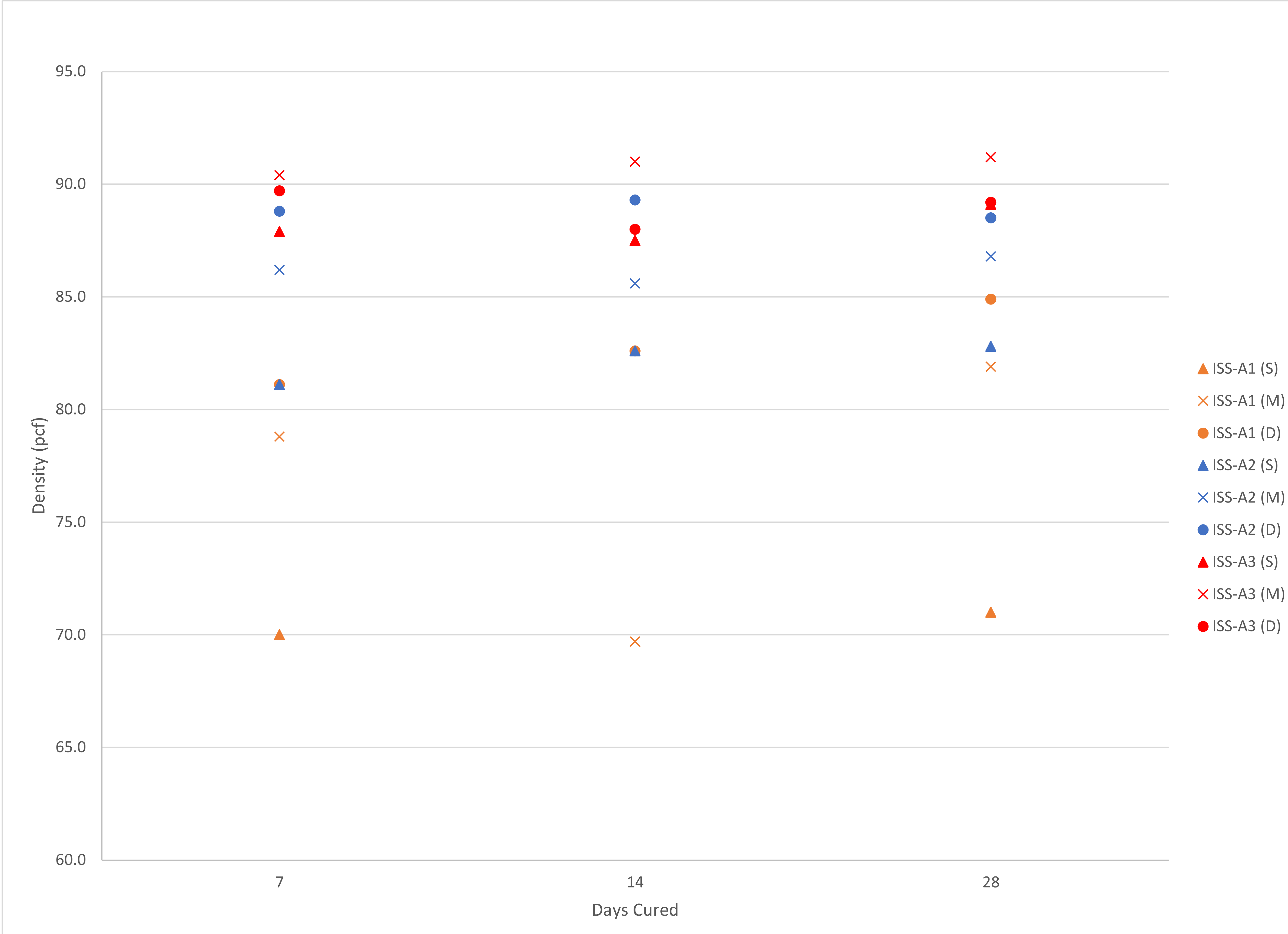
FIGURE 5
ISS PILOT STUDY COLUMN LAYOUT



CDM Smith

USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 6
UCS VERSUS TIME (ALL LOCATIONS/ALL DEPTHS)



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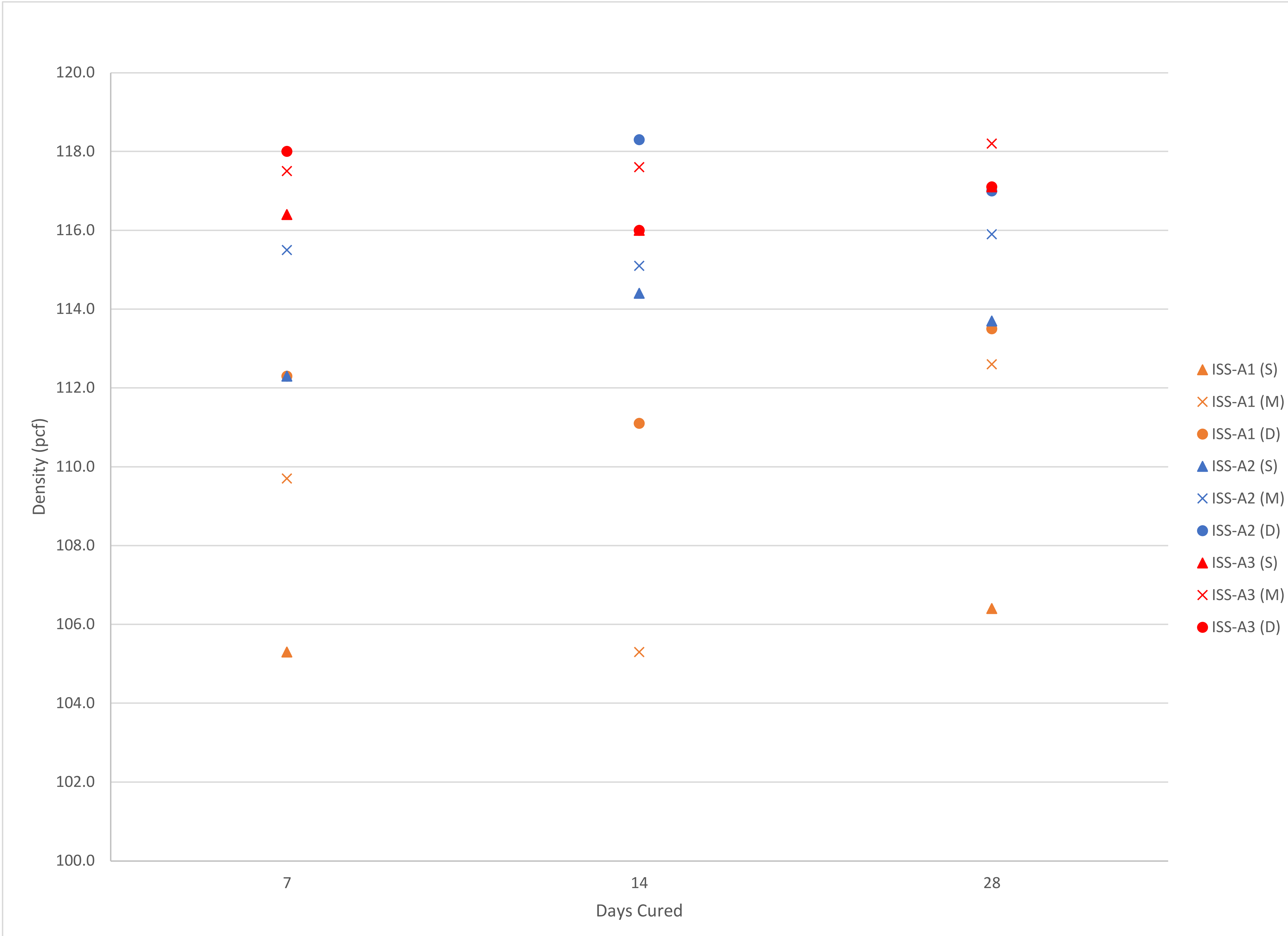
PUYALLUP, WASHINGTON

FIGURE 7
DRY DENSITY VERSUS TIME (ALL LOCATIONS/ALL DEPTHS)



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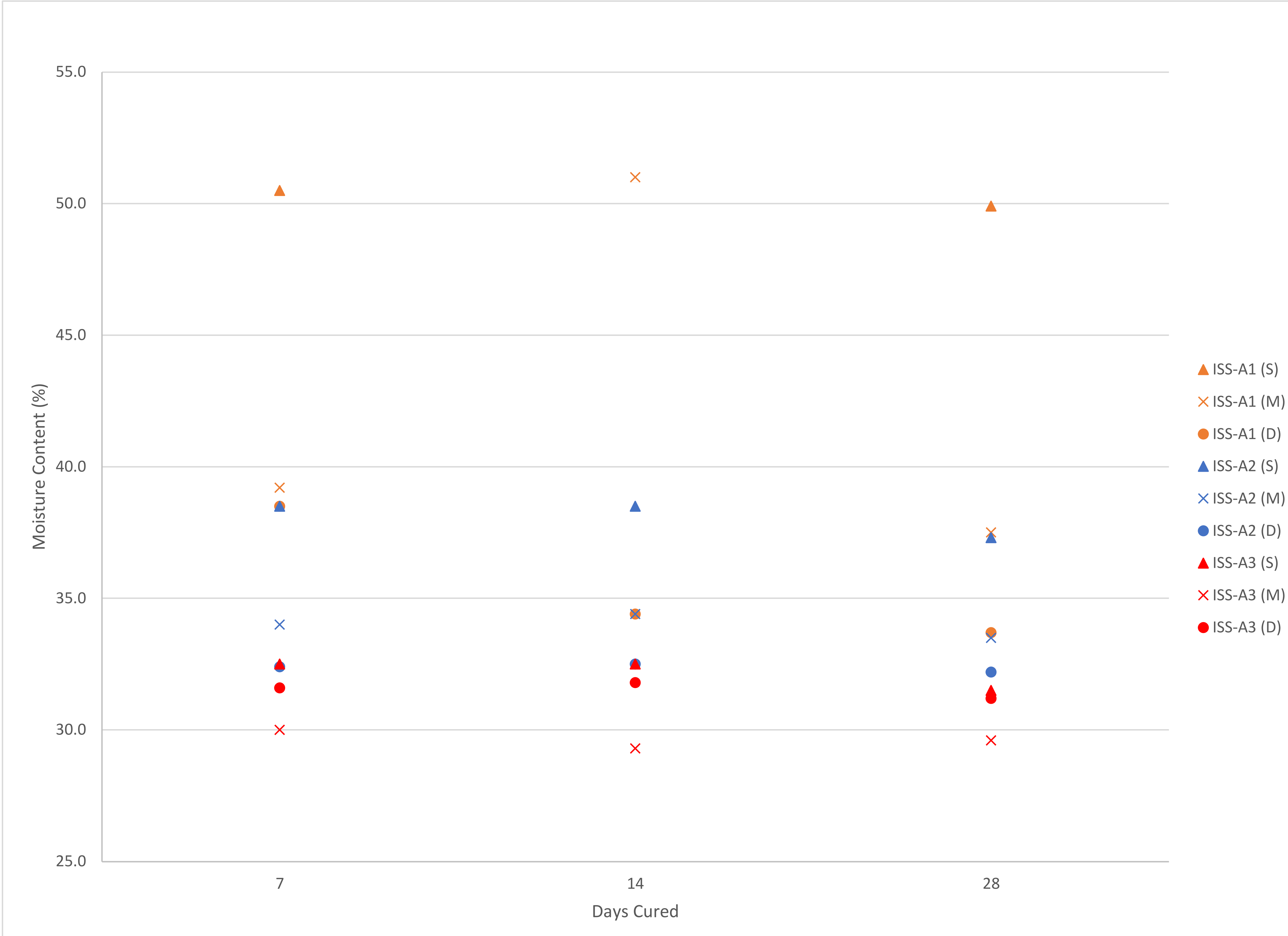
PUYALLUP, WASHINGTON

FIGURE 8
WET DENSITY VERSUS TIME (ALL LOCATIONS/ALL DEPTHS)



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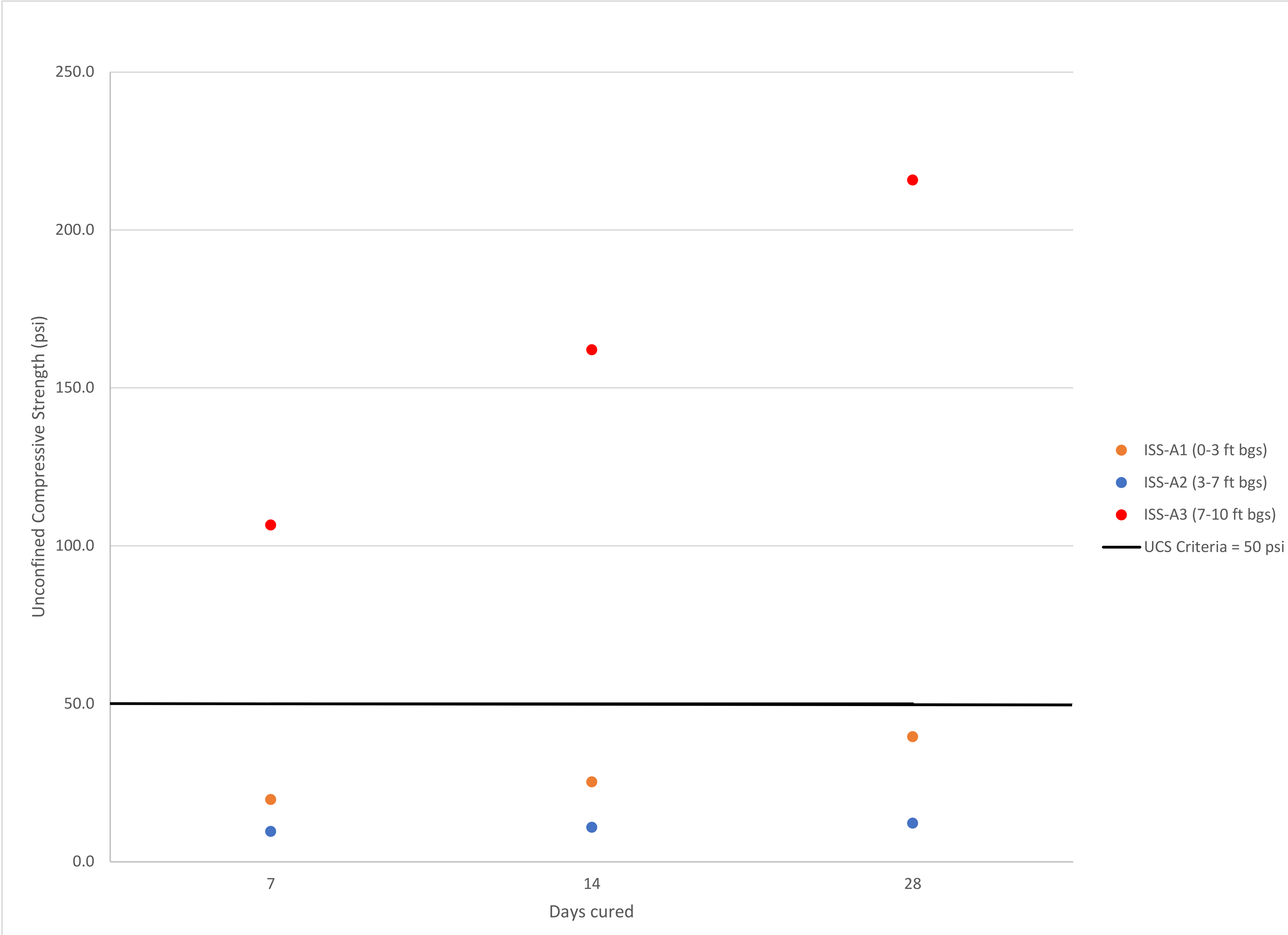
PUYALLUP, WASHINGTON

FIGURE 9
MOISTURE CONTENT VERSUS TIME (ALL LOCATIONS/ALL DEPTHS)



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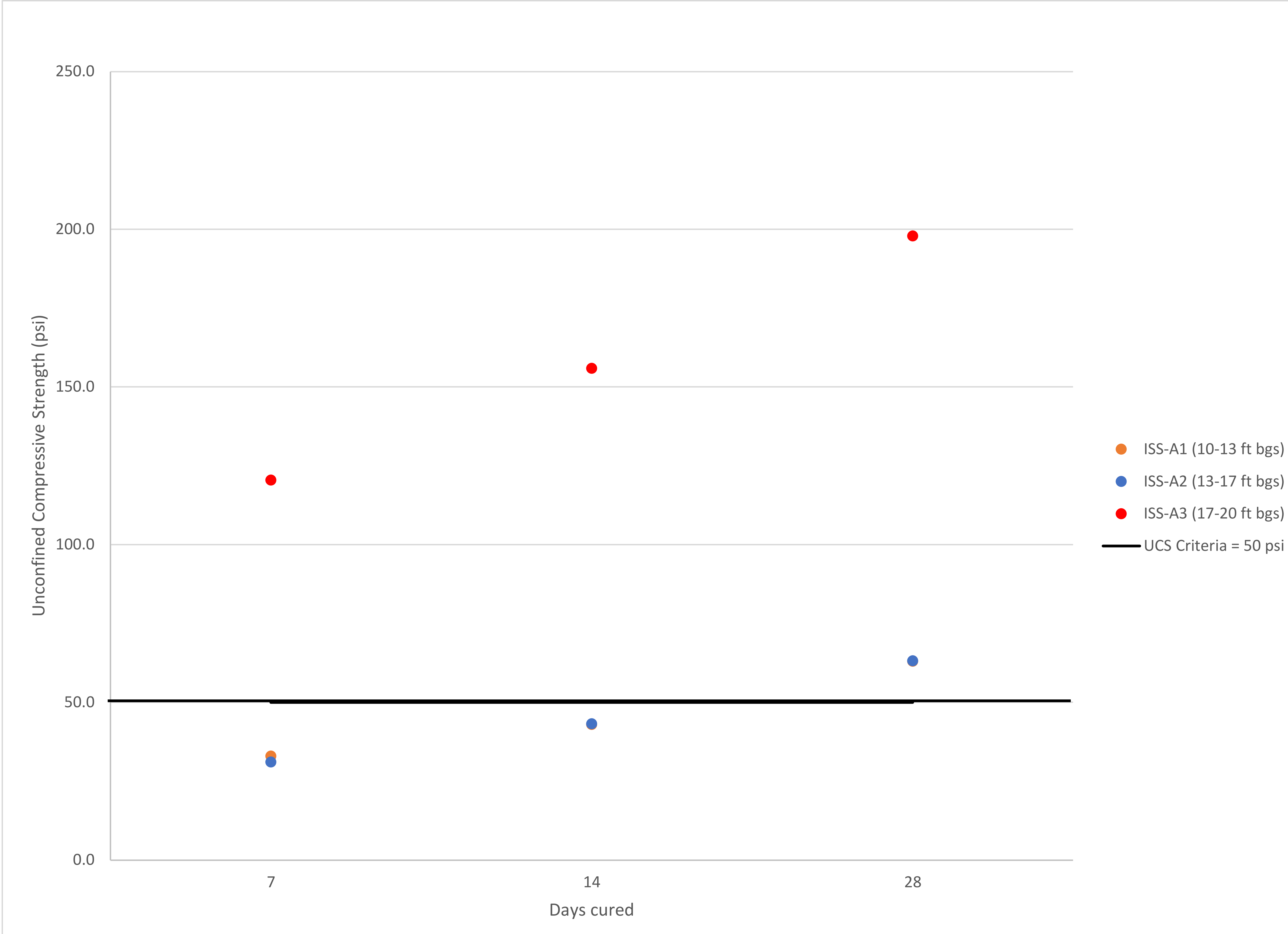
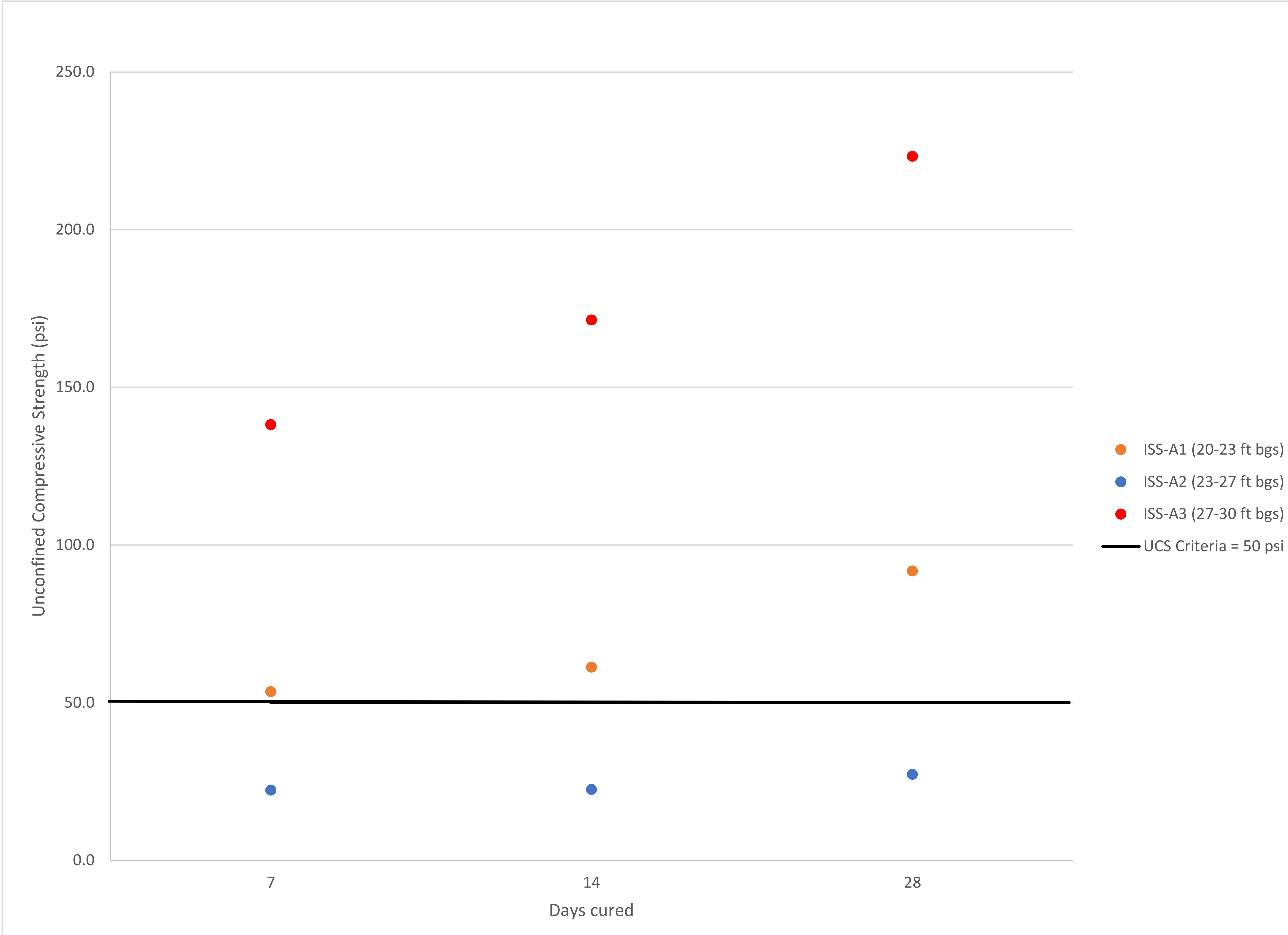
PUYALLUP, WASHINGTON

FIGURE 10
UCS VERSUS TIME (ALL LOCATIONS - SHALLOW DEPTH INTERVAL)



USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 11
UCS VERSUS TIME (ALL LOCATIONS - MEDIUM DEPTH INTERVAL)



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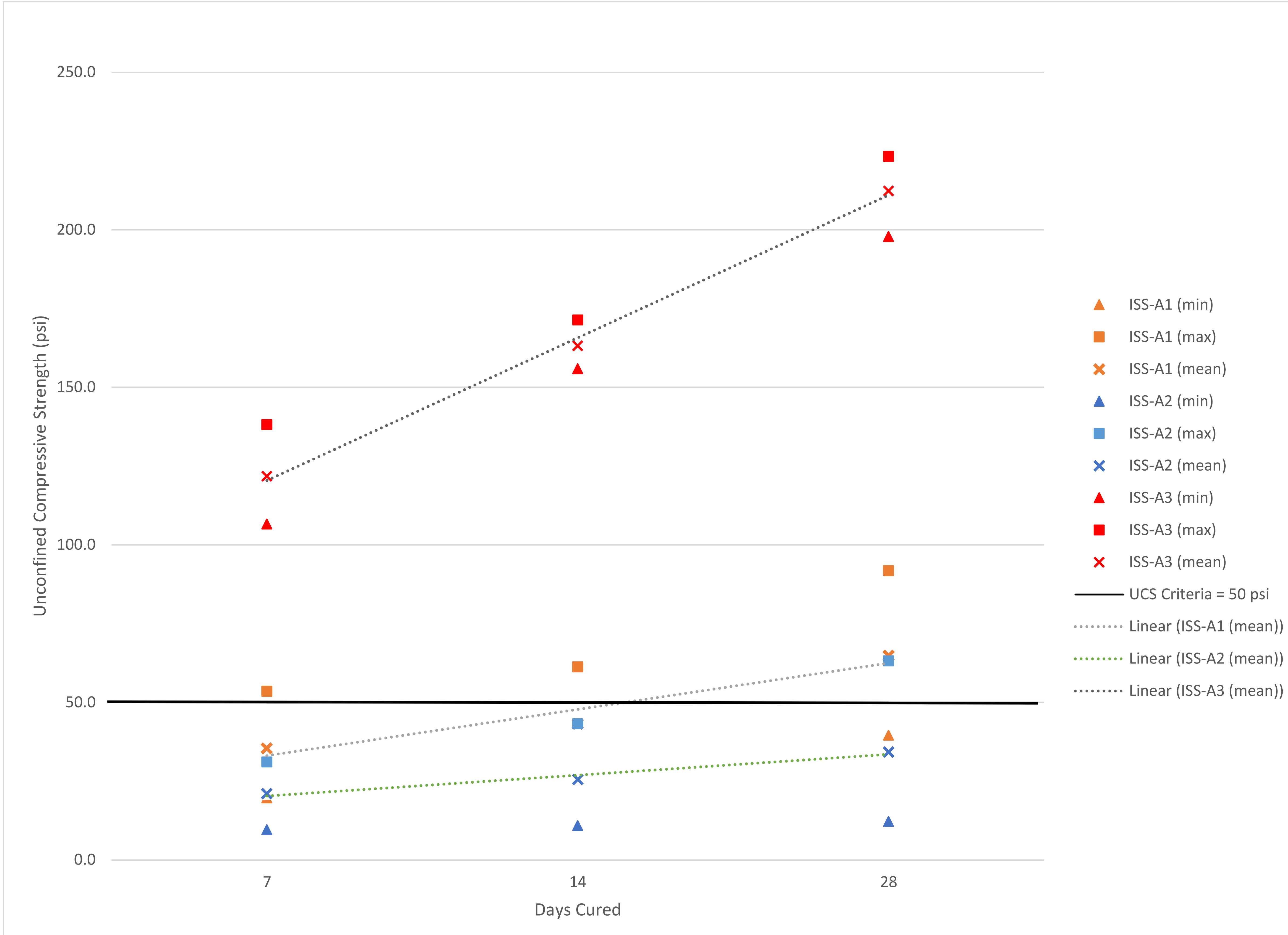
PUYALLUP, WASHINGTON

FIGURE 12
UCS VERSUS TIME (ALL LOCATIONS - DEEP DEPTH INTERVAL)



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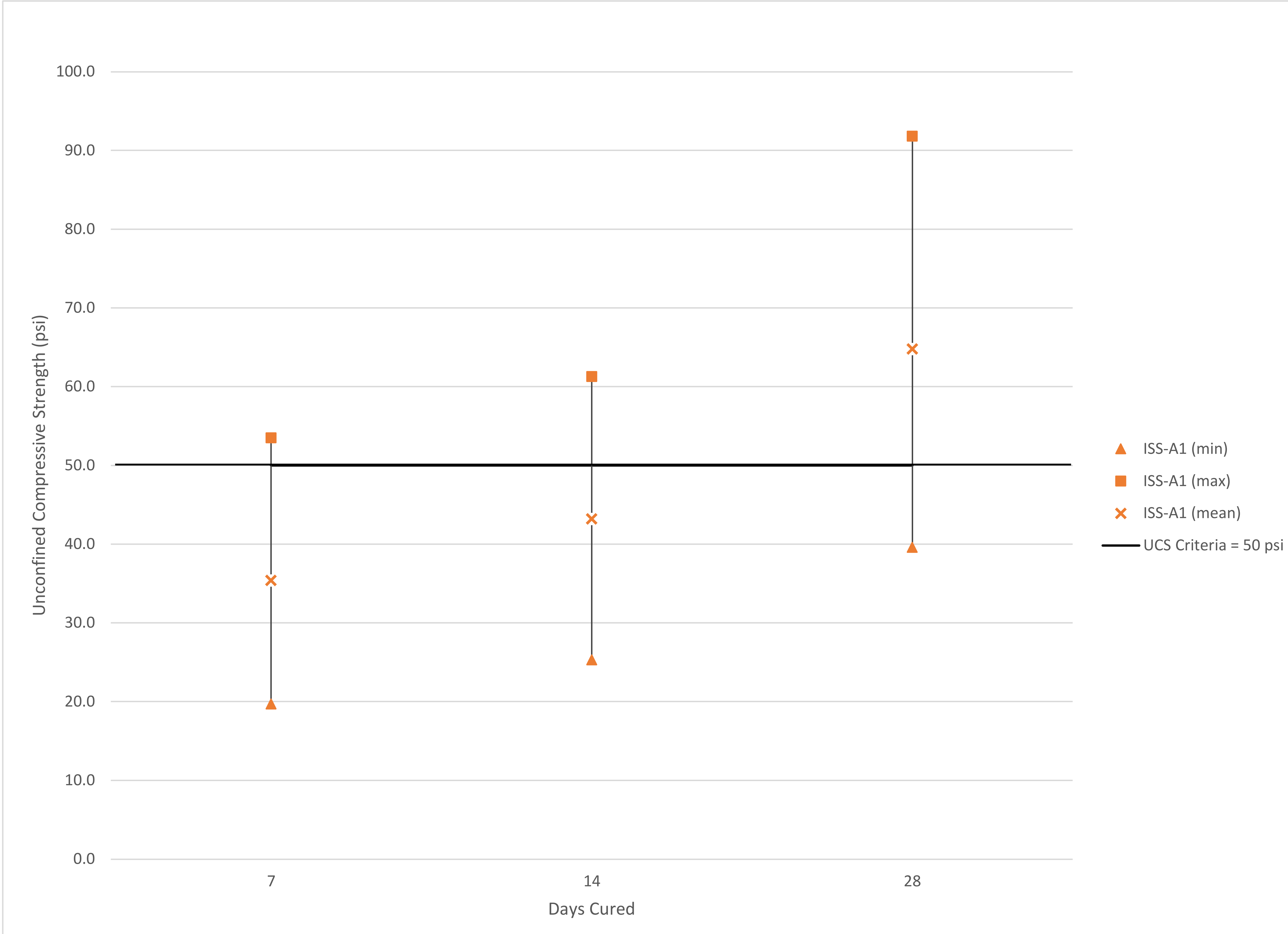
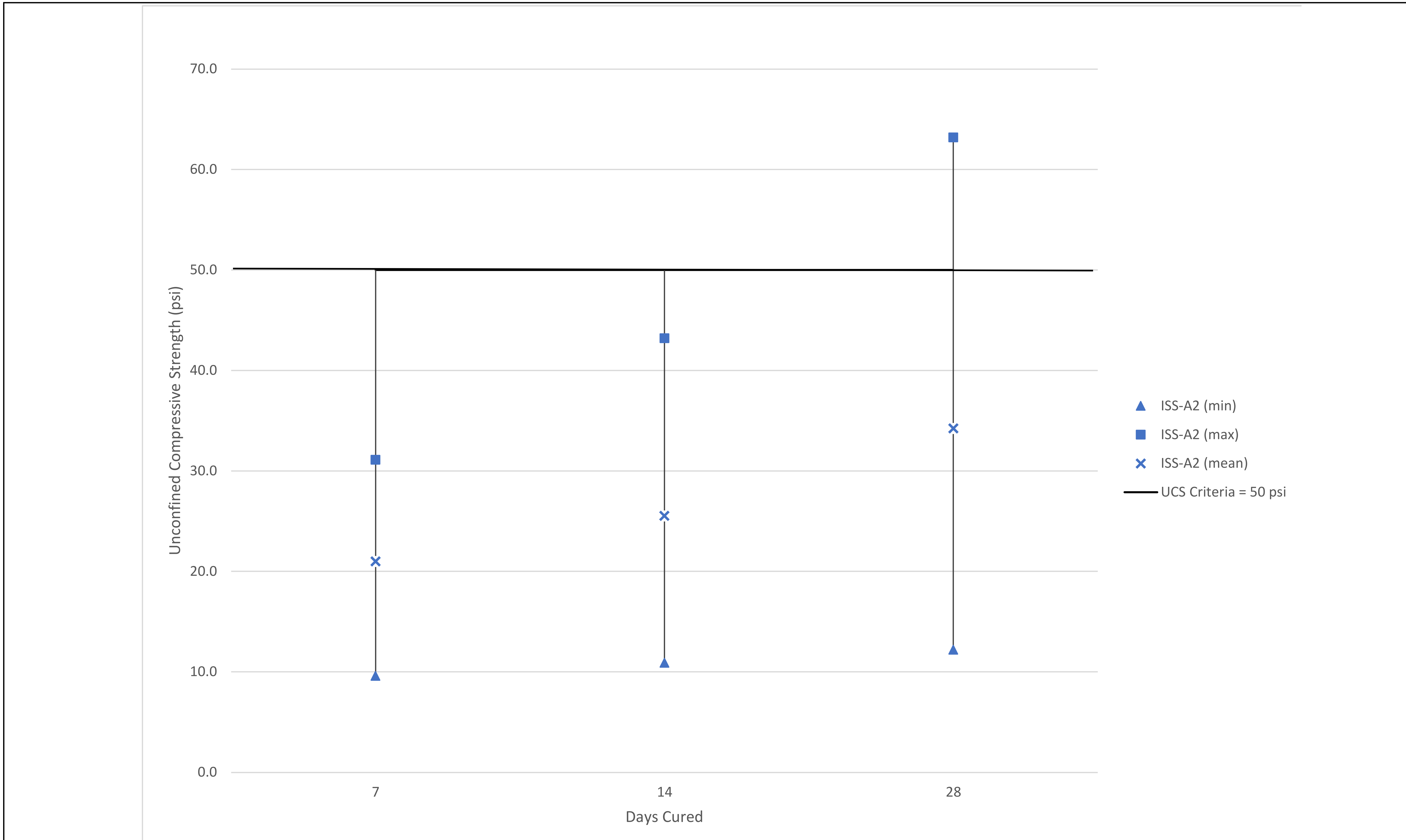
USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 13
STATISTICAL SUMMARY (ALL LOCATIONS)



USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 14
STATISTICAL SUMMARY - ISS-A1



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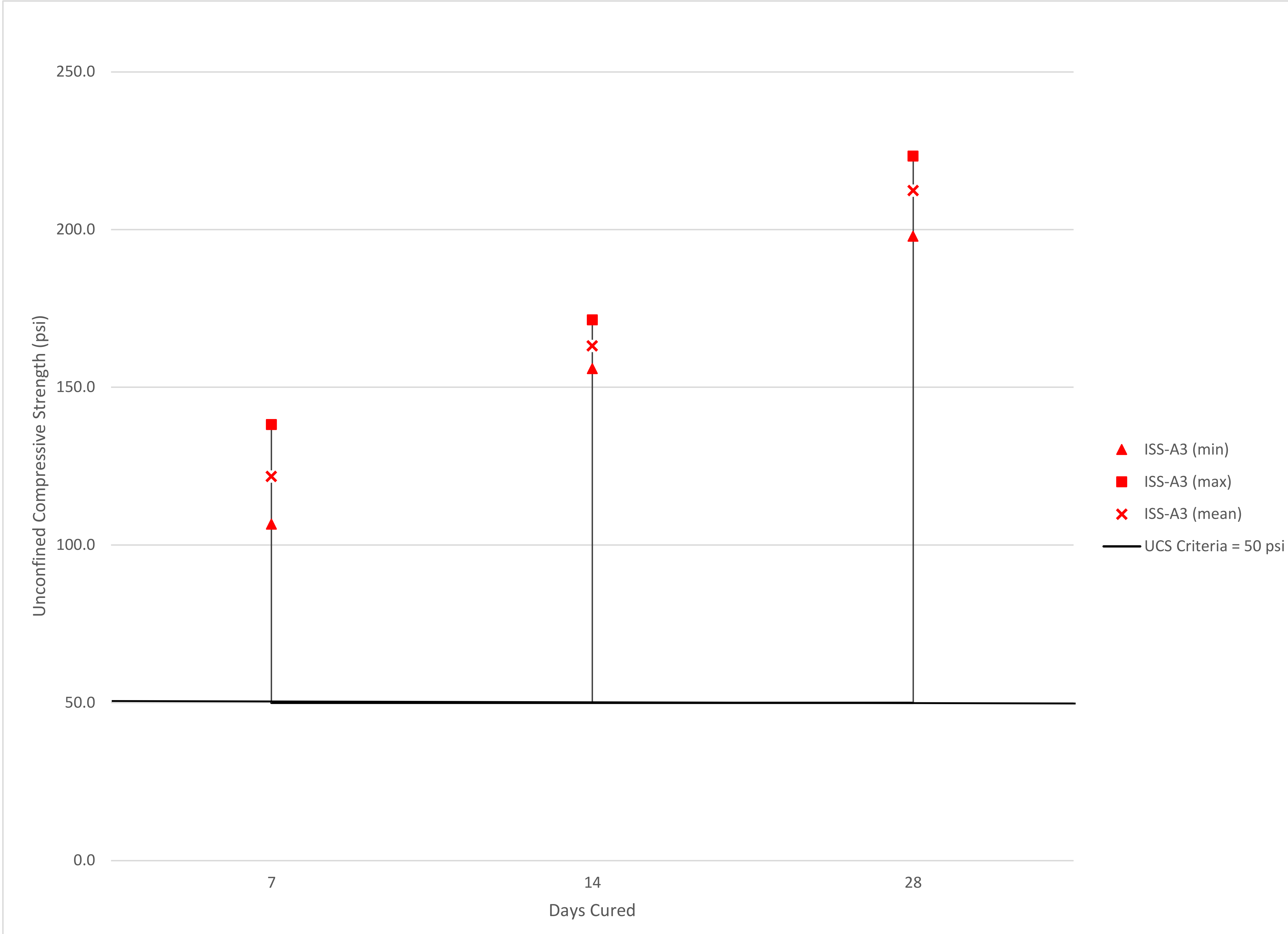
PUYALLUP, WASHINGTON

FIGURE 15
STATISTICAL SUMMARY - ISS-A2



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USG INTERIORS/PUYALLUP SITE
PUYALLUP, WASHINGTON

FIGURE 16
STATISTICAL SUMMARY - ISS-A3

Appendix A

Contractor Work Plan

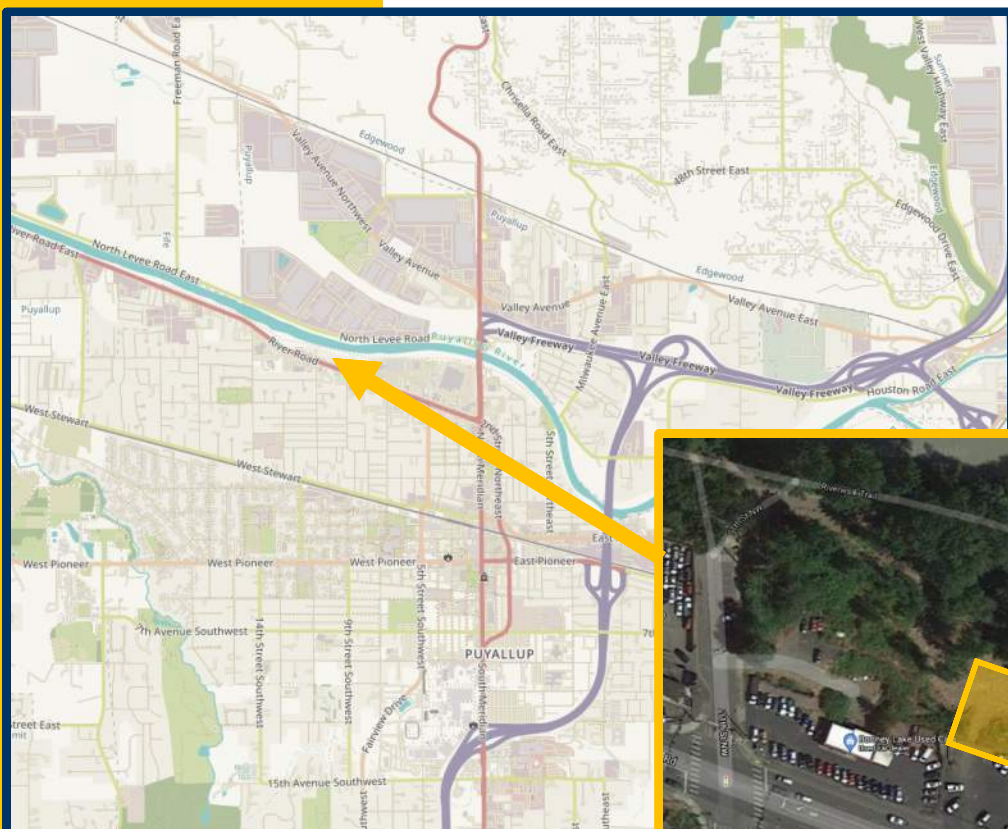
CDM Smith

IN-SITU SOLIDIFICATION AND STABILIZATION (ISS) PILOT STUDY

PROJECT NO. 16221028

CONSTRUCTION WORK PLAN

REVISION 2



Keller North America, Inc.
18300 Cascade Ave S, Suite 265
Seattle, WA 98188
t: 206-223-1732

THINK SAFE

TABLE OF CONTENTS

1.0 Project Introduction & Overview

Keller is providing herein its Construction Work Plan (CWP) a description of the means and methods required to complete the ISS Ground Improvement scope of work. This CWP has been prepared in consideration of the bid documents for the in-situ solidification and stabilization (ISS) pilot study in Puyallup, WA.

The contents of this CWP have been specifically prepared for consideration by the project partners. The project partners are defined as the following parties for the purpose of this plan:

OWNER

USG Corporation
550 West Adams Street
Chicago, IL 60661

ENGINEER

CDM Smith Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007

ISS CONTRACTOR

Keller North America, Inc.
18300 Cascade Ave S, Suite 265
Seattle, WA 98188

The Keller contact for this project is Dylan Fisher. Mr. Fisher serves as the project manager for the ISS pilot Study and can be reached at any of the following:

Dylan Fisher Project Manager
Keller – North America
t: +1-206-223-1732
m: +1-206-419-9010
e: dcfisher@keller-na.com

1.1 Project Description

Based upon review of the information provided to Keller, we understand the project to be the field trial and implementation of a laboratory tested cementitious mix design to stabilize arsenic contaminated soil in-situ using a common ground improvement technique known as deep soil mixing (DSM); herein called "ISS". The purpose of the field trials is to determine the effectiveness of drilling and mixing parameters for full scale implementation at a later date.

2.0 ISS Element Construction

Wet soil mixing, which is a form of Deep Soil Mixing (DSM), is the main method of ground improvement used for this project. ISS mechanically blends the in-situ soil with grout mixture of neat cement, bentonite, admixtures and sand to create elements made of a product called soilcrete. A large drill type rig equipped with specialized tooling is used in this method. As the tooling is drilled and advanced into the ground, ready mix is pumped out the bottom of the mixing tool. By utilizing the high torque of the drill rig to rotate the paddles the tooling is advanced with a predetermined, controlled penetration rate to design tip elevation. Once the design tip elevation is reached, the mud flow is reduced, and the tooling is withdrawn, while still rotating, to complete the mixing process. One of Keller's many experienced operators will use our in-house data acquisition system (DAQ) and in-cab drill controls to control the penetration, withdrawal, and rotational rate of the drill string along with matching the mud flow with predetermined parameters in order to deliver the specified material content.

2.01 Sequencing of ISS Work

2.01.1 Working Pad Preparation and Temporary Site Fencing

The working platform will be constructed of compacted subbase/material competent enough to sufficiently support the operating weight of Keller's equipment, maximum anticipated operating weight 100 tons. Preparation, stabilization, and maintenance of the working platform(s) shall be the responsibility of Keller. If working platform conditions impair Keller's operations, the working pad shall be improved before proceeding with the work to ensure safe operations. Temporary site fencing will be provided by Keller around the work area and at all areas where current fencing is anticipated to be removed to facilitate access to the site.

2.01.2 Temporary Access Ramp Preparation

A temporary ramp will be necessary for the drilling equipment and personnel to access the working platform. The temporary ramp shall meet the minimum requirements below in advance of Keller's mobilization to site. The temporary ramp shall be located at the Northwest corner of the existing asphalt parking lot and provide access to the working area.

1) Maximum Slope of 10% *with no* tooling on installation rig
2) Maximum Slope of 5% *with* tooling on installation rig
3) Minimum width of 16ft

2.01.3 Mobilization to Project Site

Keller will mobilize to the project site shortly before, or soon after, the completion of the working platform. Mobilization will mainly consist of the importation and assembly of large pieces of mechanical equipment. Equipment will include, but is not limited to, a large-scale hydraulic drill rig, drill mast, and electric batching equipment. All equipment will be pressure washed prior to mobilization to site to remove any non-site soil or other contaminates.

2.01.5 Survey Control

A licensed surveyor (WH PACIFIC) in the state of Washington shall prepare survey control and/or coordinates for use by Keller on this project to locate and as-built the ISS columns.

2.01.6 Construction of ISS Elements

Once sufficient layout has been provided via surveying, construction of production ISS elements will commence per the approved construction shop drawings. Construction parameters are provided herein in the mix design section of work.

2.01.7 Verification Testing

During the construction of the ISS elements, verification testing shall be taking place. Verification testing will consist of wet grab sampling each column as detailed in the verification testing section below.

2.01.8 Decontamination

After construction of ISS elements is complete Keller's site crew will construct a decontamination containment area using heavy duty plastic sheeting and timber. The drill rig and any tools and equipment exposed to contaminated soil will be taken into the containment area and pressure washed to remove any site soil and contaminates. The excess water will be pumped into 55-gallon metal drums for offsite disposal.

2.01.9 Demobilization from Project Site

Following the completion of Keller's work, Keller will clean up and demobilize from the project site. Site improvements including the working pad are anticipated to remain in place after work is completed.

2.02 Wet Soilcrete Management

Soilcrete is the product produced from the combination of soil and cement during the deep soil mixing process. Excess product is produced during the mixing process due to a volume increase from the introduction of cement grout. The handling and transport of wet soilcrete (surface return) in front of the rig will be performed by Keller. Wet soilcrete will be transported from the ISS mixing location to a temporary stockpile location adjacent to the work area. Wet soilcrete is proposed to be handled per the following methodology:

2.02.1 Wet Soilcrete Management Overview

The ISS process produces surface return wet soilcrete as additional volume (in the form of grout) is added in situ to the site soils. This wet soilcrete flows to the surface throughout the mixing process and must be handled and removed from the immediate vicinity of the installation rig to allow the process to continue.

2.02.2 Wet Soilcrete Management at the Rig

A tracked excavator or loader will be manned at the front of the ISS rig to control the wet soilcrete that will flow to the surface during the mixing process. Temporary soil berms will be used if required to contain the liquid spoils. Berms will be made of hardened spoils or imported fill material.

2.02.3 Transport of Spoils to Stockpile Locations

The wet soilcrete that returns to the surface will be in a slurry state and will need to be cured prior to movement to the designated stockpile location. As the wet soilcrete continues to cure and become more solid, an excavator will transport the material from the mixing location to the stockpile location.

2.02.5 Temporary Erosion & Sediment Control (TESC) Measures

All disturbed soil will be managed using the best management practice (BMP)'s for stormwater and dust generation; such BMPs may include silt fencing, straw wattles, and/or soil wetting during excavation.

2.02.6 Dust Control

Fugitive dust emissions will be managed during activities that may generate dust (e.g., test pitting, trenching, grading). If fugitive dust is visible, engineering controls (i.e., soil wetting) must be used to control fugitive dust emissions so as to protect workers and the general public. Water to be used for dust control will be provided on site to manage fugitive dust as necessary. This provision specifically applies to the ISS work for any excavation, handling, hauling, and stockpiling of ISS wet soilcrete, and other material within the work zone.

2.03 Equipment

2.03.1 Drilling Equipment

Drilling and installation of ISS elements will be performed using a Bauer BG-24 track mounted hydraulic drill rig. The Bauer BG-24 will be fitted with a 3-foot diameter single axis ISS tooling. ISS tooling will be advanced from ground elevation to design depth in a single stroke. ISS tooling will be the nominal size of the element and each element will be constructed in a continuous manner without the need to add or remove sections. Installation depths are anticipated to be a maximum of 35 feet deep. Drill tool will be marked in 5 ft. Intervals.

2.03.2 Batching Equipment Ready-mix Option

Keller will utilize a local ready-mix plant (CORLISS RESOURCES) to supply trucks with proportioned concrete sand, cement and an initial volume of water. Once onsite Keller will utilize a high shear colloidal mixer to blend the remaining volume of water, bentonite and ferrous sulphate heptahydrate before pumping the blended products into the truck and mixing until well blended.

3.0 Drilling & Production Monitoring Equipment

The ISS installation rig will be equipped with Keller's in-house real-time data acquisition system (DAQ) that will be displayed and read by the operator. The DAQ system will be used to record numerous QA/QC measures such as: mast inclination along x and y axis, drill depth, grout volume, grout flow, withdrawal and rotation rates, binder content and grout pressure. This data will be recorded graphically, and production reports will be generated daily. Additionally, the drill stem can be marked in 5 foot increments to allow for visual verification of drilling depth. Digital outputs of the depths in real-time shall be provided for verification.

3.01 Verticality Monitoring

As mentioned in the introduction to this section, Drilling and Production Monitoring Equipment, Keller's DAQ system will record mast inclination. Measurements will be taken along the x and y axis. The inclination of the mast will be visible to the operator at all times. This constant visualization will ensure that all ISS elements will be installed within the specified alignment criteria.

3.02 Treatment Depths

In addition to monitoring verticality, drill depth will also be recorded by the DAQ system. The depth of treatment will be measured from tip elevation to ground surface.

4.0 Mix Design

4.01 Materials

As discussed in the opening paragraph, grout slurry will be mixed with in situ soil. The grout slurry will consist of Type IL Cement, bentonite, ferrous sulfate heptahydrate and potable water mixed in a concrete truck before being pumped to the rig and down the column using a concrete style line pump.

4.02 Mix Production/Batching

The table below shows the typical parameters that will be used to construct the production ISS elements in consistent soil conditions. The table below is representative of parameters within the GI limits. Also, the parameters shown below may vary so long as the correct binder is introduced, and the strength criteria is met.

Description	Value	Units
Arsenic Concentration	550- 850	mg/kg
Unit Weight of Soil	92	pcf
Total Weight of Soil Per column	22765.40	lbs
Total Weight of Soil Per column	10326.22	kg
Column Diameter	3	ft
Column Length	35	ft
Column Volume	247.45	cf
Column Volume	9.16	cy

MIN Grout Mix Design (850 PPM ARESENIC)

S.G.	Description	Min Value	Units
3.15	10% Cement by soil weight	2277	lbs
2.6	2% Bentonite by soil weight	455	lbs
1.89	4:1 mass ratio 'FSH'	385	lbs
2.65	10% Sand by soil weight	2277	lbs
1	water weight added	3644	lbs

MIN Grout Mix Design (550 PPM ARESENIC)

S.G.	Description	Min Value	Units
3.15	10% Cement by soil weight	2277	lbs
2.6	2% Bentonite by soil weight	455	lbs
1.89	4:1 mass ratio 'FSH'	225	lbs
2.65	10% Sand by soil weight	2277	lbs
1	water weight added	3644	lbs

4.03 Quality Assurance of Mix

The quality of the mix will be continuously monitored. The grout density, which largely defines the quality of the mix, will be measured electronically by the batch plant operator using a mass flow meter. Periodic mud balances of the grout in the mixing tank will be taken for comparison to ensure accuracy of the mass flow meter. As the grout specific gravity varies, penetration and withdrawal rates will be controlled and adjusted to ensure adequate mixing of the soil.

5.0 Verification Testing

Verification testing shall be performed in accordance with the specifications and shall consist of wet grab sampling for in-situ strength and permeability testing by the Engineer.

5.01 Wet Grab Sampling

Keller will perform wet grab sampling as outlined in the specifications. Bulk wet sample shall be retrieved from 3 intervals (within the bottom 5 feet, middle and within the top 5 feet) from 3 of the total 5 columns installed. The sampling shall be performed with a bailer style sampling box at in the presence of the Engineer. Once a bulk sample has been collected the specimen will be prepared and stored by the Engineer for testing.

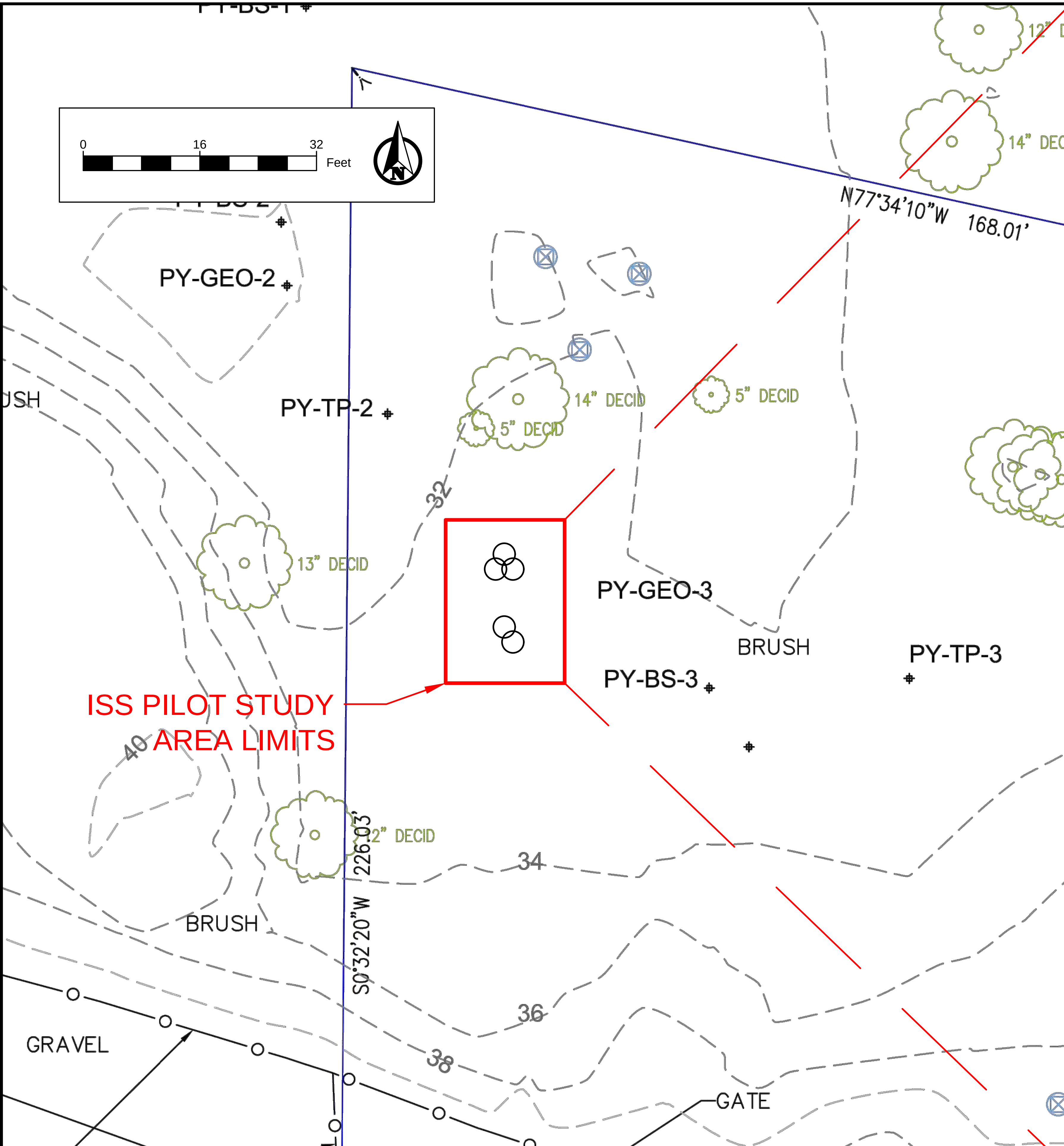
6.0 ISS Shop Drawings

See attachment A for ISS Shop Drawings and Site Plan.

7.0 Scheduling & Phasing

I. The anticipated start date for the construction of production Late September 2021
II. Working hours will be 7AM – 5:30PM Monday through Friday
III. The estimated duration of the construction of production ISS Work is 2-3 days however setup and site work will take an additional 8-10 Days.

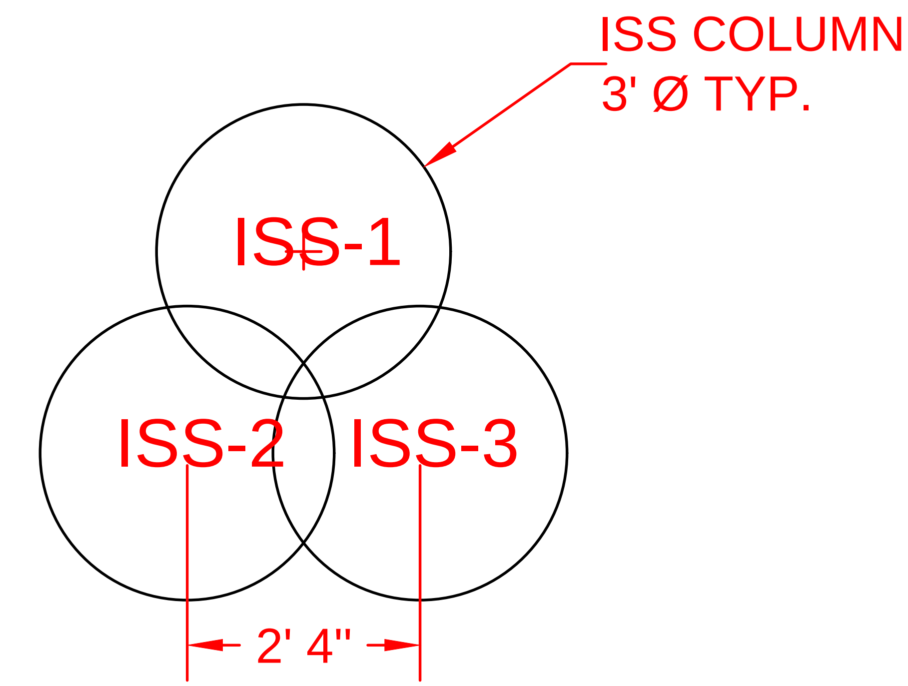
ATTACHMENT A: SHOP DRAWINGS



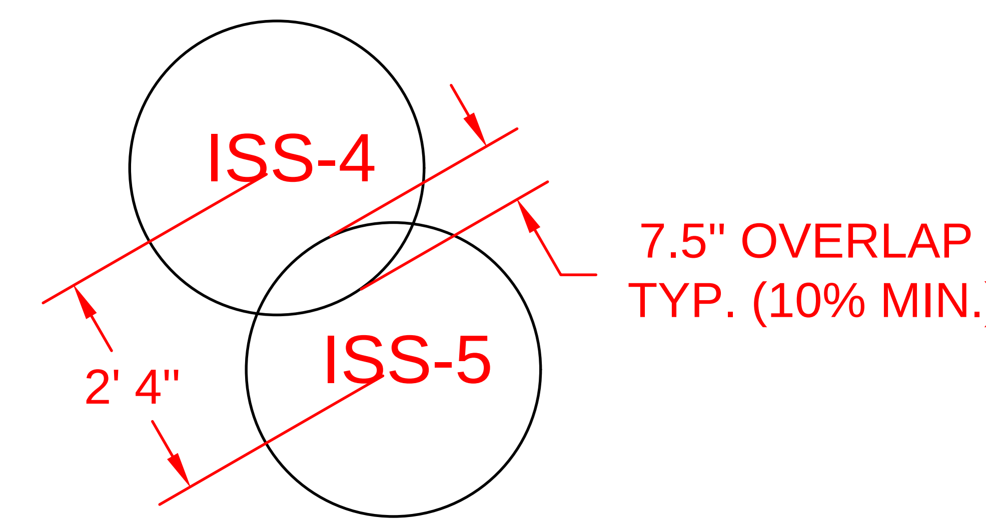
Notes:

1.) Base Drawing Referenced From:

- Invitation to Bid - ISS Pilot Study 5/27/21

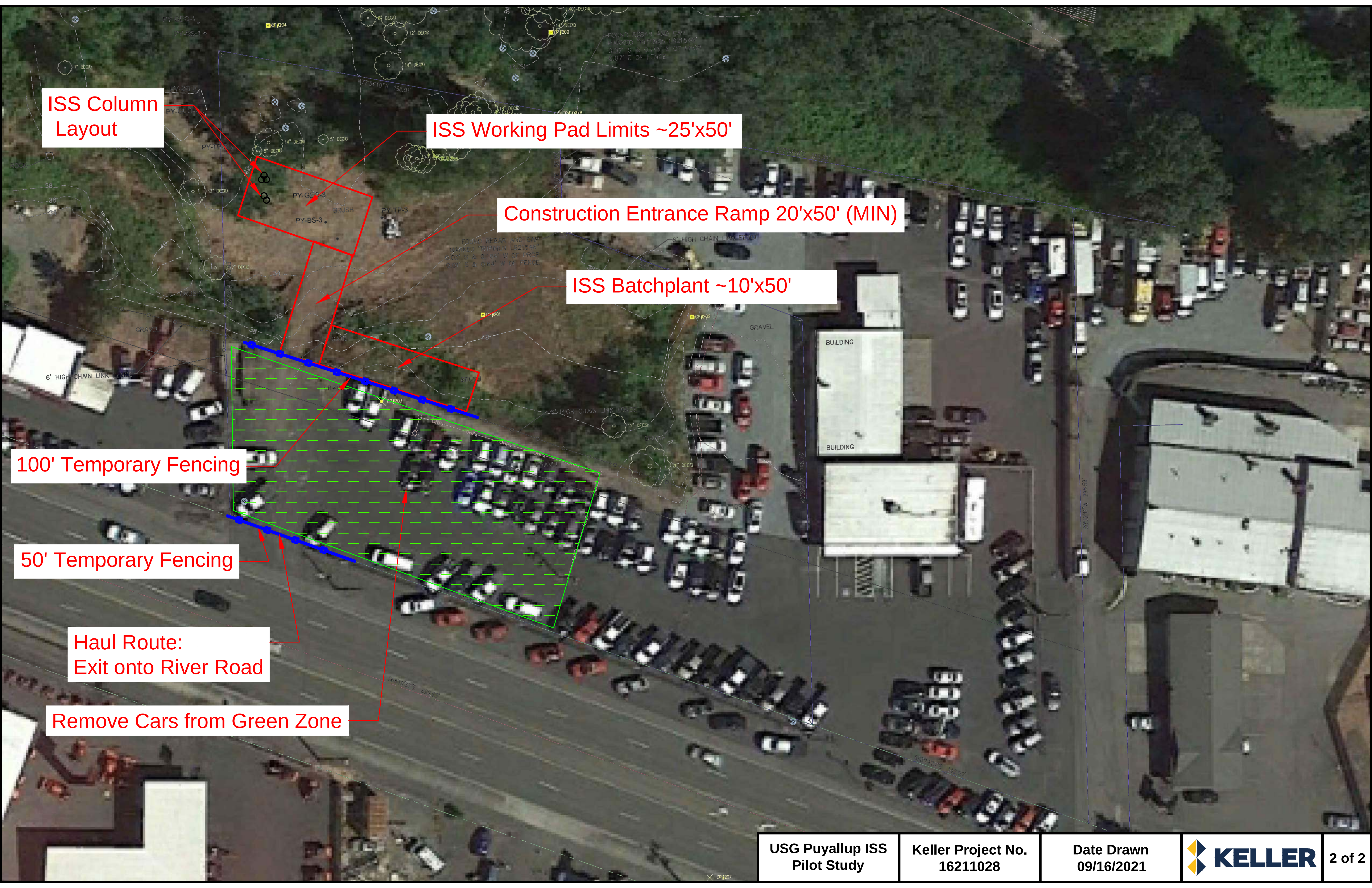


ISS COLUMNS LAYOUT
(500 PPM ARSENIC)



ISS COLUMNS LAYOUT
(850 PPM ARSENIC)

USG Puyallup ISS Pilot Study	Keller Project No. 16211028	Date Drawn 09/21/2021	KELLER	1B of 2



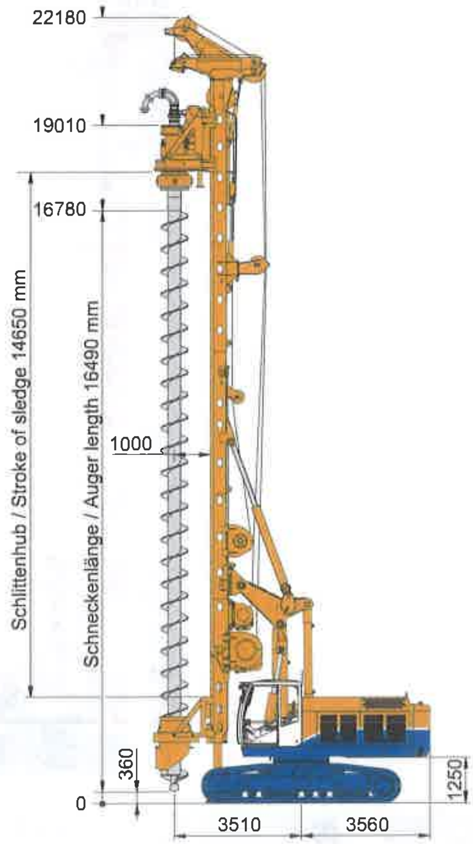
USG Puyallup ISS Pilot Study	Keller Project No. 16211028	Date Drawn 09/16/2021	KELLER	2 of 2

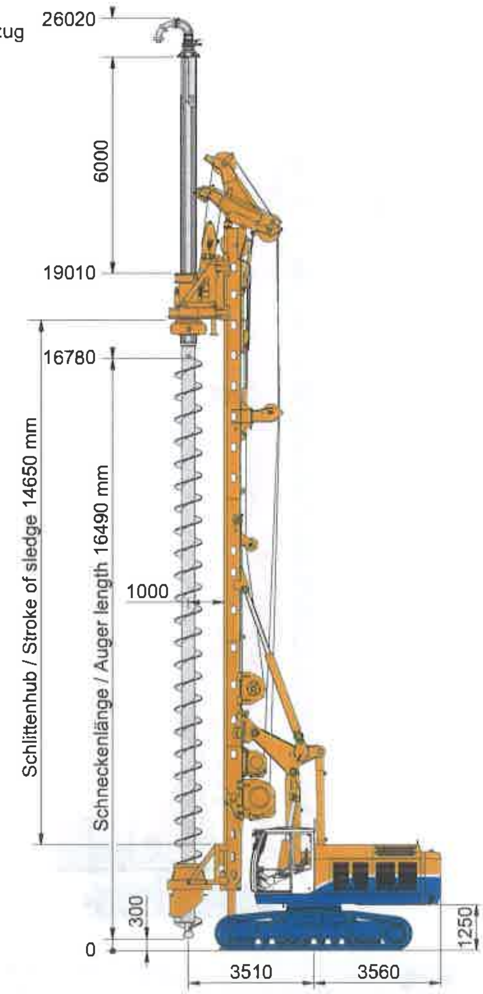
ATTACHMENT B: EQUIPMENT CUT SHEET

SOB - Bohrverfahren / CFA - drilling system

hydraulische Mastabstützung erforderlich / hydraulic mast support required

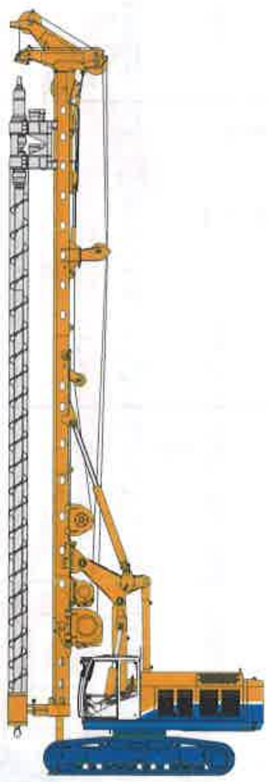
Zeichnung (mit Kellyverlängerung) mit Traverse für zusätzlichen Hauptwindenzug
Illustration (with kelly extension) showing spreader beam for additional pull with main winch

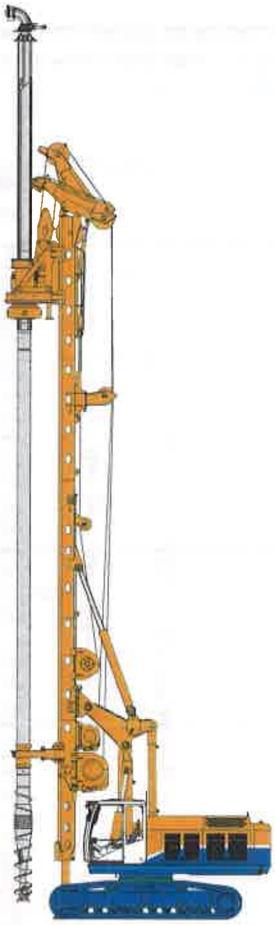




	ohne Kellyverlängerung without kelly extension	mit Kellyverlängerung 6,0 m with kelly extension 6,0 m
Bohrtiefe mit Schneckenputzer Drilling depth with auger cleaner	13,00 m	19,00 m
Bohrtiefe ohne Schneckenputzer Drilling depth without auger cleaner	14,20 m	20,20 m
Max. Bohrdurchmesser Max. drilling diameter	1.000 mm	1.000 mm
Max. Zugkraft Max. extraction	330 kN	330 kN
Max. Zugkraft mit Haupt- und Vorschubwinde (effektiv) Max. extraction force with main- and crowd winch (effective)	730 kN (400 + 330 kN)	730 kN (400 + 330 kN)
Max. Anpresskraft Max. crowd force	270 kN + Schneckengewicht 270 kN + auger weight	270 kN + Schneckengewicht 270 kN + auger weight
Schneckenlänge (inkl. Pilot) Continuous flight auger length (incl. pilot)	16,49 m	16,49 m

Weitere Bohrverfahren / Additional drilling systems





VdW

Vor-der-Wand Bohren Front-Of-Wall drilling (FOW)	
Durchmesser Diameter	406 – 610 mm
Tiefe ca. Depth (approx.)	15 m
Drehgetriebe Rotary drive	DKS 60/80

FDP

Verdrängerbohren Full displacement piling	
Durchmesser Diameter	410 – 620 mm
Tiefe ca. Depth (approx.)	15 m
Tiefe (mit Gittermastverlängerung) Depth (with lattice boom extension)	30 m
Drehgetriebe Rotary drive	KDK 235 K

Anwendungen — Applications

Mischverfahren — Soil-Mixing systems

SMW

Soil-Mixing Wall System	
Durchmesser Diameter	3 x 370 mm
Stichlänge Panel length	1.000 mm
Tiefe Depth	ca. 15 m
Drehgetriebe Rotary Drive	RH 1400/1000

CSM

Cutter Soil-Mixing System	
Dicke Thickness	500 mm
Stichlänge Panel length	2.200 – 2.400 mm
Tiefe Depth	ca. 15 m
Mischkopf Mixing head	BCM 5

BG-System – H-Version

BG 12 H

BG 15 H

BG 18 H

BG 20 H

BG 24 H

BG 28 H

BG 36 H

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905.652.1 10/11

Putzmeister

Thom-Katt®

Trailer-Mounted Concrete/Shotcrete/Grout Pumps

Big power and performance in pompact packages

We took our big-boom-pump expertise and applied it to our Thom-Katt® trailer-mounted pumps for shotcrete, concrete and grout pumping. You see the results in powerful performance and rugged reliability. Depend on them to pump a variety of materials, handle the harshest mixes, and tackle difficult applications with ease.

Choose from a wide range of outputs and pressures, from the TK 7 low-output unit, to the TK 70 high-output, low-pressure system. A variety of options are available to customize units for your specific needs.

To enhance performance, you can add accessories: hoses and couplings, nozzles, dosing pumps, reducers and pipeline, clamps, water booster pumps, pumping agents, and special accessories.

More Thom-Katt units are used in the United States than any other brand of small to mid-sized trailer pumps. Engineered in America for more than 30 years, and continually enhanced through our lasting commitment to product excellence, they'll deliver all you expect from a leader in concrete pump technology.

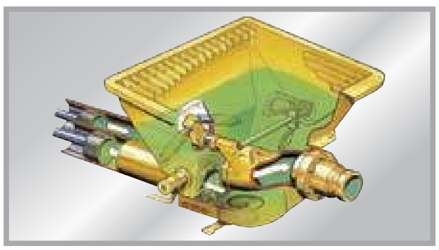
- **Easy filling and operation**
- **Inexpensive maintenance**
- **Fast setup**
- **Smooth pumping**
- **Simple cleanup**
- **Long-term dependability**

Ideal for Larger Aggregate Concrete Pumping and Shotcrete Applications

- **Specially designed hopper**
- **Proven reliable S-Valve**
- **Electric cycling**
- **High-strength trailer**

Putzmeister Thom-Katt trailer pumps are ideal for concrete pumping and wet-process shotcrete applications. With rugged construction and an angled hopper design, they handle the rigors of any jobsite. High-pressure operation lets you pump material over long distances.

The Thom-Katt hydraulic S-Valve is ideal for pumping larger-aggregate materials. It lets you reverse the stroke to relieve pressure from plugs or when pumping difficult low-slump or fiber mixes. The material cylinders and variable, smooth hydraulics allow precise control at low output for specialized applications. You can maintain substantial output pressure when reducing to smaller-diameter conveying lines.



Stronger
Count on our reliable S-Valve for strong, long-lasting performance. A gradual reduction from the hard-chromed material cylinders to the outlet ensures even flow and longer life. Few wear parts, a single seal surface and hard-faced S-Valve and wear ring mean lower operating and replacement costs.

Tougher
Gulp down the toughest mixes in our specially designed hopper. Its dynamic shape eliminates hard-to-clean areas, so a steady flow can funnel down the angled hopper sides. Cleanup is a breeze. (N/A – TK 7, TK 20)

Wider
Work longer and access any job with a bigger fuel tank on our wide, high-strength trailer, built for maximum towing stability and increased ground clearance. (N/A – TK 7)

Smoother
Run smooth with twin-shifting cylinders, providing more precise shifting of the splined shaft S-Valve, reduced shock in the system, and less line surge. The ball-and-socket design has fewer parts for easy maintenance and long life. (N/A – TK 7, TK 20)

Safer
The control box provides for real-time presentation of pump information, diagnostics and an emergency run mode. This feature allows the operators to make sure their pump is operating at peak performance. As always, depend on electric cycling for reversibility at any point in the stroke and to relieve line pressure.

Easier
Discover the convenience of our simple and highly reliable hydraulic control system. Mounted on a compact block atop the hydraulic tank, it offers easy access and lets you service the pump without draining the oil tank. (N/A – TK 7)

Thom-Katt specifications

Thom-Katt Series — Tier 3

Thom-Katt Series — Tier 4 Final

		TIER 4 INTERIM	
Performance	**TK 7**	**TK 20**	**TK 40**
Maximum volume output†	7 yd^3/hr (4.6m^3/hr)	17 yd^3/hr (13m^3/hr)	40 yd^3/hr (30m^3/hr)
Maximum concrete pressure	1,240 psi (85 bar)	2,015 psi (139 bar)	1,150 psi (79 bar)
Maximum aggregate size	0.75" (19mm)	1.00" (25mm)	1.50" (38mm)
Technical Information			
Material cylinders	2" x 24" (51x610mm)	4.5" x 30" (114x762mm)	6" x 39" (150x1,000mm)
Maximum strokes per minute	36	31	31
Variable volume control	0 to full	0 to full	0 to full
S-Valve (cast)	3" x 3" (76x76mm)	4.5" x 4" (114x100mm)	6" x 5" (150x125mm)
Number of shift cylinders	1	1	2
Hydraulic tank capacity	28 gal (105L)	46 gal (175L)	46 gal (175L)
Hopper height	42.1" (1,070mm)	49" (1,245mm)	49" (1,245mm)
Hopper capacity	7.8 cu ft (220L)	9.5 cu ft (270L)	9.5 cu ft (270L)
Outlet diameter	3" HD (76mm)	4" HD (102mm)	5" HD (125mm)
Engine			
Manufacturer's model (all water-cooled except TK 20, TK 40)	TEFC Motor	Deutz TD2011L04i	Deutz TD2011L04i
Horsepower	30 hp (22kW)	68 hp (51kW)	68 hp (51kW)
Fuel tank capacity	–	22 gal (83L)	26 gal (98L)
Trailer			
Axle	–	Single	Single
Axle capacity	–	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)
Tires/Load range	–	LT 235/85R16G	LT 235/85R16G
Brakes	–	Electric	Electric
Outriggers	–	Manual	Manual
Dimensions			
Length	87.4" (2.22m)	174" (4.42m)	191" (4.85m)
Width	37.2" (0.94m)	74.5" (1.89m)	74.5" (1.89m)
Height	54" (1.37m)	78" (1.98m)	78" (1.98m)
Weight (approx.)	2,360 lbs (1,070kg)	4,800 lbs (2,177kg)	5,600 lbs (2,540kg)

TIER 3 EXPORT		TIER 4 FINAL			
TK 50	**TK 70**	**TK 40**	**TK 50**	**TK 60HP**	**TK 70**
54 yd^3/hr (41m^3/hr)	74 yd^3/hr (57m^3/hr)	40 yd^3/hr (30m^3/hr)	54 yd^3/hr (41m^3/hr)	60 yd^3/hr (46m^3/hr)	74 yd^3/hr (57m^3/hr)
1,150 psi (79 bar)	1,130 psi (78 bar)	1,150 psi (79 bar)	1,150 psi (79 bar)	1,450 psi (100 bar)	1,130 psi (78 bar)
1.50" (38mm)	1.50" (38mm)	1.50" (38mm)	1.50" (38mm)	1.50" (38mm)	1.50" (38mm)
6" x 39" (150x1,000mm)	7" x 39" (180x1,000mm)	6" x 39" (150x1,000mm)	6" x 39" (150x1,000mm)	6" x 39" (150x1,000mm)	7" x 39" (180x1,000mm)
43	44	31	43	48	44
0 to full	0 to full	0 to full	0 to full	0 to full	0 to full
6" x 5" (150x125mm)	7" x 5" (180x125mm)	6" x 5" (150x125mm)	6" x 5" (150x125mm)	6" x 5" (150x125mm)	7" x 5" (180x125mm)
2	2	2	2	2	2
46 gal (175L)	46 gal (175L)	46 gal (175L)	44 gal (167L)	44 gal (167L)	44 gal (167L)
49" (1,245mm)	49" (1,245mm)	49" (1,245mm)	49" (1,245mm)	49" (1,245mm)	49" (1,245mm)
9.5 cu ft (270L)	9.5 cu ft (270L)	9.5 cu ft (270L)	9.5 cu ft (270L)	9.5 cu ft (270L)	9.5 cu ft (270L)
5" HD (125mm)	5" HD (125mm)	5" HD (125mm)	5" HD (125mm)	5" HD (125mm)	5" HD (125mm)
Deutz TCD2012L04m	Deutz TCD2012L04m	Deutz TD2.9L4	Cummins QSF3.8	Cummins QSF3.8	Cummins QSF3.8
100 hp (75kW)	100 hp (75kW)	74 hp (55kW)	100 hp (75kW)	130 hp (97kW)	100 hp (75kW)
26 gal (98L)	26 gal (98L)	26 gal (98L)	28 gal (105L)	28 gal (105L)	28 gal (105L)
Single	Single	Single	Single	Single	Single
7,000 lbs (3,175kg)	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)
LT 235/85R16G	LT 235/85R16G	LT 235/85R16G	LT 235/85R16G	LT 235/85R16G	LT 235/85R16G
Electric	Electric	Electric	Electric	Electric	Electric
Manual	Manual	Manual	Manual	Manual	Manual
191" (4.85m)	191" (4.85m)	191" (4.85m)	191" (4.85m)	191" (4.85m)	191" (4.85m)
74.5" (1.89m)	74.5" (1.89m)	74.5" (1.89m)	74.5" (1.89m)	74.5" (1.89m)	74.5" (1.89m)
90" (2.28m)	90" (2.28m)	81.5" (2.07m)	87" (2.21m)	87" (2.21m)	87" (2.21m)
6,200 lbs (2,810kg)	6,500 lbs (2,950kg)	6,000 lbs (2,720kg)	6,700 lbs (3,040kg)	7,000 lbs (3,175kg)	7,000 lbs (3,175kg)

† Optional electric versions have decreased output.

Maximum theoretical values listed. Maximum attainable distances depend on concrete mix design, pipeline diameter and specific job site conditions. Note: Max output and pressure can't be achieved simultaneously. Specifications subject to change without prior notice. Weights vary with options selected. Photos for illustrative purposes only. Refer to Putzmeister operational manual for safe and proper equipment operation.

Appendix B

CDM Smith ISS Pilot Study Daily Reports and Photolog

CDM Smith

CDM Smith

Daily Report

CDM Smith Inc.

September 20, 2021

Project Name: USG Puyallup ISS Pilot Study
Project Number: 261175
Owner: USG
Project Manager: Pam Morrill

	Daily Job Report #		Work Day #	1
	Day of Week	Monday	Weather	Overcast AM Partly Cloudy PM
CDM Smith Representative: Haley Provinsal	Temp @ 8:00 am	66	Temp @ 2:00 pm	68
Signature: [signature]	High Temp.	70	Low Temp.	50

Visitors (include time)	
Supplier (include time/material received)	

No. of Workers	Postion (trade) of Subcontractors	Hours	**Extent of Work** complete description of days activity
4	Keller		Unloading trucks and putting together drill rig

Verbal Directives	None
Changes from Specification	None
Backcharges and/or extra work	None

CDM Smith

Daily Report (Cont.)

Date: September 20, 2021

Time	Notes
~0900	Drill rig arrives on site
~1000	First delivery truck arrives on site with rig materials
~1200	Crane onsite to assist in putting drill rig together
1300 ~~1400~~ hr	Crane offsite
1700	All work complete for the day. All personnel off site. No further entries.

[signature] 9/20/2021

Equipiment on Project	Hours	Description of Operation of Equipment
Forklift		Unloaded trucks as they arrived
Crane	2	Used to set up drill rig
Drill Rig	Ø	
Excavator	Ø	
Boom Lift		Used to setup drill rig

CDM Smith

Daily Report

CDM Smith Inc.

September 21, 2021

Project Name	USG Puyallup ISS Pilot Study
Project Number	261175
Owner	USG
Project Manager	Pam Morrill

CDM Smith Representative: Haley Provinsal

Signature: [signature]

Daily Job Report #		Work Day #	2
Day of Week	Tuesday	Weather	Sunny
Temp @ 8:00 am	70	Temp @ 2:00 pm	75
High Temp.	79	Low Temp.	43

Visitors (include time)	
Supplier (include time/material received)	

No. of Workers	Postion (trade) of Subcontractors	Hours	**Extent of Work** complete description of days activity

Verbal Directives	
Changes from Specification	
Backcharges and/or extra work	

CDM Smith

Daily Report (Cont.)

Date: September 21, 2021

Time	Notes
0700	No site activity for the day
1400	Kick off meeting (virtual) between CDM Smith and Keller.
1700	No further entries.

[signature] 9/21/2021

Equipiment on Project	Hours	Description of Operation of Equipment
Forklift	Ø	
Drill Rig	Ø	
Excavator	Ø	
Boom Lift	Ø	

CDM Smith
Daily Report
CDM Smith Inc.

September 22, 2021

Project Name: USG Puyallup NS Pilot Study
Project Number: 261175
Owner: USG
Project Manager: Pam Morrill

CDM Smith Representative: Haley Provinsal	Daily Job Report #		Work Day #	3
Signature: [signature]	Day of Week	Wednesday	Weather	cloudy
	Temp @ 8:00 am	55	Temp @ 2:00 pm	
	High Temp.	68	Low Temp.	53

Visitors (include time)	
Supplier (include time/material received)	

No. of Workers	Postion (trade) of Subcontractors	Hours	**Extent of Work** complete description of days activity

Verbal Directives	
Changes from Specification	
Backcharges and/or extra work	

CDM Smith

Daily Report (Cont.)

Date: September 22, 2021

Time	Notes
~1000	2 Keller workers onsite to continue working on drill rig set up
1430	2 additional Keller workers on site to work on drill rig.
1500	2 additional Keller worker onsite
1505	Truck load containing 3 pieces arrives onsite (pumps)
1600	Truckload with equipment and materials arrives onsite
1630	All work complete for the day
1700	All personnel off site. No Further entries.

HKP 9/22/2021

Equipment on Project	Hours	Description of Operation of Equipment
Forklift	2	Used to unload trucks throughout the afternoon
Excavator	Ø	
Drill Rig	Ø	
Boom Lift		Used to set up drill rig

CDM Smith

Daily Report

CDM Smith Inc.

9/23/2021

Project Name	USG Puyallup
Project Number	264 // 261175
Owner	USG
Project Manager	PAM MORRILL

Daily Job Report #	~~34~~	Work Day #	~~34~~ 118
Day of Week	THURSDAY ~~TUES~~	Weather	CLEAR
Temp @ 8:00 am	55	Temp @ 2:00 pm	EST 75 F
High Temp.		Low Temp.	

CDM Smith Representative: MATTHEW SCHULTZ

Signature: [signature]

Visitors (include time)		
	Andy Smith – Ecology –	~~2:30~~ 14:30 – 16:15

No. of Workers	Postion (trade) of Subcontractors	Hours	**Extent of Work** complete description of days activity
6	KELLER	06:45	START – SAFETY ORIENTATION / STRETCHING
	ANDY, KEVIN, LEE		
1	TRAVIS – SUPERINTENDENT		
2	CORLISS – Concrete drilling & pumping – approx 10:45–1:30	10:45–1:30	
	2nd CORLISS crew	1:30–4:30 pm	

Verbal Directives	NONE
Changes from Specification	NONE
Backcharges and/or extra work	none indicated

PM-0029

CDM Smith

Daily Report (Cont.)

Date: 9/23/2021

Supplier	9/23 ~~Date~~ In	Date Out	Material Received
CORLISS - TRUCK 1	~~9/23~~ 10:45		REDI MIX BLEND
TRUCK 2	13:20		REDIMIX BLEND

Time	Notes	Time	Notes
07:00 ~~0:70~~	BEGIN EQUIPMENT SET UP		
	TRAVIS PLAN FOR JHA AT 10:00		
08:00	HALEY ARRIVES		
08:15	DYLAN FISHER - KELLER ARRIVES		
09:09	AMY ; JOSH - KELLER ARRIVE (SAFETY)		
08:00 -	SET UP CONTINUES - HOSE CONNECTION		
10:30	ATTACH 'TOOL' TO SHAFT		
	EXCAVATOR MOVES TO TEST LOCATION		
10:45	FIRST load of cement/water/ bentonite ARRIVES		
11:00	JSA MEETING - GROUP DISCUSSION -		discussed ARSENIC ISSUE ; DECON roundtable discussion ; lifting plan
11:10	FIRST BATCH MIX ~~[illegible]~~ BEGINS		
1:20	Second truck —		LOST TOOTH ON DRILL TOOL
≈ 16:00	Started 2nd core		TRAVIS TO SHOP TO REPLACE IT
≈ 16:30	completed 2nd core		replaced first concrete pump w/ 2nd
15:30	process / weigh cylinders -	- 15:45	secured site ; site
16:00	depart site -		

Equipment on Project	Hours	Description of Operation of Equipment
JCB 512 REACH FORK	all day	
KOBELCO MINI EX w/ CLEANOUT BUCKET		INTERMITTENT USE ALL day
(2) SERVICE / PICKUP TRUCKS		
DRILL RIG - BAUER BG24H	STARTS w/ work 3 10:30	NOTE - 1 #1 CONCRETE PUMP (TK20)
GENIE 4X4 MANLIFT		WAS NOT OPERATING EFFICIENTLY
2 KELLER MIX TRAILERS - TK40		SWAPPED OUT FOR BACKUP TK20

MISC HOSES

JOB BOX

2 x 5000-gal water tanks

1 BATCH / BENTONITE tanks plant // WACKER / NEUSON GENSET (NOT USED)

CDM Smith
Daily Report
CDM Smith Inc.

9/24/2021

Project Name: USG puyallup pilot test
Project Number: 261175 / 264
Owner: USG
Project Manager: PAM MORRILL

Daily Job Report #	5	Work Day #	5
Day of Week	Friday	Weather	High cloud
Temp @ 8:00 am	52	Temp @ 2:00 pm	71 F
High Temp.		Low Temp.	

CDM Smith Representative: MATTHEW SCHULTZ
Signature: [signature]

Visitors (include time)	UNITED RENTALS - MAINTENANCE 125 ON 3+
Supplier (include time/material received)	08:39 - SCHWING CONCRETE PUMP 09:00 - FIRST CORLISS REDIMIX BATCH ~11:00 SECOND COMES 12:45 THIRD COMES

No. of Workers	Postion (trade) of Subcontractors KELLER	Hours	Extent of Work complete description of days activity
3	OPERATORS		BLAINE ; NORM ANDY
7	LABOR/ operator		TIM LEE, —, —
1	SUPERINTENDENT - TRAVIS MCMANIGAN		
			(Schultz)
1	CDM SMITH CONSTRUCTION MANAGER - 06:45 -		
1	CDM SMITH GEOTECH OVERSIGHT / SAMPLER (HALEY) 08:25 -		
1	KELLER PM (OYLAN FISHER - ARRIVED 09:45		
1	KELLER DAQ EXPERT FROM CALIFORNIA OFFICE		

Verbal Directives	TO BLAINE - ROUND OFF EDGE OF GRAVEL WORK PLATFORM - LEAVE PLATFORM IN PLACE
Changes from Specification	/
Backcharges and/or extra work	/

CDM Smith

Daily Report (Cont.)

Date: 9/24/2021

Time	Notes
06:45	ARRIVE & SAFETY BRIEFING / DISCUSSION
07:15 - 07:00	- STRETCHING EXERCISES & SUMMARY FROM YESTERDAY/
	NOTES FROM TRAVIS MCMANIGAL - 1) will set new concrete backup pump
	2) on CORLISS READI-MIX delivery
	expected 09:00, 10:30, 12:00
0839	Schwing concrete pump ARRIVES
0900	1st CORLISS REDIMIX BATCH ARRIVES
0900 - 11:00	MIXING BENTONITE - ADDING FE SULFATE - 4 passes
	coring into 2nd core from yesterday
0945	DYLAN FISHER ARRIVES
11:15	500 gall water delivered to site by KELLER
11:15 - 11:30	SAMPLES COLLECTED
NOON	second core begun
done 12:30	- stopped at 31' BGS
12:45 - 14:00	3rd core
13:25	UNITED RENTALS - MAINTENANCE truck on site
14:00	coring complete to 32' bgs - wood debris present / gritty to ~30'
14:36	DYLAN DEPARTS
14:30 -	CLEANUP.
16:30	depart site

Equipment on Project	Hours	Description of Operation of Equipment
JCB 512 REACH FORK		OPERATIONS AT WORK PLATFORM
SAUER B624 drill rig + drill tool		LARGELY COMPLETE AT 14:30
GENIE 4x4 MANLIFT		
KELLER TK20 - concrete pump		
KELLER BENTONITE BATCH PLANT		
KUBOTA MIN EXCAVATOR		
2 x 4000-gal water tanks		

KELLER TK-15 concrete pump

Picture Date:	Saturday 08/28/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Debris found near asphalt and fence (contained large blocks of cement, bricks, and trash)

Picture Date:	Saturday 08/28/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Land clearing

Picture Date:	Saturday 08/28/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Debris pile

Picture Date:	Saturday 08/28/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Land clearing

Picture Date:	Saturday 08/28/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Land clearing with installation of straw waddles

Picture Date:	Friday 09/10/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Removal of fencing along River Road

Picture Date:	Friday 09/10/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Temporary fence prior to be connected to original fence (middle of apple tree)

Picture Date:	Thursday 09/16/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Laying down liner in preparation of gravel and rock delivery for rock ballast and working pad

Picture Date:	Thursday 09/16/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Placement of rock ballast

Picture Date:	Thursday 09/16/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Delivery of 2 water tanks and water

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Gravel and rock delivery

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Surveyed locations for 5 columns (includes 5 column bundle and offsets for each column)

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Surveyed locations for 5 columns (includes 5 column bundle, 2 column bundle, and offsets for each column)

Picture Date:	Thursday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	New post for new gate on western side of River Road entrance

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	New post for new gate on eastern side of River Road entrance

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Equipment on site

Picture Date:	Friday 09/17/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Placement of rock ballast and rock/gravel pad

Picture Date:	Monday 09/20/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS Drill Rig arrived on site

Picture Date:	Monday 09/20/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Unloading equipment

Picture Date:	Monday 09/20/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Setting up the drill rig

Picture Date:	Wednesday 09/22/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Working on the connections on the drill rig

Picture Date:	Wednesday 09/22/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Truck delivery with 3 pumps

Picture Date:	Wednesday 09/22/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Unloading a pump off the trailer

Picture Date:	Wednesday 09/22/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Truck delivery with additional equipment and mixing materials

Picture Date:	Wednesday 09/22/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Placement of equipment and materials at the end of the day

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Drill head and port

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Prepping for ISS-1

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Mixing Ferrous Sulfate Heptahydrate into the cement truck

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Mixing ISS-1

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Final spoils for ISS-1

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Mounting the sampling box onto the rig

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Mixing ISS-2

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Spoils pile following ISS-2

Picture Date:	Thursday 10/29/2009
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Concrete pump, Concrete truck, and grout line set up

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Pallet of Ferrous Sulfate Heptahydrate

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Mixing bentonite mixture

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Recovering ISS-2 Sample depth 20-23 ft bgs.

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-2 Sample depth 20-23 ft bgs.

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-2 Sample depth 20-23 ft bgs 3/8” Sieve retained material (gravel, cobbles, and twigs)

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-2 Sample depth 10-13 ft bgs.

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Sieving ISS-2 Sample depth 10-13 ft bgs.

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-2 Sample depth 0-3 ft bgs.

Picture Date:	Thursday 09/23/2021
Picture Taken By:	Matt Schultz
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-2 Sample depth 0-3 ft bgs following the 3/8" sieve with water on top.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-3 Sample depth 23-27 ft bgs.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-3 Sample depth 23-27 ft bgs 3/8” Sieve retained material (gravel, cobbles, and twigs)

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-3 Sample depth 13-17 ft bgs

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-3 Sample depth 13-17 ft bgs 3/8” Sieve retained material (gravel, wood, roots)

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-3 Sample depth 3-7 ft bgs.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-3 Sample depth 3-7 ft bgs 3/8" Sieve retained material (gravel, cobbles, roots)

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-5 Sample depth 27-30 ft bgs

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-5 Sample depth 27-30 ft bgs.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-5 Sample depth 27-30 ft bgs 3/8" Sieve retained material (gravel, cobbles, wood, twigs)

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-5 Sample depth 17-20 ft bgs.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	ISS-5 Sample depth 17-20 ft bgs 3/8" Sieve retained material (gravel, cobbles, twigs)

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-5 Sample depth 7-10 ft bgs.

Picture Date:	Friday 09/24/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	ISS-5 Sample depth 7-10 ft bgs 3/8" Sieve retained material (gravel, cobbles, wood)

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Breaking down Drill rig

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Removing pipe from drill rig for transport

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Status of site following field work

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Drill rig staged for transport

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Equipment remaining on site

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Equipment remaining on site

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Equipment remaining on site

Picture Date:	Monday 09/27/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Drill rig staged for transport

Picture Date:	Wednesday 09/29/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Equipment remaining on site – Drill rig

Picture Date:	Wednesday 09/29/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup Site
Project Description:	Equipment remaining on site - forklift

Picture Date:	Wednesday 09/29/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Equipment remaining on site – temporary fencing

Picture Date:	Friday 10/01/2021
Picture Taken By:	Haley Provinsal
Picture Location:	Puyallup, Washington
Project Name:	USG Puyallup ISS Pilot Study
Project Description:	Status of parking lot after demobilization

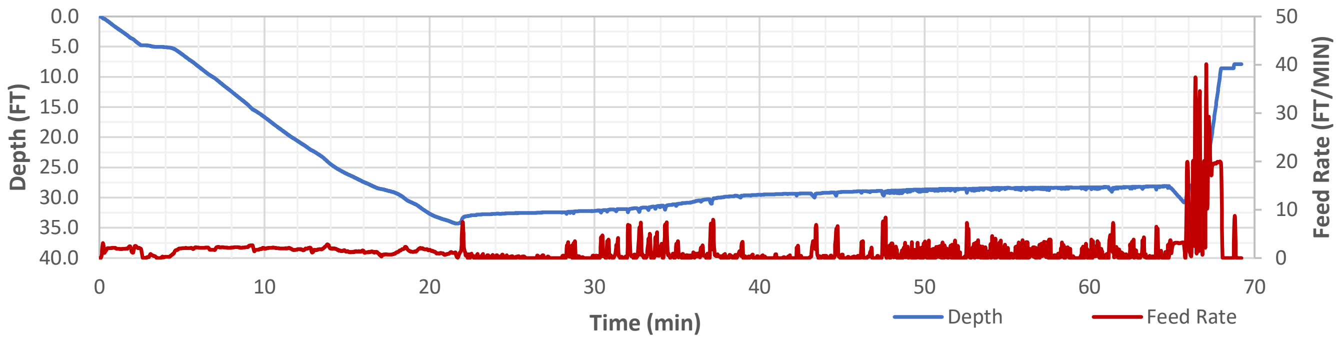
Appendix C

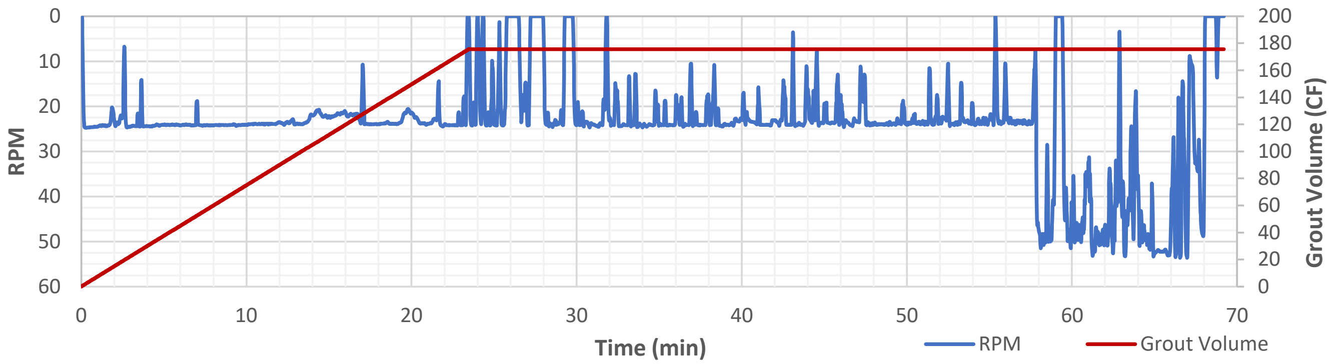
Contractor Daily Reports

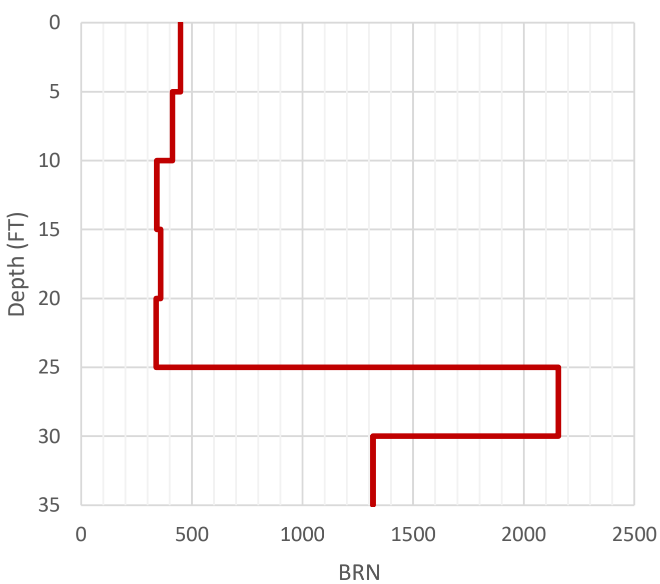
Job Number: 16211028

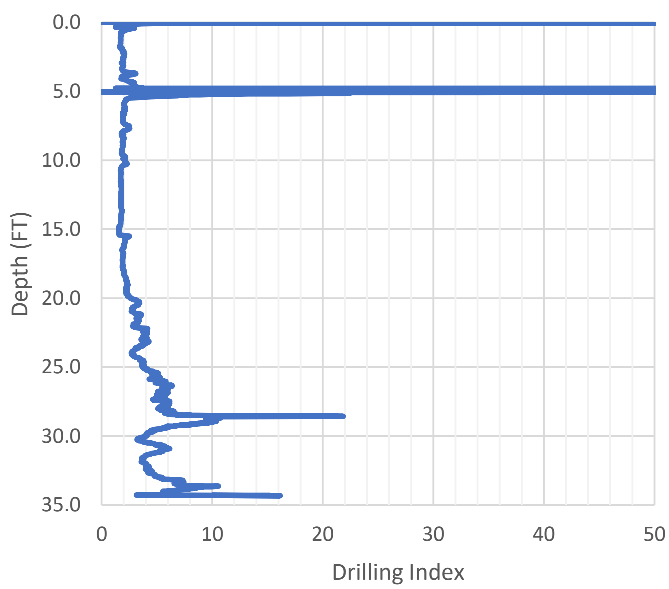
Wet Soil Mixing Log
Puyallup ISS Pilot Program
Column ISS-1

Column Diameter:	3.0 FT	**Date:**	09/23/21	**Notes:**
Column Length:	34.3 FT	**Start Time:**	12:32 PM	*550 PPM Mix Column.
Total Grout Volume:	6.5 CY	**End Time:**	1:41 PM	*Truck pumped out of grout 23 min into install.
Grout Injection Rate:	7.5 CFM	**Total Time:**	1:09:12	*SMX tool stuck duiring removal.
				*Swapped TK pumps between holes.







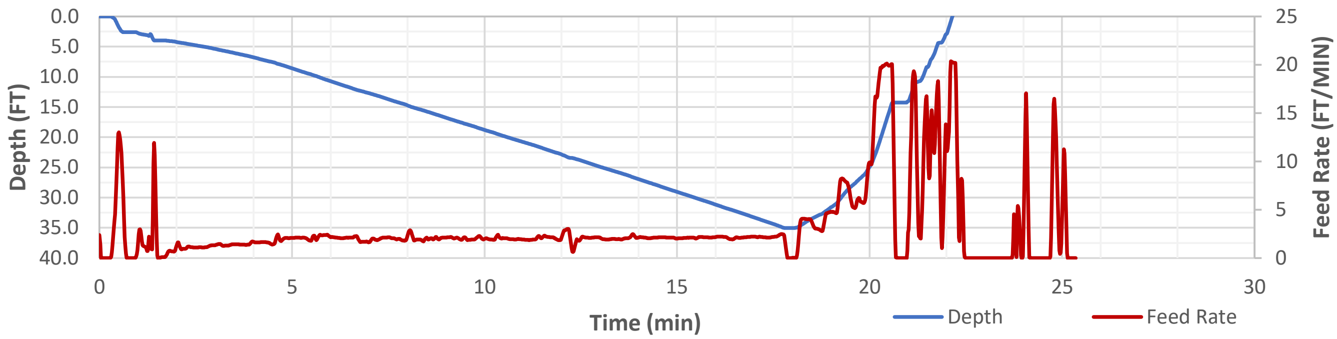


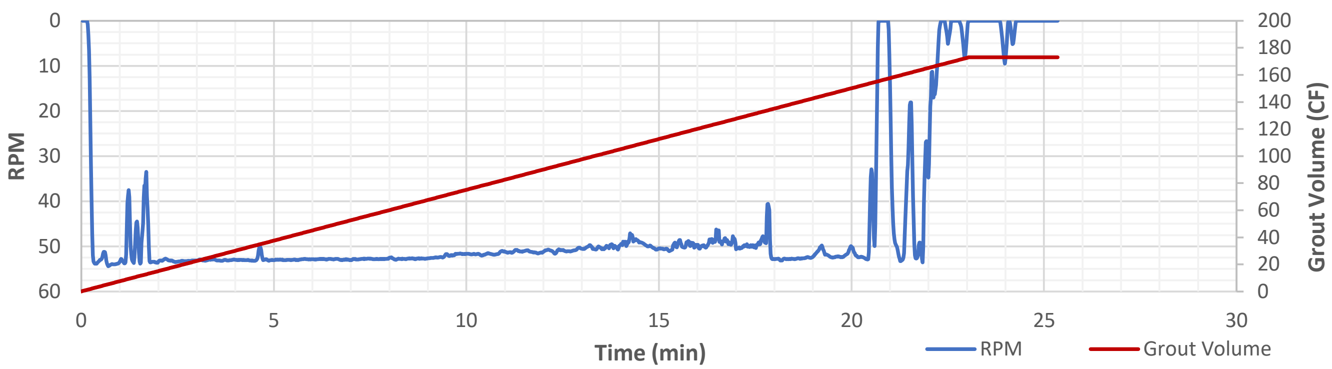
THINK SAFE

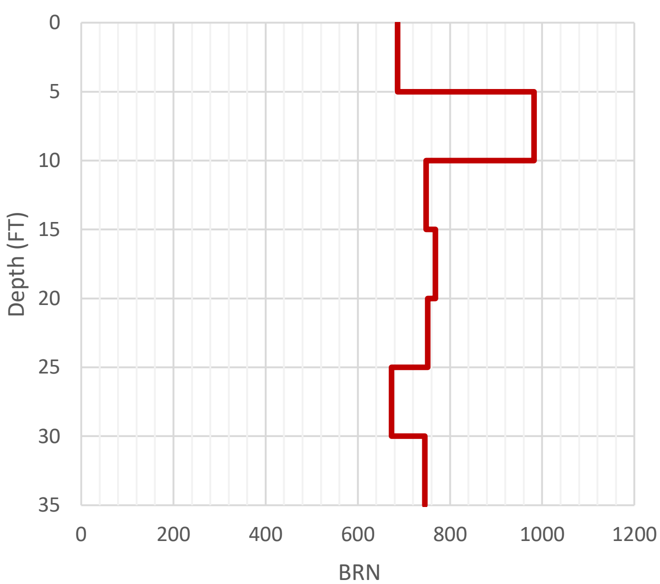
Job Number: 16211028

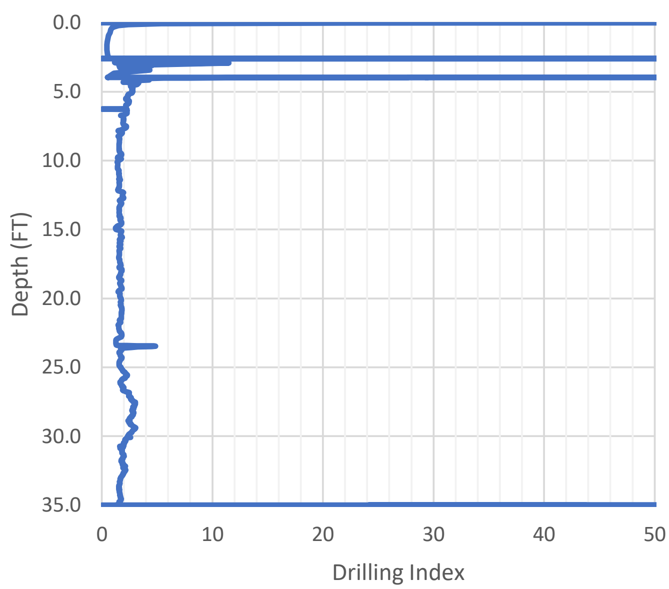
Wet Soil Mixing Log
Puyallup ISS Pilot Program
Column ISS-2

Column Diameter:	3.0 FT	**Date:**	09/23/21	**Notes:**
Column Length:	35 FT	**Start Time:**	3:54 PM	*550 PPM Mix Column. (CDMS Sampled)
Total Grout Volume:	6.4 CY	**End Time:**	4:19 PM	*Truck pumped out of grout 23 min into install.
Grout Injection Rate:	7.5 CFM	**Total Time:**	0:25:21	









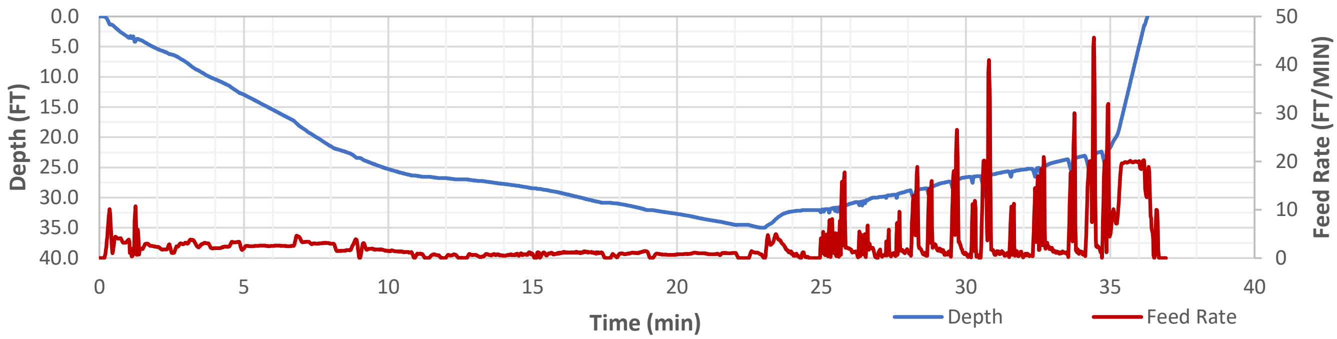
THINK SAFE

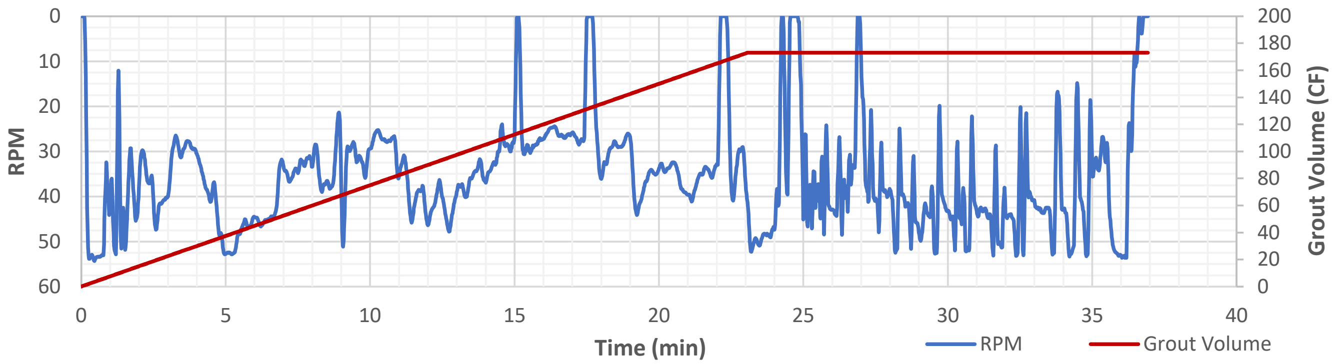
Job Number: 16211028

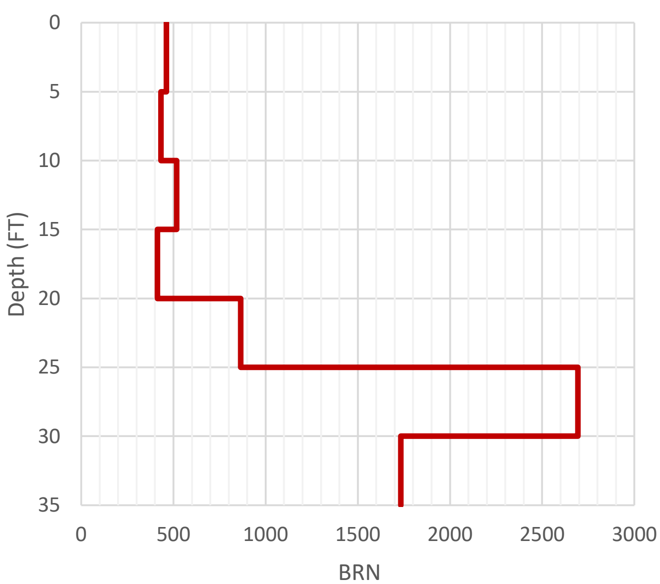
Wet Soil Mixing Log
Puyallup ISS Pilot Program
Column ISS-3

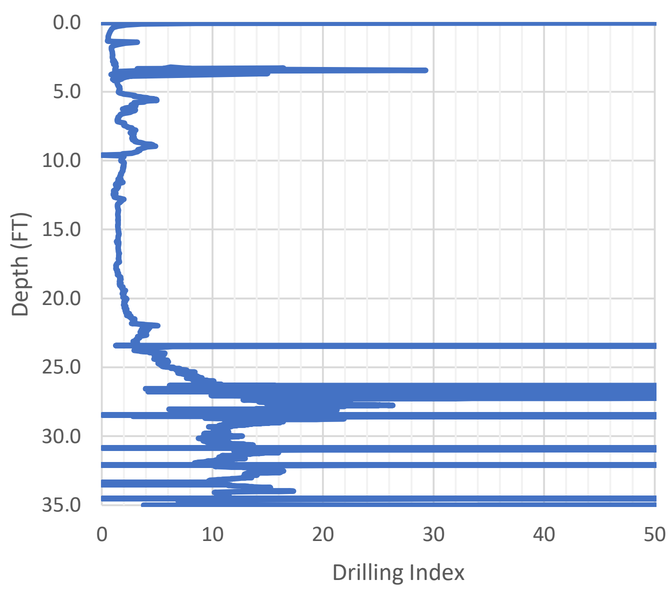
Column Diameter:	3.0 FT	**Date:**	09/24/21
Column Length:	35 FT	**Start Time:**	10:00 AM
Total Grout Volume:	6.5 CY	**End Time:**	10:37 AM
Grout Injection Rate:	7.5 CFM	**Total Time:**	0:36:56

Notes:
*550 PPM Mix Column. (CDMS Sampled)
*Slow penetration due to adjacent columns ISS-1 and ISS-2 installed 9/23/21.
*Truck pumped out by 23 min. 4X additional mixing passes w/o grout.









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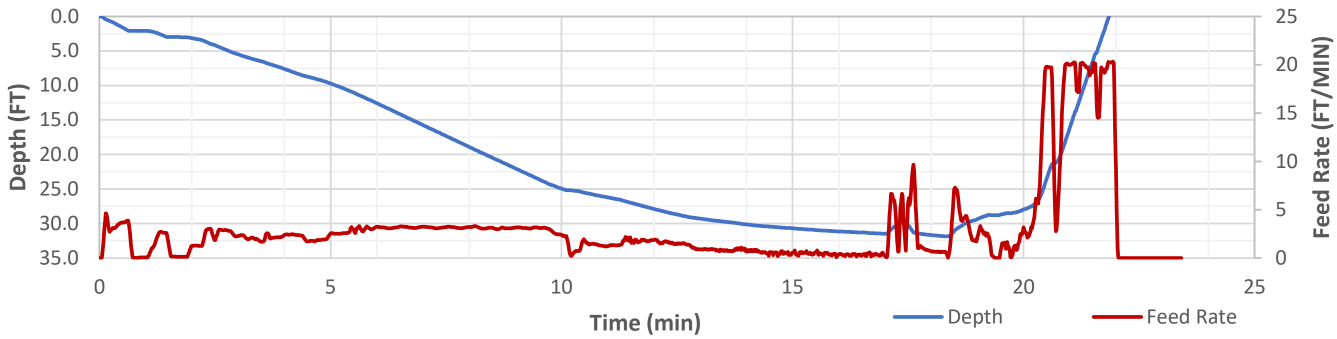
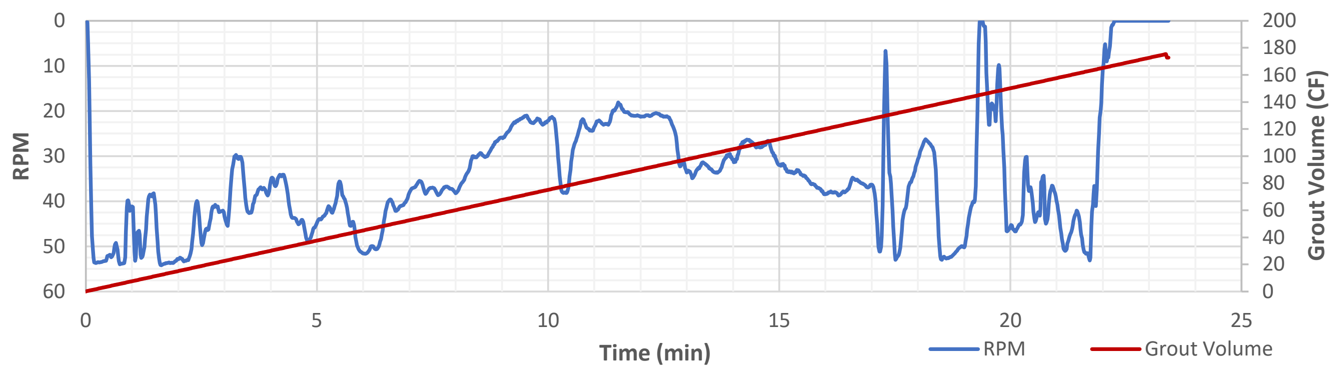
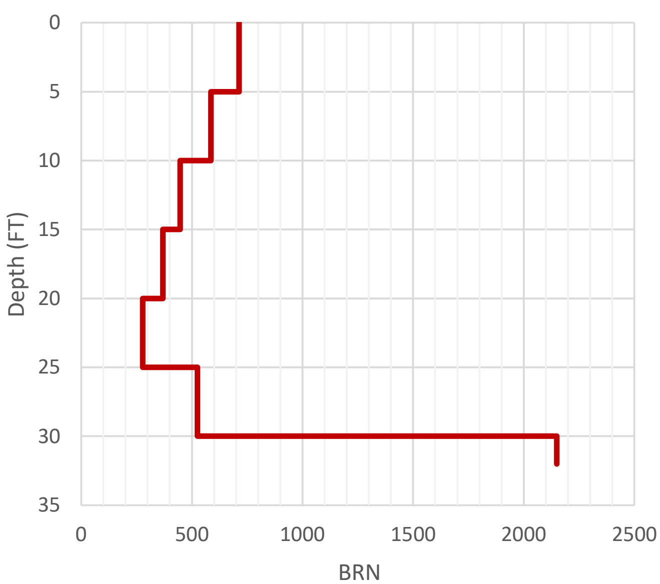
Job Number: 16211028

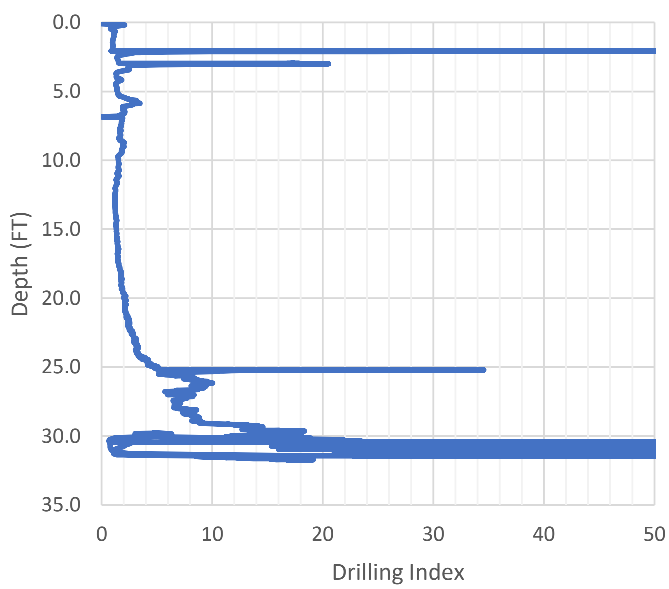
Wet Soil Mixing Log
Puyallup ISS Pilot Program
Column ISS-4

Column Diameter:	3.0 FT	**Date:**	09/24/21	**Notes:**
Column Length:	31.9 FT	**Start Time:**	11:42 AM	*850 PPM Mix Column.
Total Grout Volume:	6.5 CY	**End Time:**	12:05 PM	*Refusal at 31.9 ft.
Grout Injection Rate:	7.5 CFM	**Total Time:**	0:23:25	*Truck pumped out of grout. Mixed slow w/o adding grout on the withdrawal.









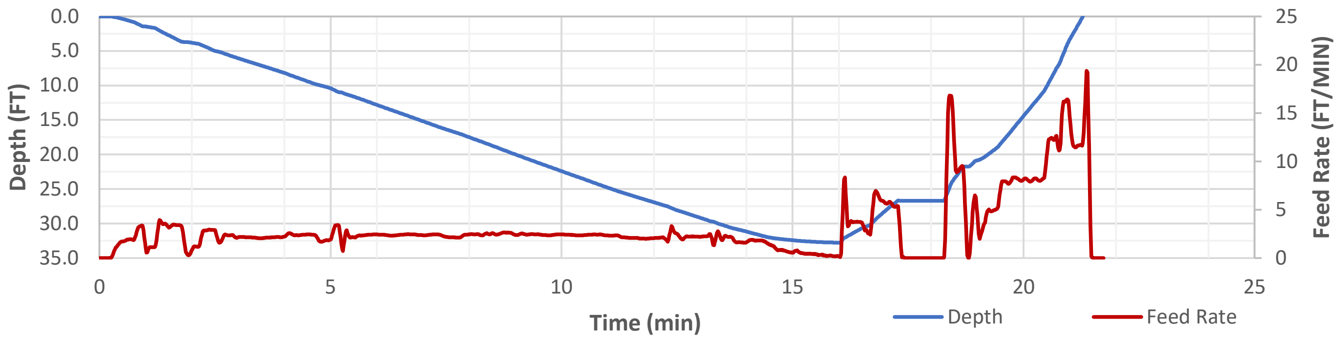
THINK SAFE

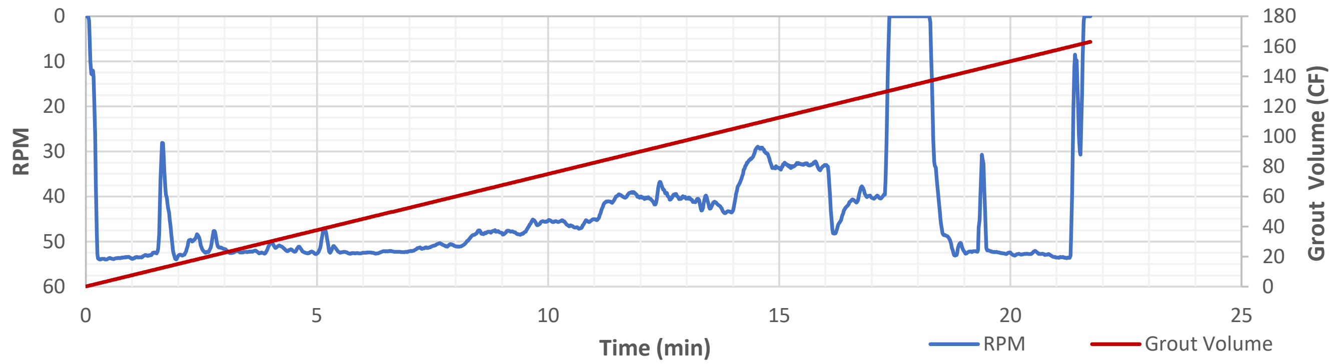
Job Number: 16211028

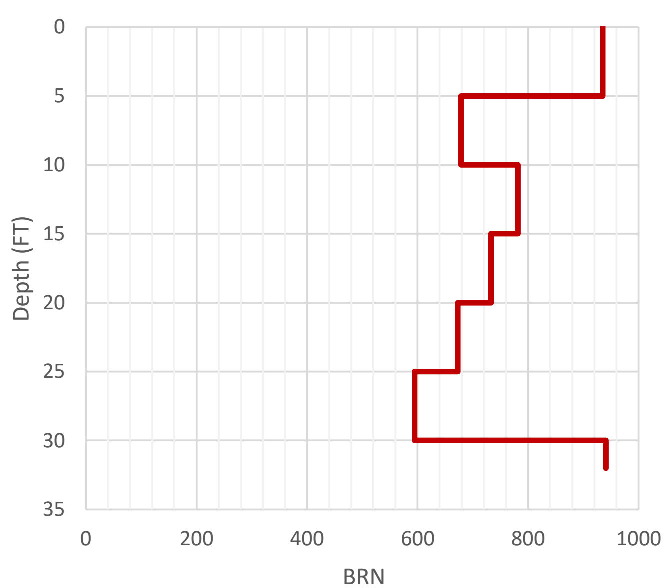
Wet Soil Mixing Log
Puyallup ISS Pilot Program
Column ISS-5

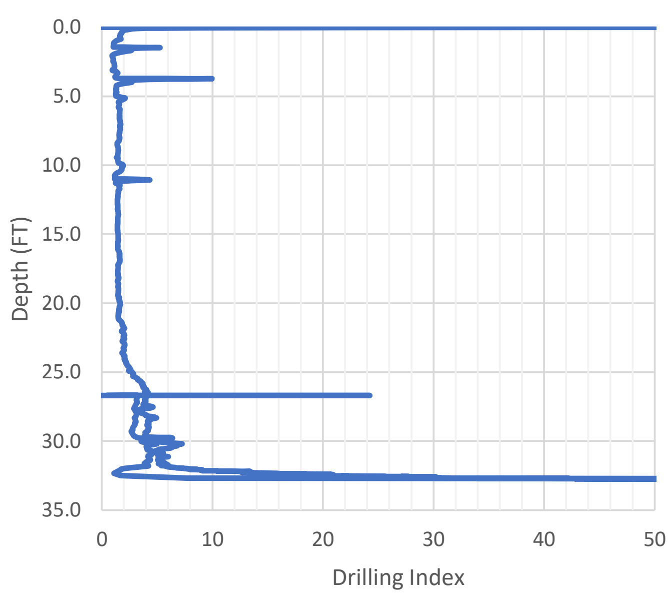
Column Diameter:	3.0 FT	**Date:**	09/24/21
Column Length:	32.8 FT	**Start Time:**	1:06 PM
Total Grout Volume:	6.0 CY	**End Time:**	1:27 PM
Grout Injection Rate:	7.5 CFM	**Total Time:**	0:21:44

Notes:
*850 PPM Mix Column. (Sampled by CDMS)
*Refusal at 32.8 ft.
*Column was mixed w/o adding grout 5X after initial mixing pass before sampling.









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Appendix D

CDM Smith SDL Standard Operating Procedures

Synthetic Precipitation Leaching Procedure and Semi-Dynamic Leaching Procedure on Amended Soils	Laboratory-Specific SOP: DTL 1-10 Revision: 1 Date: November 28, 2017

Prepared:	Todd Burgesser	**Technical Review:**	Roger Olsen
Lab Manager:	Todd Burgesser	**Editorial Review:**	Traci Mordell
Laboratory Name:	CDM Smith Denver Treatability Laboratory (DTL)		

1.0 Overview and Application

This technical standard operating procedure (SOP) describes the laboratory procedures that will be followed to prepare and leach composite soil and stabilized and solidified soils for leaching by the synthetic precipitation leaching procedure (SPLP) by modified EPA SW-846 1312 and the semi-dynamic leaching procedure (SDL) by modified EPA 1315 and ASTM 1308. All procedures will be performed in the CDM Smith Denver Treatability Laboratory (DTL). The SPLP and SDL procedures have the options of using extraction fluid #1 at a pH of 4.2 (site location east of the Mississippi River), extraction fluid #2 at a pH of 5.0 (site location east of the Mississippi River), site groundwater, or synthetic water formulated to replicate a specific process water. The SPLP procedure will be modified to use a 2:1 liquid to solid ratio. The SDL procedure will be modified to incorporate nine sampling intervals at times contained in both ASTM 1308 and EPA 1315. These sampling intervals will be 2 hours, 24 hours, 48 hours, 72 hours, 7 days, 14 days, 21 days, 28 days, and 42 days. The solidified cylinders or stabilized soils will be leached using the selected SPLP water (discussed above). The liquid to surface area ratio will be maintained at approximately 10:1 milliliter per square centimeters. All leaching procedures will be performed in the CDM Smith DTL.

2.0 Associated Procedures

- SOP 1-2 Sample Custody
- SOP 4-1 Logbook Documentation

3.0 General Responsibilities

Laboratory Manager – The laboratory manager is responsible for ensuring that laboratory personnel are trained in the use of this procedure, the required equipment, and health and safety procedures and that soil samples are prepared in accordance with this procedure and any other SOPs pertaining to laboratory procedures. The laboratory manager must also ensure that the quantity and type of quality assurance samples collected meet the requirements of the work plans.

4.0 Project Planning

This section provides a list of general equipment used for sample preparation operations and health and safety considerations.

4.1 General Equipment

- Site-specific plans (e.g., sampling, work, health and safety)
- Laboratory logbook
- Indelible black ink pens and markers
- Appropriate sample containers
- Labels and appropriate forms/documentation for sample shipment
- Nitrile or appropriate gloves
- Sample containers
- Ice/Refrigerators
- Plastic cylinders with endcaps (2- x 6-inch)
- Disposal spatulas, spoons, and other miscellaneous equipment.
- Twelve-inch 2-millimeter stainless steel sieve
- Extraction fluid
- Peristaltic pump
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon®-lined spatulas and pans and knives, trays, bowls, trowels, or spoons
- Decontamination supplies
- Sample chain-of-custody forms
- Laboratory grade oven capable of 160°C +/- 2°C
- Riffle splitter with catch pans (1/2- or 3/4-inch)
- Stainless steel bowls
- Rotary tumbler
- Analytical balance (0.01 gram [g] accuracy)
- Polytetrafluoroethylene (PTFE) bottles – 500 to 1000 milliliters (mL)

- pH meter with pH electrode and oxidation reduction potential (ORP) electrode
- Borosilicate glass beakers (various sizes)
- Silicon tubing
- Conductivity meter

5.0 Modified SPLP Procedure

After preparation of the soils samples, the following steps should be taken to leach the desired materials by SPLP:

1. Label the appropriate-sized PTFE bottles with the relevant sample identifications of samples to be leached.
2. Transfer the appropriate mass of the soil to the tared PTFE bottles and weigh to the nearest 0.1 g. Record the mass.
3. Quantitatively add the selected extraction fluid to each bottle (general ratio is 1:2, g/mL). Record the exact volume added.
4. Securely cap each bottle and invert the bottle to mix the soil and extraction fluid.
5. Uncap the bottles and measure the solution pH, ORP, and conductivity and record the measurements.
6. Cap the bottles and secure the cap with electrical tape.
7. Place each bottle in the rotary tumbler drum and pack the drum with bubble wrap to secure the bottles. Place the lid on the drum.
8. Rotate the bottles for 24 hours at 30 revolutions per minute.
9. After the 24 hours tumbling time, remove the sample bottles from the tumbler and allow them to sit for 30 minutes to settle the solids.
10. Remove the caps from the bottles and measure the pH, ORP, and conductivity and record the measurements.
11. Decant the solution into a labeled preserved sample bottle for analysis of total mercury.
12. Submit the samples to the contracted laboratory for total mercury analysis.

6.0 Modified SDL Procedure

The SDL procedure can be performed on either solidified solid materials (a monolith generally molded in a 2- x 6-inch cylinder) or on loose chemically stabilized soil (compacted granular material).

1. Label the selected leaching vessels (hermetic glass jar with lid and a rubber gasket, preventing contact with the leaching fluid or PTFE bottles).
2. For loose chemically stabilized material, compact the soil in a mold that matches the inside diameter of the leaching vessel. This vessel should have an opening that is equivalent or slightly larger than the bottom of the vessel (1-liter [L] beaker). Granular samples are compacted into the sample holder using a variation on the modified Proctor compaction (see Ref. 5) to include the use of 6-centimeter (cm) high-test molds. Shorter or taller molds (or packing depths) may be used as long as the compaction effort of 56,000 ft-lbf/$ft^3$is achievable. The number of packing layers should be five layers. Compaction can be performed in the leaching vessel if the vessel is sturdy enough to withstand the compaction efforts.
3. For solidified monolith samples, measure the mass and dimensions of each unmolded cylinder. Each 2- x 3-inch cylinder should have an approximate surface area of 200 square centimeters. Record the measurements and calculate the surface area. For compacted granular materials, measure the surface area of the surface that will be in the direction of mass transfer (directly in contact with the leaching fluid).
4. For monolith molded samples, suspend each cylinder (mold removed) in the leaching vessel by constructing a sling out of Teflon disks (top and bottom) and Teflon string. Place the cylinder between the disks and secure with the Teflon string. Attach the Teflon string to the outside of the vessel with packaging tape. The Teflon disks are designed in a way to contact the cylinder or core minimally at the very edges of the top and bottom of the cylinder. Suspend the cylinder at a minimum of 1 cm from the bottom and walls of the leaching vessel (glass jar). The Teflon string should not come into contact with the cylinder.
5. For compacted granular materials, place the molded compacted material directly in the bottom of the vessel.
6. Quantitatively transfer the appropriate volume of extraction fluid to the vessels. The volume of extraction fluid will equal the surface area of the cylinder times 10.

7. At the specified sampling intervals (2 hours, 24 hours, 48 hours, 72 hours, 7 days, 14 days, 21 days, 28 days, and 42 days), open the leaching vessel and transfer the leachate to a 2-L glass beaker with a peristaltic pump and clean silicon tubing. Every attempt should be made not to touch or disturb the cylinder.
8. Measure the pH, ORP, and conductivity of the leachate contained in the 2-L beakers and record the measurements.
9. Transfer the leachate to the appropriate preserved sample bottles and submit to the contracted laboratory for analysis.
10. Repeat steps 4 through 7 for each sampling interval.

7.0 Equipment Cleaning Procedures

To ensure that samples are not contaminated by equipment or containers, it is necessary to follow certain procedures for cleaning or decontaminating equipment. All equipment in direct contact with the sample must be cleaned between each sample. Decontamination procedures for this equipment are discussed below:

1. Rinse all surfaces of the glassware with deionized or distilled water.
2. Using a spray bottle, apply a layer of phosphate-free detergent to all surfaces.
3. Vigorously scrub all surfaces of glassware.
4. Rinse all surfaces again with deionized or distilled water until all detergent has been removed. Perform in triplicate.
5. Place the equipment in the drying rack. To accelerate drying, the equipment can be place in the oven at 60°C until dry.

8.0 Quality Control

Two types of quality control samples (laboratory duplicates and equipment blanks) will be prepared as described below:

8.1 Laboratory Duplicates

When adequate sample volumes are available, a laboratory duplicate sample will be prepared following the preparation of the original sample at a rate of 1 per 20 samples. The laboratory duplicate sample will be treated in the same manner as the original sample. The relative percent difference (RPD) between the original and the laboratory duplicate will be calculated as described below. Corrective action for the initial calibration is to investigate the outlying level and reanalyze that level. If the problem is not corrected, it may be necessary to remake the standard or correct the problem with the instrument and reanalyze all levels.

$$\mathbf{RPD = (D^1 - D^2)/([D^1 + D^2]/2)x100}$$

Where: RPD = relative percent difference
D^1 = first sample value
D^2 = second sample value (laboratory duplicate)

8.2 Equipment Blanks

Equipment blanks are collected after equipment decontamination. Place a suitable-sized aliquot (50 g) of sand into a drying pan and follow the procedure outlined in Sections 5 and 6. Equipment blank samples are prepared at a rate of 1 per 20 samples.

9.0 Documentation

Bound laboratory logbooks shall be used for the maintenance of laboratory records. All aspects of sample preparation and visual observations shall be documented in the laboratory logbooks. The soil drying and splitting logs, documenting the sequence and results for each day's activities, shall be filled out during preparation of all samples. All entries in laboratory logbooks should be legibly recorded and contain accurate and inclusive documentation of an individual's activities. Corrections to logbook and run log entries will be accomplished by a single cross out with the date and initials of the person making the entry. Correction fluid or correction tape is not permitted. Logbooks will be maintained in accordance with SOP DTL 4-1.

METHOD 1315[1]

MASS TRANSFER RATES OF CONSTITUENTS IN MONOLITHIC OR COMPACTED GRANULAR MATERIALS USING A SEMI-DYNAMIC TANK LEACHING PROCEDURE

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required methods used for the analysis of method-defined parameters, are intended to be guidance methods that contain general information on how to perform an analytical procedure or technique, which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. Performance data included in this method are for guidance purposes only and must not be used as absolute quality control (QC) acceptance criteria for purposes of laboratory QC or accreditation.

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[1] This method has been derived from the MT001 and MT002 procedures (Ref. 12). The method is analogous to the monolithic mass transfer methods NEN 7345 (Ref. 9) developed under Dutch regulation and CEN/TS 15863 (Ref. 13) developed for the Comité Européen de Normalisation (CEN).

1.0 SCOPE AND APPLICATION

1.1 This method is designed to provide the mass transfer rates (release rates) of inorganic analytes contained in a monolithic or compacted granular material, under diffusion-controlled release conditions, as a function of leaching time. Observed diffusivity and tortuosity may be estimated through analysis of the resulting leaching test data.

1.2 This method is suitable to a wide range of solid materials which may be in monolithic form (e.g., cements, solidified wastes) or may be compacted granular materials (e.g., soils, sediments and stacked granular wastes) which behave as a monolith, in that the predominant water flow is around the material and release is controlled by diffusion to the boundary. The method is not required by federal regulations to determine whether waste passes or fails the toxicity characteristic as defined at 40 CFR 261.24.

1.3 This leaching characterization method provides intrinsic material parameters for release of inorganic species under mass transfer controlled leaching conditions. This test method is intended as a means for obtaining a series of eluents which may be used to estimate the diffusivity of constituents and physical retention parameters of the solid material under specified laboratory conditions.

1.4 This method is not applicable to characterize the release of organic analytes with the exception of general dissolved organic carbon.

1.5 This method is a characterization method and does not provide a solution considered to be representative of eluate under field conditions. This method is similar in structure and use to predecessor methods such as MT001.1 (see Ref. 12), NEN 7345 (see Ref. 9), ANSI/ANS 16.1 (see Ref. 15), and ASTM C1308 (see Ref. 11). However, this method differs from previous methods in that: 1) leaching intervals are modified to improve QC; 2) sample preparation accounts for mass transfer from compacted granular samples; and, 3) mass transfer may be interpreted by more complex release models that account for physical retention of the porous medium and chemical retention at the pore wall through geochemical speciation modeling.

1.6 The geometry of monolithic samples may be rectangular (e.g., bricks or tiles), cubes, wafers or cylinders. Samples may also have a variety of faces exposed to eluent, forming anything from 1-dimensional (1-D) through 3-dimensional (3-D) mass transfer cases. In all cases, a minimum sample size of 5 cm in the direction of mass transfer must be employed and the liquid-surface-area ratio (L/A) must be maintained at 9 ± 1 mL/cm^2.

Monolithic samples should be suspended or held in the leaching fluid such that at least 98% of the entire sample surface area is exposed to eluent and the bulk of the eluent (e.g., a minimum of 2 cm between any exposed surface and the vessel wall) is in contact with the exposed sample surface. Figure 1 provides examples of appropriate sample holders and leaching configurations for 3-D and 1-D cases.

1.7 Compacted granular materials are granular solids, screened to pass through a 2-mm sieve, compacted following a modified Proctor compaction effort (see Ref. 10). The sample geometry must be open-faced cylinders due to limitations of mechanical packing. However, the diameter and height of the sample holder may be altered to correspond appropriately with the diameter and volume of the leaching vessel. In all cases, the sample size of at least 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

The sample should be positioned at the bottom of the leaching vessel with a minimum of 5 cm of distance between the solid-liquid interface and the top of the vessel. The distance between the non-leaching faces (i.e., outside of the mold surfaces) and the leaching vessel wall should be minimized to < 0.5 cm, such that the majority of the eluent volume is on top of the sample. Figure 2 shows an example of a holder and leaching configuration for a compacted granular sample.

1.8 The solvent system used in this characterization method is reagent water. Other systems (e.g., groundwater, seawater, and simulated liquids) may be used to infer material performance under specific environmental conditions. However, interaction between the eluent and the solid matrix may result in precipitation and pore blocking, which may interfere with characterization or complicate data interpretation.

1.9 Prior to employing this method, analysts are advised to consult the base method for each type of procedure that may be employed in the overall analysis (e.g., Methods 9040, 9045 and 9050, and the determinative methods for the target analytes) for additional information on QC procedures, development of QC acceptance criteria, calculations, and general guidance. Analysts also should consult the disclaimer statement at the front of the manual and the information in Chapter Two for: 1) guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies; and, 2) the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to federal testing requirements. The information contained in this method is provided by the Environmental Protection Agency (EPA or the Agency) as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.10 This method is restricted to use by, or under supervision of, properly experienced and trained personnel. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

This method comprises leaching of continuously water-saturated monolithic or compacted granular material in an eluent-filled tank with periodic renewal of the leaching solution. The vessel and sample dimensions are chosen such that the sample is fully immersed in the leaching solution. Monolithic samples may be cylinders or parallelepipeds, while granular materials are compacted into cylindrical molds at optimum moisture content using modified Proctor compaction methods (see Ref. 10). In either case, the exposure of a regular geometric area to the eluent is recommended. Samples are contacted with reagent water at a specified L/A. The leaching solution is exchanged with fresh reagent water at nine pre-determined intervals (see NOTE below). The sample is freely drained and the mass is recorded to monitor the amount of eluent absorbed into the solid matrix at the end of each leaching interval. The eluate pH and specific conductance is measured for each time interval and analytical samples are collected and preserved accordingly based on the determinative methods to be performed. Eluate concentrations are plotted as a function of time, as a mean interval flux, and as a cumulative release as a function of time. These data are used to estimate mass transfer parameters (i.e., observed diffusivity) for each constituent of potential concern (COPC). A flowchart for performing this method is shown in Figure 3.

NOTE: The leaching schedule may be extended for additional exchanges with individual intervals of 14 days to provide more information about longer-term release.

3.0 DEFINITIONS

3.1 Constituent of potential concern (COPC) – A chemical species of interest, which may or may not be regulated, but may be characteristic of release-controlling properties of the sample geochemistry.

3.2 Release – The dissolution or partitioning of a COPC from the solid phase to the aqueous phase during laboratory testing (or under field conditions). In this method, mass release is expressed in units of mg COPC/kg dry solid material.

3.3 Liquid-to-surface area ratio (L/A) – The ratio representing the total liquid volume used in the leaching interval to the external geometric surface area of the solid material. L/A is typically expressed in units of mL of eluent/cm^2 of exposed surface area.

3.4 Observed mass diffusivity – The apparent, macroscopic rate of release due to mass transfer from a solid into a liquid as measured using a leaching test under conditions where mass transfer controls release. The observed diffusivity accounts for all physical and chemical retention factors influencing mass transfer and is typically expressed in units of cm^2/s.

3.5 Effective mass diffusivity – The intrinsic rate of mass transfer in a porous medium accounting for physical retention. The effective mass diffusivity is typically expressed in units of cm^2/s.

3.6 Physical retention factor – A mass transfer rate term that describes the retardation of diffusion due to intrinsic physical properties of a porous medium (e.g., effective porosity, tortuosity).

3.7 Chemical retention factor – A mass transfer rate term that describes the chemical processes (e.g., dissolution/precipitation, adsorption/desorption, complexation) occurring at the pore water interface with the solid mineral phases within the porous structure of the solid material.

3.8 Eluent – The solution used to contact the solid material in a leaching test. The eluent is usually free of COPCs but may contain other species used to control the test conditions of the extraction.

3.9 Eluate – The solution collected as an extract from a leaching test that contains the eluent plus constituents leached from the solid phase.

3.10 Refer to Chapter One and Chapter Three, and the manufacturer's instructions for definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method to be used for specific guidance on QC procedures and to Chapters Three and Four for general guidance on glassware cleaning. Also refer to Methods 9040, 9045, and 9050 and the determinative methods to be used for information regarding potential interferences.

4.2 The reaction of atmospheric gases can influence the measured concentrations of constituents in eluates. For example, reaction of carbon dioxide with eluents from highly alkaline or strongly reducing materials will result in neutralization of eluate pH and precipitation of carbonates. Leaching vessels, especially those used when testing highly alkaline materials, should be designed to be airtight in order to minimize the reaction of samples with atmospheric gases.

4.3 Use of certain solvent systems may lead to precipitation at the material surface boundary, which may reduce mass transport rates. For example, exposure of cement-based materials to seawater leads to sealing of the porous block (see Ref. 8).

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of the chemicals specified in this method. A reference file of safety data sheets (SDSs) should be available to all personnel involved in these analyses.

5.2 During preparation and processing of extracts and/or eluents/eluates, some waste materials may generate heat or evolve potentially harmful gases when contacted with acids and bases. Adequate prior knowledge of the material being tested should be used to establish appropriate personal protection and workspace ventilation.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during the method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

This section does not list common laboratory glassware (e.g., beakers and flasks) that might be used.

6.1 Sample holder

6.1.1 Monolithic samples

6.1.1.1 A mesh or structured holder constructed of an inert material such as high density polyethylene (HDPE) or other material resistant to high and low pH is recommended.

6.1.1.2 The holder should be designed such that at least 98% of the external surface area of the sample may be exposed to eluent.

6.1.1.3 The holder should be designed to match the geometry of the mass transfer such that the bulk of the eluent may be in contact with the sample and the exposed surfaces of the sample centered within the leaching fluid.

NOTE: In the case of 1-D mass transfer from the axial face of a cylindrical sample, the outer diameter (OD) of the holder should be matched as closely as possible to the inner diameter (ID) of the leaching vessel so that the majority of the eluent is above the sample (e.g., in contact with the exposed material surface), while allowing for easy placement and removal of the holder in the leaching vessel (see Figure 1).

6.1.2 Compacted granular samples

6.1.2.1 A cylindrical mold constructed of an inert material such as HDPE or other material resistant to high and low pH is recommended.

6.1.2.2 The holder should be capable of withstanding the compaction force required to prepare the sample (see Sec. 11.3) without breaking or distorting.

NOTE: The outer diameter of the holder for a compacted granular sample should be matched as closely as possible to the inner diameter of the leaching vessel so that the majority of the eluent is above the sample (e.g., in contact with the exposed material surface) while allowing for easy placement and removal of the holder in the leaching vessel.

6.2 Leaching vessel

6.2.1 A straight-sided container constructed of a material resistant to high and low pH is recommended. Jars or buckets composed of HDPE, polycarbonate (PC), polypropylene (PP), or polyvinyl chloride (PVC) are recommended when evaluating the mobility of inorganic species.

6.2.2 The leaching vessel should have an airtight seal that can sustain long periods of standing without gas exchange with the atmosphere.

6.2.3 The container must be of sufficient volume to accommodate both the solid sample and an eluent volume based on an L/A of 9 ± 1 mL /cm^2 sample surface area. Ideally, the vessel should be sized such that the headspace is minimized within the tolerance of the L/A.

6.3 Leaching setup

Example photos of three possible leaching equipment arrangements for monolithic and compacted granular samples are shown in Figures 1 and 2, respectively. The equipment used in the each of these cases is described below.

6.3.1 Figure 1a shows a monolithic sample 3-D configuration with the following accessories:

- Sample holder – PP sink washers, 43-mm OD, 37-mm ID, 6-mm high, with four holes drilled at the quadrants to accept 2-mm OD nylon string knotted at the top
- Sample stand – PVC pipe, 47-mm OD, 51-mm high, cut to have four legs approximately 8-mm wide and 30-mm high
- Leaching Vessel – PP bucket, 140-mm ID at top, 120-mm ID at bottom, 200-mm high (Berry Plastics #T51386CP3, VWR Scientific, or equivalent)

6.3.2 Figure 1b shows a monolithic sample 1-D configuration with the following accessories:

- Sample holder – Polyethylene (PE) mold, 54-mm OD, 100-mm high (MA Industries, Peach Tree City, GA, or equivalent), with the test sample cured in mold and cut to 51-mm high
- Leaching vessel – 250-mL PC jar, 60-mm ID, 100-mm high (Nalgene #2116-0250, Fisher Scientific, or equivalent)

6.3.3 Figure 2 shows a compacted granular sample 1-D Configuration with the following accessories:

- Sample holder – PE mold, 100-mm OD, 200-mm high, (MA Industries, Peach Tree City, GA, or equivalent) cut to 63-mm high with three tabs drilled for 0.7-mm fishing line knotted at the top
- Leaching vessel – 1000-mL PC jar, 110-mm ID at top, 130-mm high (Nalgene #2116-1000, Fisher Scientific, or equivalent)
- Glass beads, borosilicate – 2-mm diameter

6.4 Filtration apparatus – Pressure or vacuum filtration apparatus composed of appropriate materials to maximize the collection of extracts and minimize the loss of COPCs (Nalgene #300-4000 or equivalent)

6.5 Filtration membranes – Composed of hydrophilic polypropylene or equivalent material with an effective pore size of 0.45 µm (e.g., Andwin Scientific GH Polypro 28143-288 or equivalent)

6.6 pH meter – Laboratory model with the capability for temperature compensation (e.g., Accumet 20, Fisher Scientific or equivalent) and a minimum resolution of 0.1 pH units

6.7 pH combination electrode – Composed of chemically resistant materials

6.8 Conductivity meter – Laboratory model (e.g., Accumet 20, Fisher Scientific or equivalent), with a minimum resolution of 5% of the measured value

6.9 Conductivity electrodes – Composed of chemically resistant materials

6.10 Proctor compactor (for compacted granular samples only) – Equipped with a slide hammer capable of dropping a 4.5-kg weight over a 0.46-m interval (see Ref. 10 for further details)

7.0 REAGENTS AND STANDARDS

7.1 Reagent-grade chemicals, at a minimum, should be used in all tests. Unless otherwise indicated, all reagents should conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available. Other grades may be used, provided the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. Inorganic reagents and extracts should be stored in plastic to prevent interaction of constituents from glass containers.

7.2 Reagent water – Reagent water must be interference-free. All references to water in this method refer to reagent water unless otherwise specified.

7.3 Other reagents may be used in place of reagent water on a case-specific basis.

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1 See Chapter Three, "Inorganic Analytes," and Chapter 4, "Organic Analytes," for sample collection and preservation instructions.

8.2 Both plastic and glass containers are suitable for the collection of samples. All sample containers must be prewashed with a metal-free detergent and triple-rinsed with nitric acid and reagent water, depending on the history of the container. For further information, see Chapter Three.

9.0 QUALITY CONTROL

9.1 Refer to Chapter One for guidance on quality assurance (QA) and quality control (QC) protocols. When inconsistencies exist between QC guidelines, method-specific QC criteria take precedence over both technique-specific criteria and Chapter One criteria, and technique-specific QC criteria take precedence over Chapter One criteria. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a quality assurance project plan (QAPP) or a sampling and analysis plan (SAP), which translates project objectives and specifications into directions for those who will implement the project and assess the results.

Each laboratory should maintain a formal QA program. The laboratory should also maintain records to document the quality of the data generated. Development of in-house QC limits for each method is encouraged. Use of instrument-specific QC limits is encouraged, provided such limits will generate data appropriate for use in the intended application. All data sheets and QC data should be maintained for reference or inspection.

9.2 In order to demonstrate the purity of reagents and sample contact surfaces, method blanks should be tested for each leaching interval. Refer to Chapter One for specific QC procedures.

9.3 The analysis of extracts should follow appropriate QC procedures, as specified in the determinative methods for the COPCs. Refer to Chapter One for specific QC procedures.

9.4 Initial demonstration of proficiency (IDP)

Leachate methods are not amenable to typical IDPs when reference materials with known values are not available. However, prior to using this method an analyst should have documented proficiency in the skills required for successful implementation of the method. For example, skill should be demonstrated in the use of an analytical balance, the determination of pH using Methods 9040 and 9045 and the determination of conductance using Method 9050.

10.0 CALIBRATION AND STANDARDIZATION

10.1 The balance should be calibrated and certified, at a minimum, annually or in accordance with laboratory policy.

10.2 Prior to measurement of eluate pH, the pH meter should be calibrated using a minimum of two standards that bracket the range of pH measurements. Refer to Methods 9040 and 9045 for additional guidance.

10.3 Prior to measurement of eluate conductivity, the meter should be calibrated using at least one standard at a value greater than the range of conductivity measurements. Refer to Method 9050 for additional guidance.

11.0 PROCEDURE

A flowchart of this method is presented in Figure 3. Microsoft Excel® data templates are available to aid in collecting and archiving of laboratory and analytical data.[2]

11.1 Preparatory Procedures – Determination of solids and moisture content

The moisture and solids content of the sample material are used to relate leaching results to dry-material masses. When preparing compacted granular samples for testing, the moisture content or solid content is used to determine the optimum moisture content following the modified Proctor test. This method calculates moisture content on the basis of the "wet" or "as-tested" sample.

WARNING: The drying oven should be contained in a hood or otherwise properly ventilated. Significant laboratory contamination or inhalation hazards may result when drying heavily contaminated samples. Consult the laboratory safety officer for proper handling procedures prior to drying samples that may contain volatile, hazardous, flammable, or explosive materials.

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[2] These Excel® templates form the basis for uploading method data into the data management program, LeachXS Lite™. Both the data templates and LeachXS Lite™ are available at http://vanderbilt.edu/leaching.

11.1.1 Place 5 - 10 g of solid sample material into a tared dish or crucible. Dry the sample to a constant mass at 105 ± 2 °C. Check for constant mass by returning the dish to the drying oven for 24 hours, cooling to room temperature in a desiccator and re-weighing. The two mass readings should agree within the larger of 0.2% or 0.02 g.

NOTE: The oven-dried sample is not used for the extraction and should be properly disposed of once the dry mass is determined.

11.1.2 Calculate and report the solids content as follows:

$$SC = \frac{M_{dry}}{M_{test}}$$

Where: SC = solids content of "as-tested" material (g-dry/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.1.3 Calculate and report the moisture content (wet basis) as follows:

$$MC_{wet} = \frac{M_{test} - M_{dry}}{M_{test}}$$

Where: MC_{wet} = moisture content on a wet basis (g_{H_2O}/g)
M_{dry} = mass of dry material specified in the method (g-dry)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)

11.2 Preparation of monolithic samples

11.2.1 If the material to be tested is granular, disregard this section and proceed to Sec. 11.3.

11.2.2 A representative sample of monolithic material should be obtained by molding material components in place (e.g., cementitious media) or by coring or cutting a sample from a larger existing specimen.

11.2.3 The geometry of monolithic samples may be rectangular (e.g., bricks or tiles), cubes, wafers, or cylinders. Samples may also have a variety of faces exposed to eluent forming 1-, 2-, or 3-D mass transfer cases. Examples of monolithic sample leaching setups are shown in Figure 1.

11.2.4 A minimum sample size of 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

NOTE: Since the sample holder and leaching vessel must correspond to the specifications in Sec. 6.1, it is often easier to modify the sample size and geometry rather than the holder and vessel dimensions.

11.2.5 Proceed to Sec. 11.4.

11.3 Preparation of compacted granular samples

Compacted granular materials, in most cases, must be open-faced cylinders due to the limitations of mechanical packing. However, the diameter and height of the sample holder may be altered to work appropriately with the diameter and volume of the leaching vessel. In all cases, a minimum sample size of 5 cm in the direction of mass transfer must be employed and the L/A must be maintained at 9 ± 1 mL/cm^2.

Granular samples are compacted into the sample holder using a variation on the modified Proctor compaction (see Ref. 10) to include the use of 6-cm high-test molds. Shorter or taller molds (or packing depths) may be used as long as the compaction effort of 56,000 ft-lb$_f$/ft^3 is achievable. The number of packing layers should be maintained at the five layers specified in Ref. 10. However, the number of blows per layer in a 4-in diameter mold may be changed according to the follow formula:

$$\frac{56{,}000\,\text{ft - lb}_\text{f}}{\text{ft}^3}\left|\frac{\text{blow}}{1.5\,\text{ft}\times 10\,\text{lb}_\text{f}}\right|\frac{\pi\left(0.\overline{3}/2\ \text{ft}\right)^2\times h\,\text{ft}}{5\,\text{layer}}=\frac{65.2\times h\,\text{blow}}{\text{layer}}$$

Where: *h* is the measured height of the sample mold (ft).

Thus, for the mold height of 4.584 in (0.382 ft) specified in the ASTM procedure, 25 blows per each of 5 layers are required. When a 6-cm (0.196 ft) mold height is used (as suggested in this method), 13 blows per each of 5 layers are required to obtain the same compaction effort.

The granular sample should be compacted at a moisture content corresponding to 90% of the modified Proctor optimum packing density in order to provide a uniform approach to obtaining a sample density that approximates field conditions. Optimum moisture content refers to the amount of moisture or fractional mass of water (g_{H_2O}/g material) in the granular sample that is present at the optimum packing density (g-dry material/cm^3). Optimum packing density is defined in Ref. 10. The optimum moisture content of the test material is determined from a pre-test that measures the packing density of granular materials compacted at different levels of moisture content.

11.3.1 Pre-test to determine optimum moisture content

The pre-test is conducted as a series of five batch-wise packing trials with consecutive increases in moisture content until the maximum packing density has been surpassed. The optimum moisture content is determined as the maximum of a third-order polynomial fit through the graph of dry-packing density as a function of moisture content (wet basis).

11.3.1.1 Place 1500 g of "as received" material into a pail or bowl and mix well by hand to homogenize. As an alternative to hand mixing, a mechanical paddle mixer may be used.

<u>NOTE</u>: The pre-test may be conducted from a bulk supply of solid material (e.g., 10 kg total for five batches) as long as the starting mass for each trial is recorded and incremental water additions are used.

11.3.1.2 Mix a known amount of tap water with the bulk material in the pail or bowl until homogenized based on visual inspection. For the first point in the pre-test, no water needs to be added.

NOTE: The amount of water added should be enough to increase the moisture content in approximately 3 - 5% increments. Smaller additions may be needed in order to provide finer resolution of the packing density as a function of the moisture content curve.

11.3.1.3 Calculate the new moisture content (wet basis) for the trial as follows:

$$MC^{i}_{(wet)} = \frac{M_{test} \times MC_{wet} + W_{added}}{M_{test} + W_{added}}$$

Where: $MC^{i}_{(wet)}$ = moisture content on a wet basis of the pre-test trial (g_{H_2O}/g)
M_{test} = mass of "as-tested" solid equivalent to the dry-material mass (g)
$MC_{(wet)}$ = moisture content on a wet basis of the "as-tested" material (g_{H_2O}/g)
W_{added} = mass of water added to the "as-tested" material (g_{H_2O}/g)

11.3.1.4 Compact approximately 1000 g of material into a tared 10-cm diameter mold into three consecutive layers of material. The compacted mass should have a level, flat surface as a top face.

11.3.1.5 Measure and record the height, diameter, and mass of the resulting compacted material.

11.3.1.6 Calculate and record the packing density (dry basis) as follows:

$$\rho_{pack} = \frac{m \times SC}{\pi \times h}\left(\frac{2}{d}\right)^2$$

Where: ρ_{pack} = packing density (dry basis) (g-dry/cm^3)
m = mass of the compacted sample (g)
SC = solids content of "as-tested" granular material (g-dry/g)
d = measured diameter of the compacted sample (cm)
h = measured height of the compacted sample (cm)

11.3.1.7 Repeat Sec. 11.3.1.1 - 11.3.1.6 for four subsequent trials until the value of the calculated packing density decreases.

11.3.1.8 Plot the packing density as a function of moisture content. Figure 4 shows an example of a packing density curve.

11.3.1.9 Determine the optimum moisture content at the maximum of the packing density curve. This value may be read directly from the graph or determined by the maximum of a third-order polynomial fit through the five pre-test data points (see the Microsoft Excel® spreadsheet template available at http://www.vanderbilt.edu/leaching/downloads/test-methods/).

11.3.2 Compacted granular test sample preparation

11.3.2.1 Using the optimum moisture content determined in Sec. 11.3.1.9, calculate the amount of "as-received" material that is required to pack the sample holder to within 3 mm of the rim of the holder.

$$M_{test} = \frac{\rho_{opt} \times \pi \times (h - 0.3)}{SC} \left(\frac{d}{2} \right)^2$$

Where: M_{test} = mass of "as tested" solid equivalent to the dry-material mass (g)
ρ_{opt} = optimal packing density (dry basis) (g-dry/cm^3) – determined in Sec. 11.3.1.9
h = measured height of the sample mold (cm)
SC = solids content of "as-tested" granular material (g-dry/g)
d = measured diameter of the sample mold (cm)

11.3.2.2 Adjust the moisture content of the "as-received" material to the optimum moisture content using reagent water and mix until homogenized.

11.3.2.3 Pack the sample material into the sample holder using the modified Proctor compaction as described in Ref. 10.

11.3.2.4 Place a monolayer of borosilicate glass beads (Sec. 6.3.3) on the exposed sample surface to minimize scouring and mass loss during testing.

11.3.2.5 Begin the leach test procedure promptly or cover the sample with plastic wrap to minimize moisture loss to the atmosphere.

11.4 Leaching procedure

This protocol is a semi-dynamic, tank-leaching procedure (see schematic in Figure 5) where the sample is exposed to eluate for a series of leaching intervals interspersed with eluent exchanges. The chemical composition of each eluate is determined and mass transfer from the bulk solid is determined as a function of cumulative leaching time. The schedule of leaching intervals for this method is shown in Table 1.

11.4.1 Pre-test measurements – For the surface area calculation, measure and record the dimensions of the test specimen. This should include the diameter and height for a cylinder; length, width, and depth for a parallelepiped; or diameter of exposed surface for a compacted granular sample.

11.4.2 Measure and record the mass of the specimen. This value should be monitored for each eluent exchange.

11.4.3 If a holder is used, place the specimen in the monolith holder.

11.4.4 Measure and record the mass of the specimen and holder, if applicable.

11.4.5 The recommended temperature for conducting this method is room temperature (20 ± 2 °C). When conducted at temperature readings or variations other than those recommended, record the ambient temperature at each eluent renewal.

11.5 Eluent exchange

11.5.1 Fill a clean leaching vessel with the required volume of reagent water based on an L/A of 9 ± 1 mL/cm^2. Record the amount of eluent used.

11.5.2 Carefully place the specimen or the specimen and holder in the leaching vessel (Figure 6a) so that the sample is centered in the eluent (see Figure 6b). Submersion should be gentle enough so that the physical integrity of the monolith is maintained and scouring of the solid is minimized.

11.5.3 Cover the leaching vessel with the airtight lid and place in a safe location until the end of the leaching interval. Table 1 shows the schedule of leaching intervals and cumulative release times for this method.

NOTE: Eluates of alkaline materials may be susceptible to neutralization through reaction with carbon dioxide. Precautions (e.g., ensuring airtight vessels or purging headspace) should be taken to minimize the effect of carbonation on eluates that may sit stationary for more than one week.

11.5.4 Prior to the end of the leaching interval, repeat Sec. 11.5.1 in order to prepare a vessel for the next leaching interval.

11.5.5 At the end of the leaching interval (see Table 1), carefully remove the specimen or the specimen and holder from the vessel (Figure 6c). Drain the liquid from the surface of the specimen into the eluate for approximately 20 sec.

11.5.6 Measure and record the mass of the specimen or the mass of the specimen and holder (Figure 6d).

NOTE: The change in sample mass between intervals is an indication of the potential absorption of eluent by the matrix (mass gain) or erosion of the matrix (mass loss). In the case where a holder is used, moisture may condense on the holder during the leaching interval and sample absorption may not be evident.

NOTE: Mass gain may also be indicative of carbonate precipitation if the vessel is not tightly sealed and carbon dioxide is absorbed from the atmosphere.

11.5.7 Place the specimen or the specimen and holder into the clean leaching vessel filled with new eluent as prepared in Sec. 11.5.4.

11.5.8 Cover the new leaching vessel with the airtight lid and place in a safe location until the end of the leaching interval.

11.6 Eluate processing

11.6.1 Measure and record the pH, specific conductivity, and oxidation reduction potential (ORP) of the eluate of the decanted eluate from the previous leaching interval (see Methods 9040, 9045, and 9050).

NOTE: Measurement of pH, conductivity, and ORP should be taken within 15 minutes of eluent exchange (Sec. 11.5) to avoid neutralization of the solution due to exposure to carbon dioxide, especially when alkaline materials are tested.

NOTE: The measurement of ORP is optional, but strongly recommended, especially when testing materials where oxidation is likely to change the chemistry of COPCs.

11.6.2 Filter the remaining eluate through a 0.45-µm membrane (Sec. 6.5).

11.6.3 Immediately preserve and store the volume(s) of eluate required for chemical analysis. Preserve all analytical samples in a manner that is consistent with the determinative chemical analyses to be performed.

11.6.4 Collect all subsequent eluate by repeating the eluent exchange and eluate processing procedures in Secs. 11.5 and 11.6.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Data reporting

12.1.1 Figure 7 shows an example of a data sheet which may be used to report the concentration results of this method. At a minimum, the basic test report should include the following:

a) Name of the laboratory
b) Laboratory technical contact information
c) Date and time at the start of the test
d) Name or code of the solid material
e) Material description (including monolithic or compacted granular)
f) Moisture content of material used (g_{H_2O}/g)
g) Dimensions (cm) and geometry of sample used
h) Mass of solid material used (g)
i) Mass of sample and holder at start of test (g)
j) Eluate type (e.g., reagent water)
k) Eluate-specific information (see Sec. 12.1.2 below)

12.1.2 The minimum set of data that should be reported for each eluate includes:

a) Eluate sample ID
b) Target eluent exchange date and time
c) Actual eluent exchange date and time
d) Volume of eluent used (mL)
e) Mass of sample and holder (g)
f) Measured eluate pH

g) Measured eluate conductivity (mS/cm)

h) Measured ORP (mV) (optional)

i) Concentration of all COPCs

j) Analytical QC qualifiers as appropriate

12.2 Data presentation

12.2.1 Interval concentrations

12.2.1.1 At the conclusion of the schedule of leaching intervals (see Table 1), the concentration of COPCs in each eluate may be plotted as a function of cumulative leaching time. An example of this is shown in Figure 8 for mass transport from a monolithic field sample of fixated scrubber sludge and lime.

12.2.1.2 If data is available from Method 1313, interval concentrations and Method 1313 data may be plotted on the same graph as a function of eluate pH. This QC step is conducted in order to determine whether the concentration of COPCs approached equilibrium in any leaching interval (i.e., the driving force for mass transport from the matrix may not be constant, which is a common assumption of dynamic-tank leach testing). Figure 9 shows this type of graph for the release from a field sample of fixated scrubber sludge and lime.

12.2.2 Interval mass release

At the conclusion of the schedule of leaching intervals (see Table 1), the interval mass released can be calculated for each leaching interval as follows:

$$M_{t_i} = \frac{C_i \times V_i}{A}$$

Where: M_{t_i} = mass released during the current leaching interval, i (mg/m^2)

C_i = constituent concentration in the eluate for interval i (mg/L)
V_i = eluate volume in interval i (L)
A = specimen external geometric surface area exposed to the eluent (m^2)

12.2.3 Mean interval flux

The flux of a COPC in an interval may be plotted as a function of the generalized mean of the square root of cumulative leaching time ($\sqrt{t}$). An example of a flux graph is show in Figure 10 for the release from a field sample of fixated scrubber sludge with lime. This graph may be used to interpret the mechanism of release (see Ref. 5 for further details).

12.2.3.1 The flux across the exposed surface of the sample can be calculated by dividing the interval mass release by the interval duration as follows:

$$F_i = \frac{M_i}{t_i - t_{i-1}}$$

Where: F_i = flux for interval, i ($mg/m^2 \cdot s$)

M_i = mass released during the current leaching interval, i (mg/m^2)

t_i = cumulative time at the end of the current leaching interval, i (s)

t_{i-1} = cumulative time at the end of the previous leaching interval, i-1 (s)

12.2.3.2 The time used to plot each interval mass is the generalized mean of the square root of the cumulative leaching time using the cumulative time at the end of the i^{th} interval, t_i, and the cumulative time at the end of the previous interval, t_{i-1}.

$$\overline{t_i} = \left(\frac{\sqrt{t_i} + \sqrt{t_{i-1}}}{2} \right)^2$$

Where: $\overline{t_i}$ = generalized mean leaching time for the current interval, i (s)

t_i = cumulative time at the end of the current leaching interval, i (s)

t_{i-1} = cumulative time at the end of the previous leaching interval, i-1 (s)

NOTE: If the concentrations of a COPC in the eluates approach that shown in Method 1313 for liquid-solid equilibrium, the flux curve will show the pattern in Figure 10 with intervals of the same duration having the same flux value. When the eluate concentration approaches saturation, the driving force for mass transfer approaches zero, interval flux is limited, and intervals with like durations will display similar flux limitations.

12.2.4 Cumulative release

12.2.4.1 The interval release calculated in 12.2.2 can be summed to provide the cumulative mass release as a function of leaching time. Figure 11 shows the cumulative release curves for a field sample of fixated scrubber sludge with lime.

12.2.4.2 Interpretation of the cumulative release of constituents is illustrated using the analytical solution for simple radial diffusion from a cylinder into an infinite bath presented by Crank (see Ref. 8).

$$M_t = 2\rho C_o \left(\frac{D^{obs}\, t}{\pi} \right)^{1/2}$$

Where: M_t = cumulative mass released during leaching interval i (mg/m^2)

ρ = density of the "as-tested" sample (kg/m^3)

C_o = concentration of available COPC in the solid matrix (mg/kg)

D^{obs} = observed diffusivity (m^2/s)

t = leaching time (s)

When transformed to a log-log scale, the analytical solution presented by Crank becomes linear with the square root of time.

$$\log\left[M_t\right] = \log\left[2\rho C_o\left(\frac{D^{obs}}{\pi}\right)^{1/2}\right] + \frac{1}{2}t$$

Thus, under the assumptions of the analytical solution presented by Crank, the mass release should be proportional to the square root of time. A line showing the square root of time is plotted in Figure 11 along with the data. Since flux is the derivative of release, a similar treatment of flux as a function of leaching time using the simple diffusion model would be proportional to the negative square root of time as shown in Figure 10.

Models other than the simple diffusion model presented by Crank may also be used to interpret mass release. For example, the Shrinking Unreacted Core Model (see Ref. 2) and the Coupled Dissolution-Diffusion Model (see Ref. 7) incorporate chemical release parameters (e.g., as derived from Method 1313 data) into the model to better estimate release mechanisms and predictions (see Ref. 5 for further details).

12.2.5 Observed diffusivity

An observed diffusivity for each COPC can be determined using the logarithm of the cumulative release plotted versus the logarithm of time. In the case of a diffusion-controlled mechanism, this plot is expected to be a straight line with a slope of 0.5. An observed diffusivity can then be determined for each leaching interval where the slope is 0.50 ± 0.15 (see Ref. 1 and Ref. 14) by the following:

$$D_i^{obs} = \pi\left[\frac{M_{t_i}}{2\rho C_o\left(\sqrt{t_i} - \sqrt{t_{i-1}}\right)}\right]^2$$

Where: D_i^{obs} = observed diffusivity of a COPC for leaching interval i (m^2/s)

M_{t_i} = mass released during leaching interval i (mg/m^2)

t_i = cumulative contact time at the end of the current leaching interval, i (s)

t_{i-1} = cumulative contact time at the end of the previous leaching interval, i−1 (s)

ρ = sample density (dry basis) (kg-dry/m^3)

C_0 = initial leachable content (i.e., available release potential) (mg/kg)

The mean observed diffusivity for each COPC is then determined by taking the average of the interval observed diffusivities. It should be reported with the computed uncertainty (i.e., standard deviation).

NOTE: Since the analysis presented above assumes a diffusion process, only those interval mass transfer coefficients corresponding to leaching intervals with slopes of 0.50 ± 0.15 are included in the overall average mass-transfer coefficient.

12.3 Data representation by constituent

A concise representation of all relevant data for a single constituent may be presented as shown in Figure 12 for arsenic from a field core of fixated scrubber sludge with lime (FSSL) material. The data shows eluate pH generation as a function of leaching time (Figure 12a), comparison between eluate concentrations and Method 1313 data as a function of eluate pH (Figure 12b), constituent flux as a function of generalized mean cumulative leaching time (Figure 12c), and constituent release as a function of cumulative leaching time (Figure 12d).

12.4 Interpolation/extrapolation to target time values

The collected time dependence data may be interpolated or extrapolated to the nearest target cumulative time (Σt) value for purposes of comparing different data sets (e.g., test replicates of the same or different materials). The most transparent and straightforward method is linear interpolation/extrapolation of data after $\log_{10}$ transformation.

12.4.1 Log_{10} transformation

Collected concentration values are transformed by taking the $\log_{10}$ of the measured concentration at each test position, i:

$$C_i = \log_{10}(c_i)$$

Where: C_i = $\log_{10}$-transformed concentration at test position i ($\log_{10}$[mg/L])
c_i = the concentration measured at test position i (mg/L)

12.4.2 Linear interpolation/extrapolation

Given a set of coordinate data sorted by increasing order according to Σt value (e.g., $\Sigma t_1 < \Sigma t_2 < \cdots < \Sigma t_n$), an interpolated/extrapolated $\log_{10}$-transformed concentration at a known Σt target is calculated as:

$$C_T = a_T + b_T \sum t_T$$

Where: C_T = the concentration at target Σt value, Σt_T ($\log_{10}$[s])
a_T and b_T are coefficients of the linear interpolation/extrapolation equation
Σt_T = a target cumulative time value

Depending on the values of observed Σt values relative to target Σt values, the calculations of the coefficients a_T and b_T in the equation may differ according to the following algorithm:

- If $\Sigma t_T < \Sigma t_1$, then $b_T = (C_2 - C_1) / (\Sigma t_2 - \Sigma t_1)$ and $a_T = C_2 - b_T \cdot \Sigma t_2$ (extrapolation from the two points with closest Σt values)
- If $\Sigma t_T \geq \Sigma t_n$, then $b_T = (C_n - C_{n-1}) / (\Sigma t_n - \Sigma t_{n-1})$ and $a_T = C_n - b_T \cdot \Sigma t_n$ (extrapolation from the two points with closest Σt values)
- If $\Sigma t_{j-1} \leq \Sigma t_T < \Sigma t_j$, then $b_T = (C_j - C_{j-1}) / (\Sigma t_j - \Sigma t_{j-1})$ and $a_T = y_j - b_T \cdot \Sigma t_j$ (interpolation from the two closest points surrounding Σt_T)

NOTE: Interpolation or extrapolation of data should only be conducted within a distance of ±20% of the target Σt value. Since the allowable L/S tolerance about a target L/S value is variable (see Table 1), interpolation/extrapolation should not create data at a target Σt value where collected data is missing.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. Performance data must not be used as absolute QC acceptance criteria for laboratory QC or accreditation.

13.2 Interlaboratory validation of this method was conducted using a solidified waste analog (material code SWA) and a contaminated smelter site soil (material code CFS). Repeatability and reproducibility was determined for mean interval flux excluding the first wash-off interval (see Table 2) and for cumulative mass released after 63 days of leaching (see Table 3). More details on the interlaboratory validation may be found in Ref. 4.

13.3 Ref. 5 and Ref. 12 may provide additional guidance and insight on the use, performance, and application of this method.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operations. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction*, a free publication available from the ACS, Committee on Chemical Safety, https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/less-is-better.pdf.

15.0 WASTE MANAGEMENT

The EPA requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Laboratories are urged to protect air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available at: http://www.labsafetyinstitute.org/FreeDocs/WasteMgmt.pdf.

16.0 REFERENCES

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17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables and figures referenced by this method.

TABLE 1

SCHEDULE OF ELUATE RENEWALS

Interval Label	Interval Duration (h)	Interval Duration (d)	Cumulative Leaching Time (d)
T01	2.0 ± 0.25	–	0.08
T02	23.0 ± 0.5	–	1.0
T03	23.0 ± 0.5	–	2.0
T04	–	5.0 ± 0.1	7.0
T05	–	7.0 ± 0.1	14.0
T06	–	14.0 ± 0.1	28.0
T07	–	14.0 ± 0.1	42.0
T08	–	7.0 ± 0.1	49.0
T09	–	14.0 ± 0.1	63.0

NOTE: This schedule may be extended for additional 14-day contact intervals to provide more information regarding longer-term release.

TABLE 2

METHOD PRECISON FOR MEAN INTERVAL FLUX (2^{nd} – 9^{th} Intervals)

Analyte	Symbol	Reapeatability – SWA $\%RSD_r$	Repeatability – CFS $\%RSD_r$	Reproducibility – SWA $\%RSD_R$	Reproducibility – CFS $\%RSD_R$
Aluminum	Al	7.3	13.3	25.3	25.3
Antimony	Sb	9.2	14.8	21.8	23.8
Arsenic	As	19.9	-	31.1	-
Barium	Ba	13.2	7.5	44.8	18.3
Boron	B	10.8	7.2	27.3	27.1
Cadmium	Cd	-	7.6	-	23.2
Calcium	Ca	8.1	6.6	28.7	26.0
Chromium	Cr	10.2	-	23.8	-
Lead	Pb	-	4.3	-	19.8
Potassium	K	12.4	10.8	28.8	40.1
Selenium	Se	10.9	13.3	30.8	32.4
Vanadium	V	8.5	11.3	22.3	30.6

Material	Reapeatability – SWA $\%RSD_r$	Repeatability – CFS $\%RSD_r$	Repeatability – Overall	Reproducibility – SWA $\%RSD_R$	Reproducibility – CFS $\%RSD_R$	Reproducibility – Overall
Mean	11%	10%	11%	29%	27%	28%

NOTE: First interval is removed from mean interval flux because of variances associated with wash-off of surface contaminants that do not pertain to the method precision.

Data taken from Ref. 4.

TABLE 3

METHOD PRECISON FOR CUMULATIVE RELEASE AFTER 63 DAYS

Analyte	Symbol	Repeatability – SWA %RSD$_r$	Repeatability – CFS %RSD$_r$	Reproducibility – SWA %RSD$_R$	Reproducibility – CFS %RSD$_R$
Aluminum	Al	5.4	5.3	23.6	22.9
Antimony	Sb	6.9	5.9	19.7	14.4
Arsenic	As	15.9	-	31.0	-
Barium	Ba	7.5	3.9	35.6	16.5
Boron	B	8.4	3.7	22.6	25.7
Cadmium	Cd	-	4.8	-	18.4
Calcium	Ca	4.6	3.2	23.9	24.6
Chromium	Cr	7.7	-	17.7	-
Lead	Pb	-	1.6	-	12.0
Potassium	K	10.8	6.3	24.8	44.4
Selenium	Se	8.7	3.6	26.7	20.5
Vanadium	V	5.7	4.2	21.1	22.8

Material	Repeatability – SWA %RSD$_r$	Repeatability – CFS %RSD$_r$	Repeatability – Overall	Reproducibility – SWA %RSD$_R$	Reproducibility – CFS %RSD$_R$	Reproducibility – Overall
Mean	8%	4%	6%	25%	22%	23%

Data taken from Ref. 4.

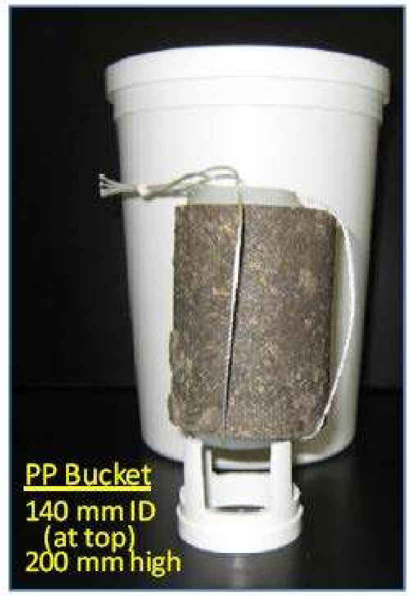
FIGURE 1

EXAMPLES OF MONOLITHIC SAMPLE HOLDERS

3-D Configuration

Sample Holder

Sample, Holder and Stand



3-D Leaching Setup

1-D Configuration

Empty Sample Holder

Full Sample Holder

1-D Leaching Setup

FIGURE 2

EXAMPLE COMPACTED GRANULAR SAMPLE HOLDER AND SETUP

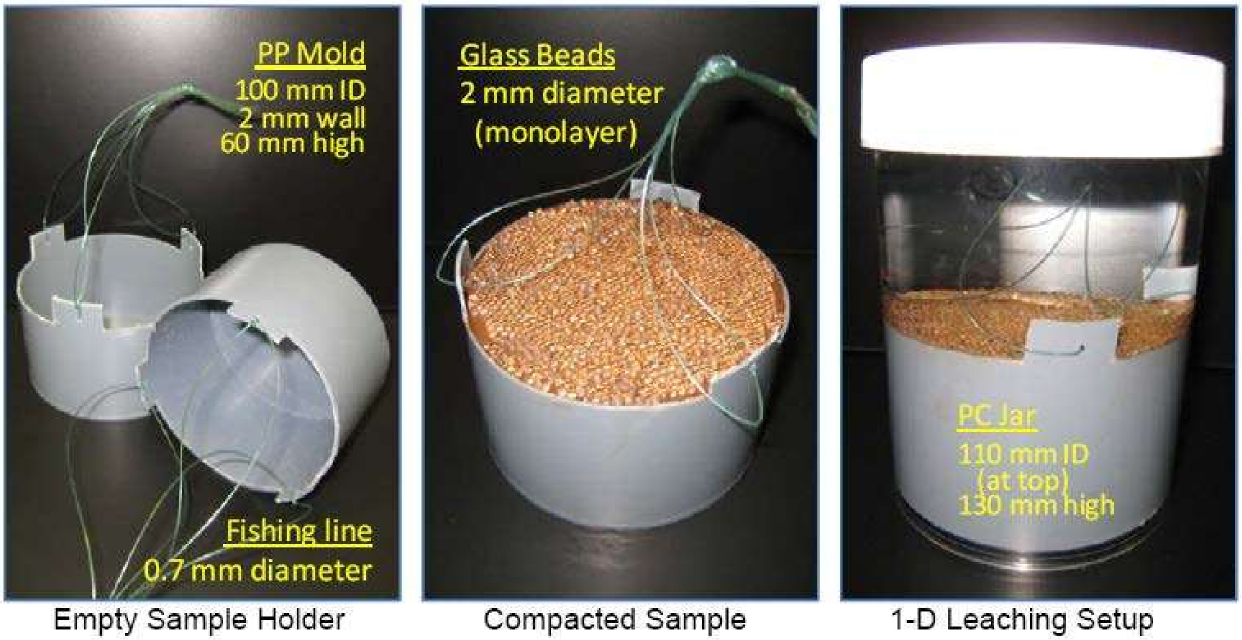


FIGURE 3

METHOD FLOWCHART

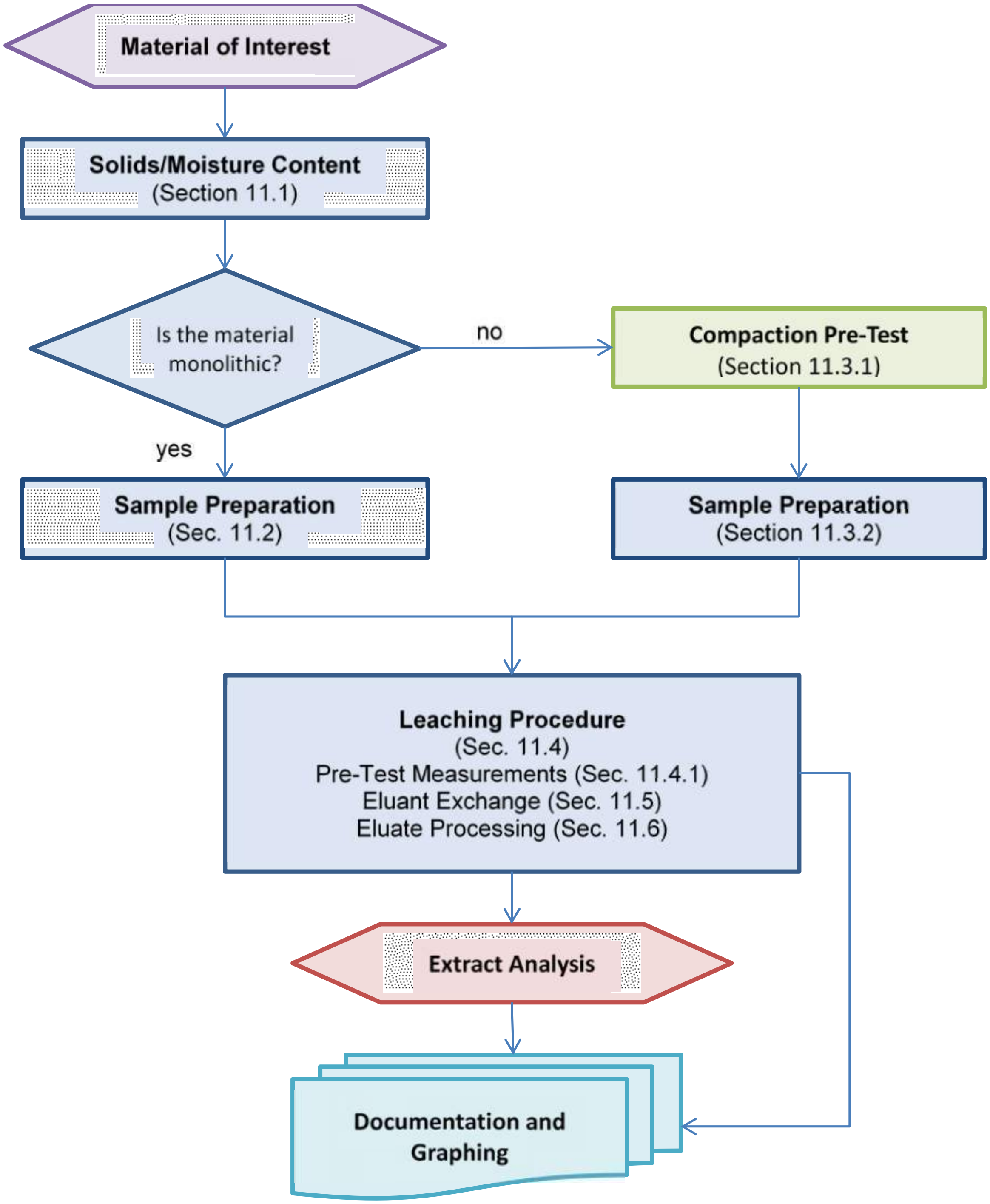


FIGURE 4

EXAMPLE CURVE OF PACKING DENSITY AS A FUNCTION OF MOISTURE CONTENT

$$y = 55.975x^3 - 65.036x^2 + 1.8352$$

$$r^2 = 0.983$$

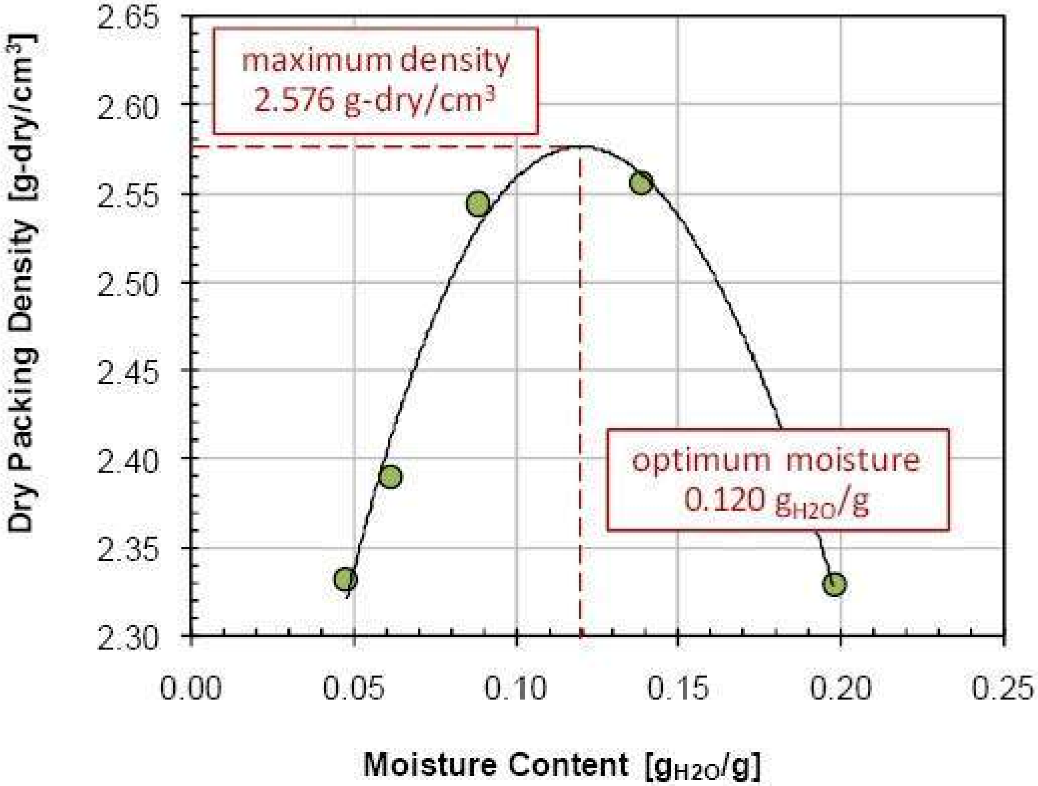


FIGURE 5

SCHEMATIC OF SEMI-DYNAMIC MASS TRANSFER TEST PROCESS

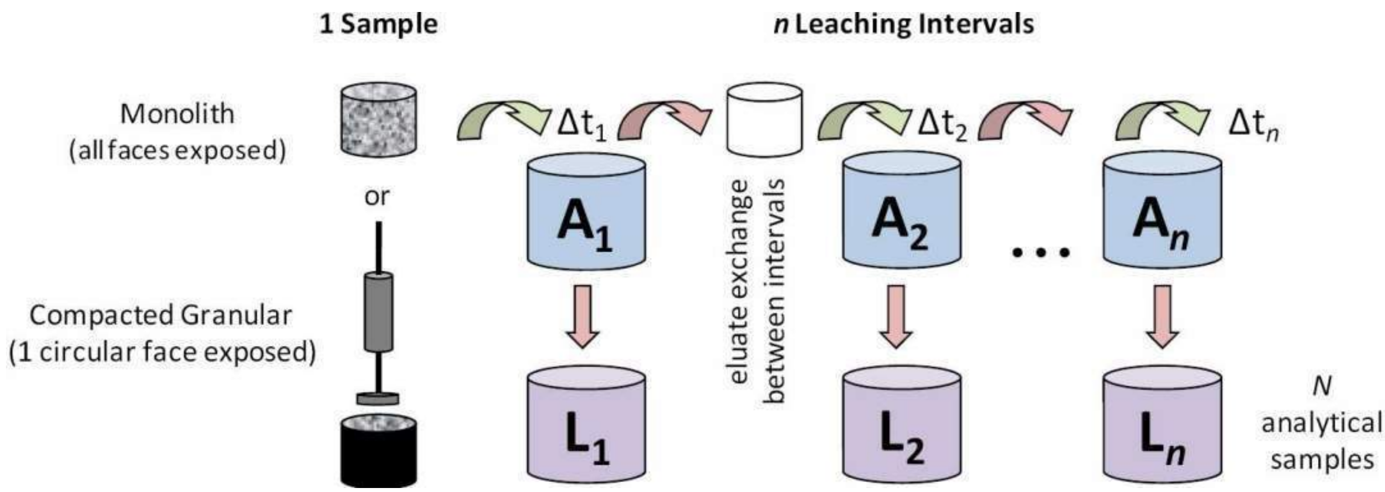


Figure obtained and modified from Ref. 1.

FIGURE 6

EXAMPLE LEACHING PROCEDURE STEPS

Start of Leaching Interval

Sample Centered in Eluant (top view)

Removing Sample for Exchange

Mass of Sample and Holder

FIGURE 7

EXAMPLE DATA REPORTING FORMAT

EPA METHOD 1315
Report of Analysis

ABC Laboratories
123 Main Street
Anytown, USA
Contact: John Smith
(555) 111-1111

Client Contact: Susan Jones
(555) 222-2222

Material Code:	**XYZ**	Particle Size:	88% passing 2-mm sieve
Material Type:	Coal Combustion Fly Ash	Mass used in Column:	860 g
Date Received:	10/1/20xx	Moisture Content:	0.002 g_{H_2O}/g
Test Start Date:	11/1/20xx	Sample Geometry:	Cylinder
Report Date:	12/1/20xx	Sample Diameter	10.0 cm
		Sample Depth:	60.3 cm
Test Type:	Compacted Granular	Mass of Sample & Holder	1020 g
Eluent:	ASTM Type II Water	Lab Temperature:	21 ± 2 °C

Test Position	Replicate	Value	Units	Method	Note
T01	**A**				
	Eluate Sample ID	**XYZ-1315-T01-A**			
	Exchange Date	11/1/20xx			
	Target Exchange Time	12:00	PM		
	Actual Exchange Time	12:15	PM		
	Mass of Sample & Holder	1026	g		
	Eluate Mass	730.4	g		
	Eluate pH	8.82	-	EPA 9040	
	Eluate Conductivity	5.4	mS/c	EPA 9050	
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	4.72	mg/L		EPA 6020	11/7/20xx	1000
As	0.12	mg/L		EPA 6020	11/7/20xx	10
Cl	5.42	mg/L		EPA 9056	11/9/20xx	1

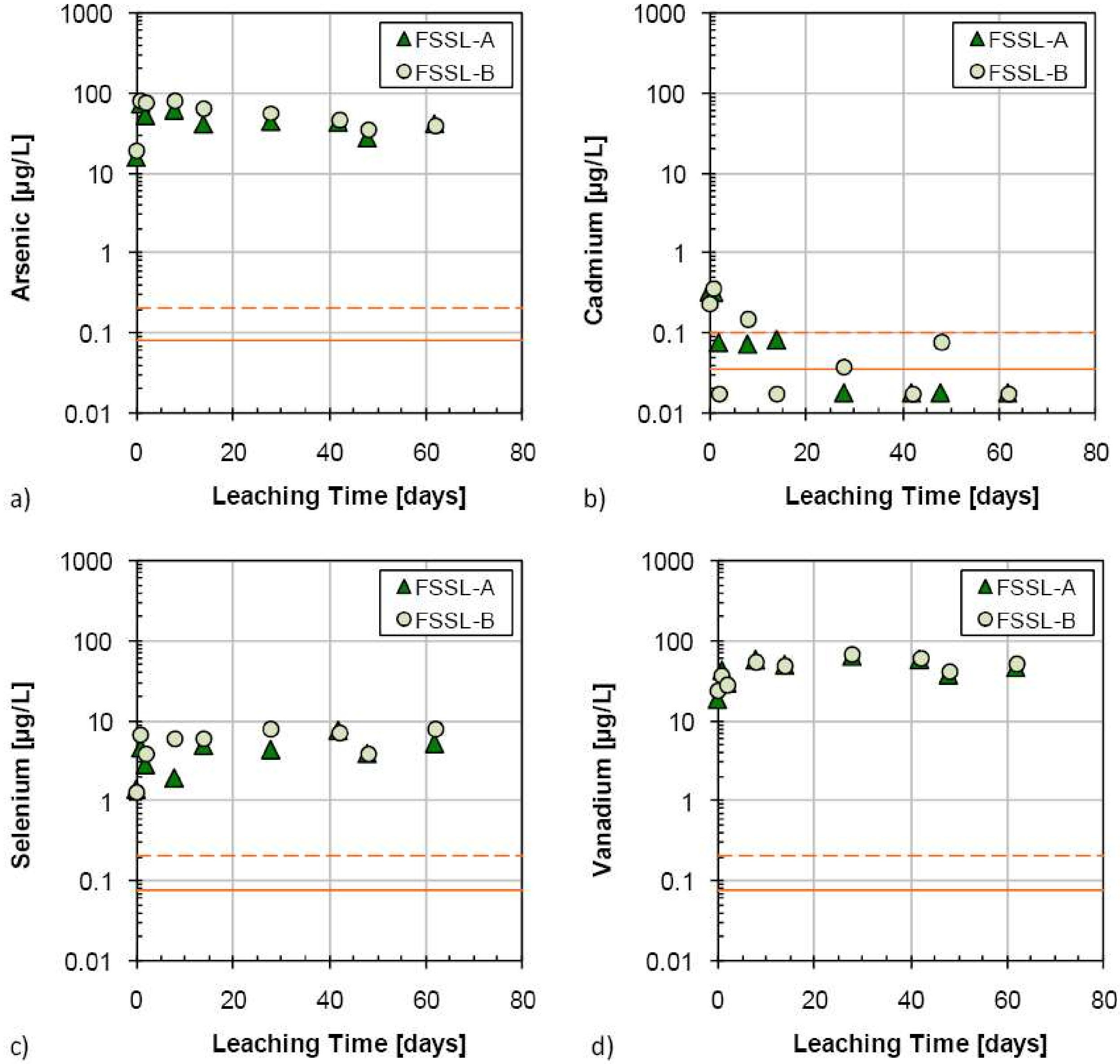
Test Position	Replicate	Value	Units	Method	Note
T02	**A**				
	Eluate Sample ID	**XYZ-1315-T02-A**			
	Exchange Date	11/1/20xx			
	Target Exchange Time	12:00	PM		
	Actual Exchange Time	12:18	PM		
	Mass of Sample & Holder	1027	g		
	Eluate Mass	725.0	g		
	Eluate pH	9.15	-	EPA 9040	
	Eluate Conductivity	2.8	mS/c	EPA 9050	
	Eluate ORP	NA	mv		

Chemical Analysis	Value	Units	QC Flag	Method	Date	Dilution Factor
Al	2.99	mg/L		EPA 6020	11/7/20xx	1000
As	0.21	mg/L		EPA 6020	11/7/20xx	10
Cl	4.20	mg/L	U	EPA 9056	11/7/20xx	1

QC Flag Key: U Value below lower limit of quantitation as reported (< "LLOQ")

FIGURE 8

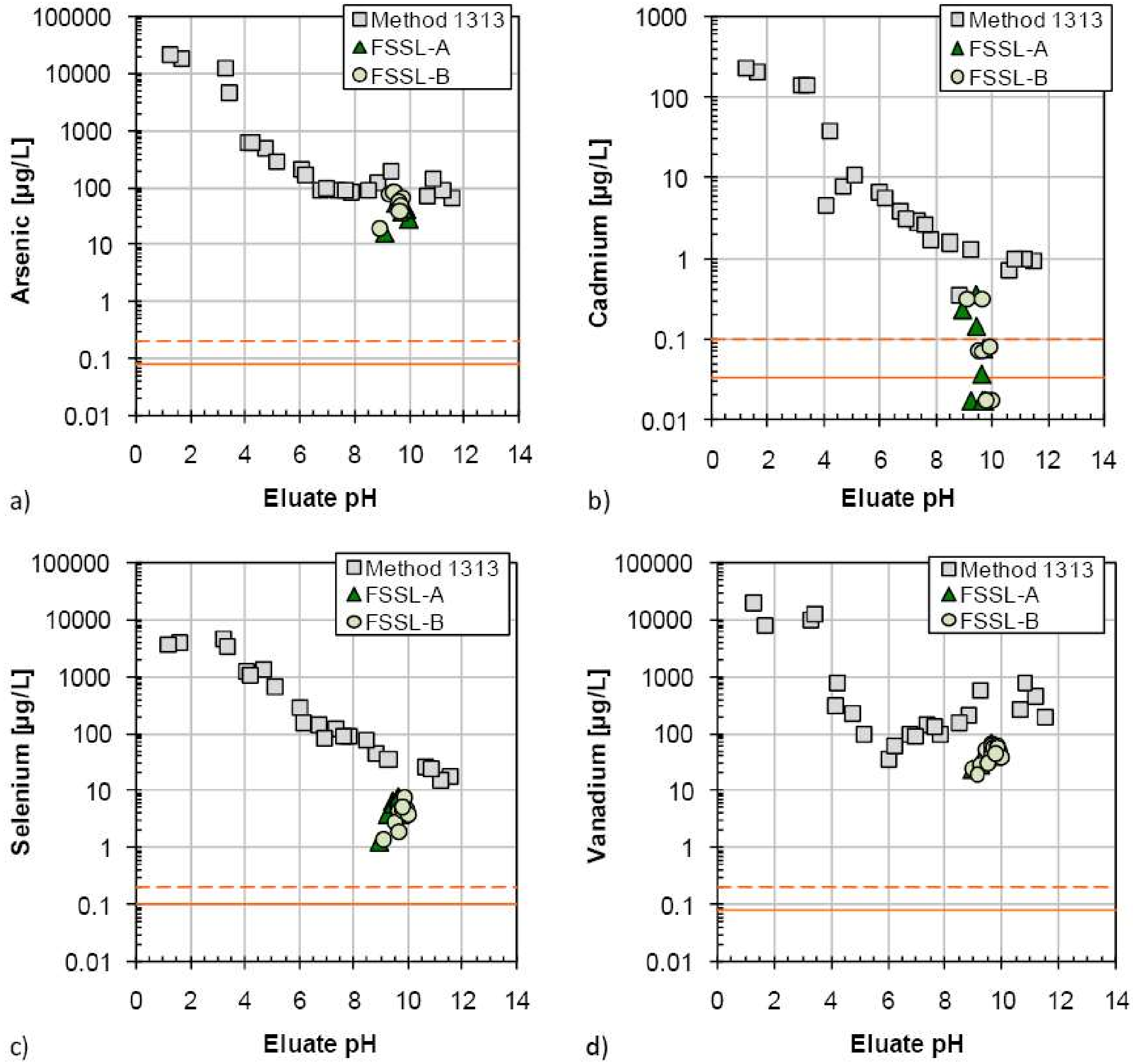
EXAMPLE INTERVAL CONCENTRATION GRAPHS



NOTE: Orange lines represent cumulative release if all eluate extracts were at the quantitation limit (dashed) and detection limit (solid). Chemical analyses below the detection limit are shown at ½ the detection limit value.

FIGURE 9

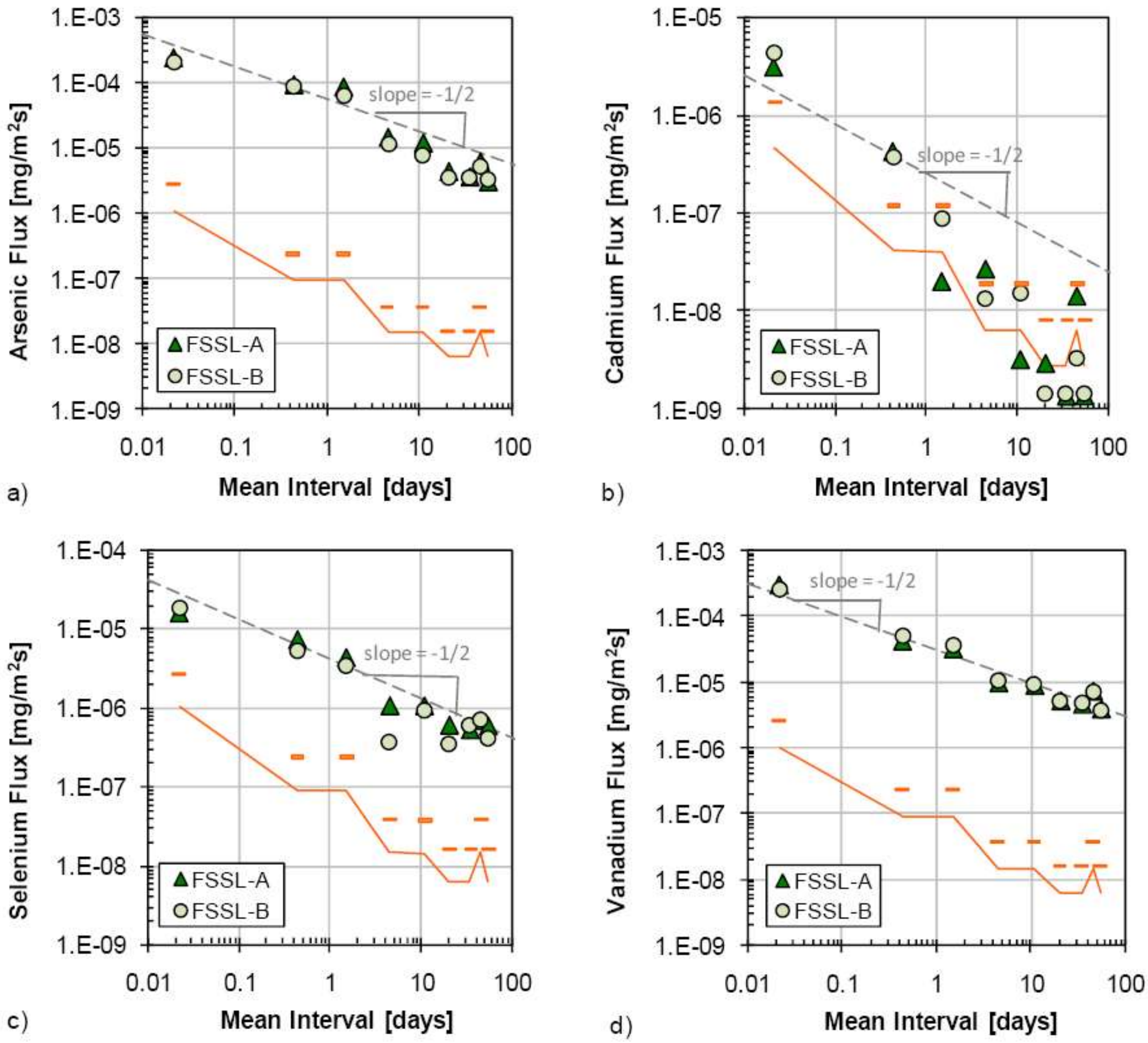
EXAMPLE OF SATURATION CHECK BETWEEN INTERVAL CONCENTRATIONS AND METHOD 1313 DATA



NOTE: Orange lines represent cumulative release if all eluate extracts were at the quantitation limit (dashed) and detection limit (solid). Chemical analyses below the detection limit are shown at ½ the detection limit value.

FIGURE 10

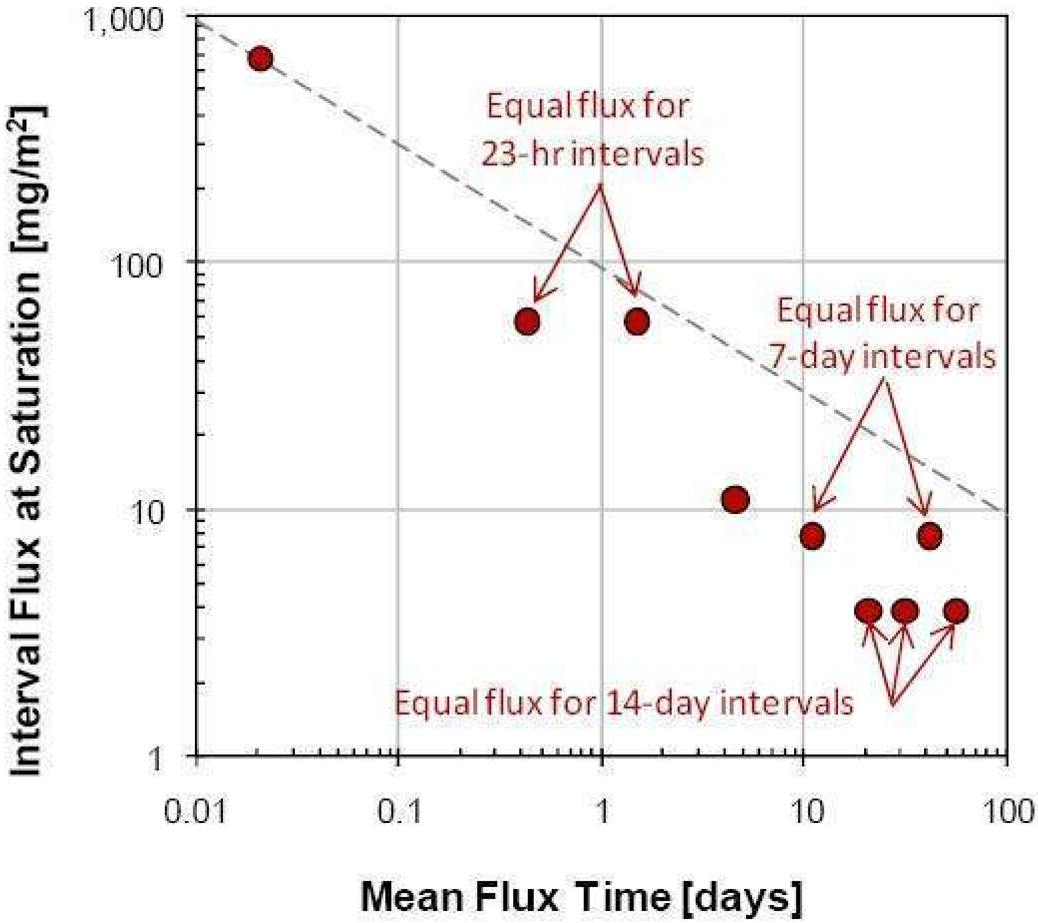
EXAMPLE INTERVAL FLUX GRAPHS



<u>NOTE</u>: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

FIGURE 11

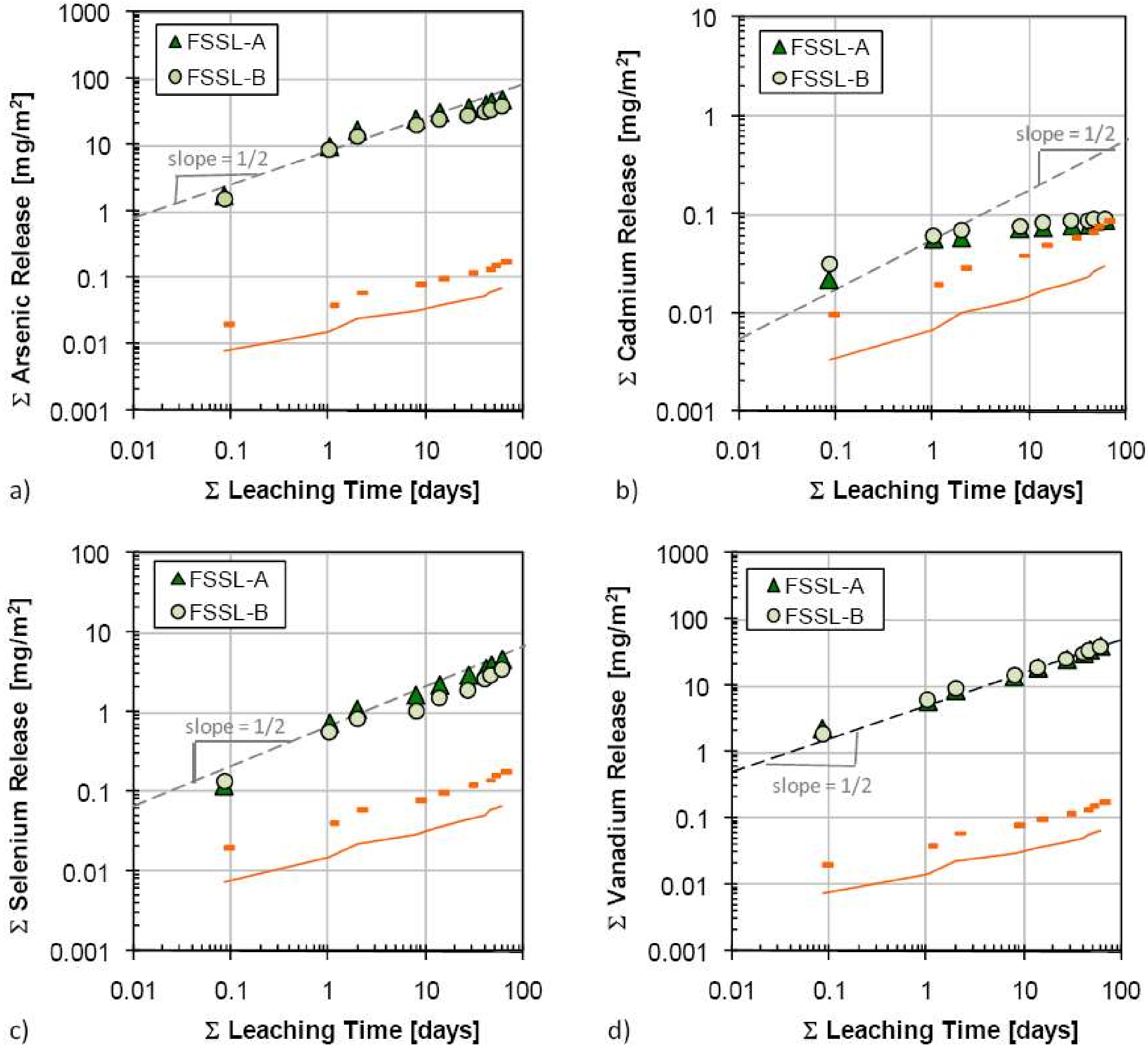
INTERVAL FLUX AT ELUATE SATURATION



NOTE: This figure assumes that the concentration in the eluate approaches saturation during the leaching interval (i.e., the driving force for diffusion approaches zero). When the leaching solution is saturated, the resulting mass release and interval flux is constant for intervals of the same duration.

FIGURE 12

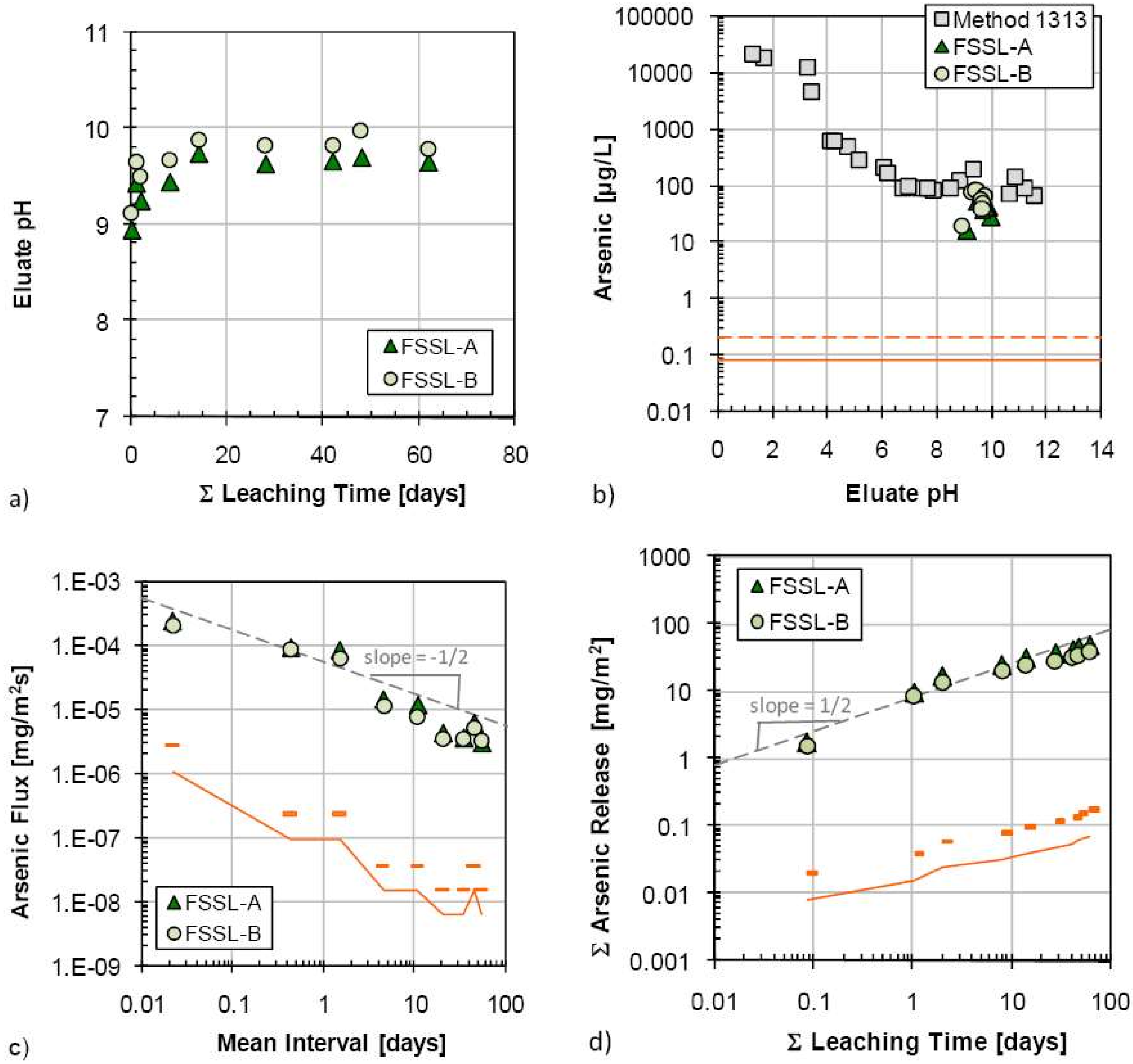
EXAMPLE CUMULATIVE RELEASE GRAPHS



NOTE: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

FIGURE 13

DATA REPRESENTATION BY CONSTITUENT (QUAD FORMAT)



NOTE: Orange data represent cumulative release if all eluate extracts were at the quantitation limit (dashes) and detection limit (solid line).

Appendix E

Groundwater Analytical Lab Results

CDM Smith

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

September 28, 2021

Pam Morrill
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project 261175
Laboratory Reference No. 2109-173

Dear Pam:

Enclosed are the analytical results and associated quality control data for samples submitted on September 17, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

Case Narrative

Samples were collected on September 17, 2021 and received by the laboratory on September 17, 2021. They were maintained at the laboratory at a temperature of 2°C to 6°C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL ARSENIC
EPA 200.8

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Arsenic	**6800**	330	EPA 200.8	9-24-21	9-24-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Arsenic	**430**	83	EPA 200.8	9-24-21	9-24-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Arsenic	**ND**	3.3	EPA 200.8	9-24-21	9-24-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL ARSENIC
EPA 200.8
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0924WM1					
Arsenic	**ND**	3.3	EPA 200.8	9-24-21	9-24-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	09-156-12										
	ORIG	DUP									
Arsenic	**ND**	**ND**	NA	NA		NA		NA	NA	20	
MATRIX SPIKES											
Laboratory ID:	09-156-12										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**123**	**114**	111	111	ND	**111**	**103**	75-125	7	20	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

DISSOLVED ARSENIC
EPA 200.8

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Arsenic	**7000**	150	EPA 200.8		9-20-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Arsenic	**390**	38	EPA 200.8		9-20-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Arsenic	**ND**	3.0	EPA 200.8		9-20-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

DISSOLVED ARSENIC
EPA 200.8
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0915F1					
Arsenic	**ND**	3.0	EPA 200.8	9-15-21	9-20-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	09-131-01										
	ORIG	DUP									
Arsenic	**ND**	**ND**	NA	NA		NA		NA	NA	20	
MATRIX SPIKES											
Laboratory ID:	09-131-01										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**79.6**	**77.0**	80.0	80.0	ND	**100**	**96**	75-125	3	20	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL ALKALINITY
SM 2320B

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Total Alkalinity	**160**	2.0	SM 2320B	9-21-21	9-21-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Total Alkalinity	**82**	2.0	SM 2320B	9-21-21	9-21-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Total Alkalinity	**86**	2.0	SM 2320B	9-21-21	9-21-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL ALKALINITY
SM 2320B
QUALITY CONTROL

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0921W1					
Total Alkalinity	**ND**	2.0	SM 2320B	9-21-21	9-21-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	09-173-01								
	ORIG	DUP							
Total Alkalinity	**156**	**156**	NA	NA	NA	NA	0	10	
SPIKE BLANK									
Laboratory ID:	SB0921W1								
	SB		SB		SB				
Total Alkalinity	**94.0**		100	NA	94	89-110	NA	NA	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

CARBONATE/BICARBONATE
SM 2320B

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	9-21-21	9-21-21	
Bicarbonate Concentration	**160**	2.0	SM 2320B	9-21-21	9-21-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	9-21-21	9-21-21	
Bicarbonate Concentration	**82**	2.0	SM 2320B	9-21-21	9-21-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	9-21-21	9-21-21	
Bicarbonate Concentration	**86**	2.0	SM 2320B	9-21-21	9-21-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

CARBONATE/BICARBONATE
SM 2320B
QUALITY CONTROL

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0921W1					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	9-21-21	9-21-21	
Bicarbonate Concentration	**ND**	2.0	SM 2320B	9-21-21	9-21-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	09-173-01								
	ORIG	DUP							
Total Alkalinity	**156**	**156**	NA	NA	NA	NA	0	10	
SPIKE BLANK									
Laboratory ID:	SB0921W1								
	SB		SB		SB				
Total Alkalinity	**94.0**		100	NA	94	89-110	NA	NA	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL SUSPENDED SOLIDS
SM 2540D

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Total Suspended Solids	**7.0**	4.0	SM 2540D	9-20-21	9-21-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Total Suspended Solids	**ND**	4.0	SM 2540D	9-20-21	9-21-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Total Suspended Solids	**ND**	4.0	SM 2540D	9-20-21	9-21-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL SUSPENDED SOLIDS
SM 2540D
QUALITY CONTROL

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0920W1					
Total Suspended Solids	**ND**	4.0	SM 2540D	9-20-21	9-21-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	09-134-01								
	ORIG	DUP							
Total Suspended Solids	**ND**	**ND**	NA	NA	NA	NA	NA	26	
SPIKE BLANK									
Laboratory ID:	SB0920W1								
	SB		SB		SB				
Total Suspended Solids	**73.0**		100	NA	73	67-118	NA	NA	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL DISSOLVED SOLIDS
SM 2540C

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1**					
Laboratory ID:	09-173-01					
Total Dissolved Solids	**250**	13	SM 2540C	9-21-21	9-22-21	
Client ID:	**P3-2**					
Laboratory ID:	09-173-02					
Total Dissolved Solids	**170**	13	SM 2540C	9-21-21	9-22-21	
Client ID:	**MW-1**					
Laboratory ID:	09-173-03					
Total Dissolved Solids	**170**	13	SM 2540C	9-21-21	9-22-21	

Date of Report: September 28, 2021
Samples Submitted: September 17, 2021
Laboratory Reference: 2109-173
Project: 261175

TOTAL DISSOLVED SOLIDS
SM 2540C
QUALITY CONTROL

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB0921W1					
Total Dissolved Solids	**ND**	13	SM 2540C	9-21-21	9-22-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	09-150-01								
	ORIG	DUP							
Total Dissolved Solids	**1980**	**1950**	NA	NA	NA	NA	2	29	
SPIKE BLANK									
Laboratory ID:	SB0921W1								
	SB		SB		SB				
Total Dissolved Solids	**444**		500	NA	89	84-110	NA	NA	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

OnSite Environmental Inc.

Analytical Laboratory Testing Services
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • www.onsite-env.com

Chain of Custody

Page 1 of 1

Laboratory Number: 09-173

Company: CDM SMITH
Project Number: 261175 (PO 102063)
Project Name: USG-PUYALLUP
Project Manager: P. MORRILL
Sampled by: B. MILLER

Turnaround Request (in working days)

(Check One)

- ☐ Same Day
- ☐ 1 Day
- ☐ 2 Days
- ☐ 3 Days
- ☒ Standard (7 Days)
- ☐ ______ (other)

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	Number of Containers
1	P3-1	9-17-21	1050	GW	4
2	P3-2	↓	1135	↓	↓
3	MW-1	↓	1225	↓	↓

Lab ID	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Gx	NWTPH-Dx (☐ Acid / SG Clean-up)	Volatiles 8260D	Halogenated Volatiles 8260D	EDB EPA 8011 (Waters Only)	Semivolatiles 8270E/SIM (with low-level PAHs)	PAHs 8270E/SIM (low-level)	PCBs 8082A	Organochlorine Pesticides 8081B	Organophosphorus Pesticides 8270E/SIM	Chlorinated Acid Herbicides 8151A	Total RCRA Metals	Total MTCA Metals	TCLP Metals	HEM (oil and grease) 1664A	TOTAL + DISSOLVED ARSENIC EPA 7066A	ALK/CARBONATE/BICARBONATE SM 2320B	TSS (SM 2540D)	TDS (SM 2540C)	% Moisture
1																		X	X	X	X	
2																		↓	↓	↓	↓	
3																		↓	↓	↓	↓	

	Signature	Company	Date	Time
Relinquished	[signature]	CDM SMITH	9-17-21	1440
Received	[signature]	OSE	9.17.21	1445
Relinquished				
Received				
Relinquished				
Received				
Reviewed/Date		Reviewed/Date		

Comments/Special Instructions

FIELD FILTERED INTO DISSOLVED METALS BOTTLE

Data Package: Standard ☐ Level III ☐ Level IV ☐

Chromatograms with final report ☐ Electronic Data Deliverables (EDDs) ☐

OnSite
Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

December 13, 2021

Pam Morrill
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project USG Puyallup
Laboratory Reference No. 2112-028

Dear Pam:

Enclosed are the analytical results and associated quality control data for samples submitted on December 2, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

Case Narrative

Samples were collected on December 2, 2021 and received by the laboratory on December 2, 2021. They were maintained at the laboratory at a temperature of 2^{o}C to 6^{o}C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL ARSENIC
EPA 200.8

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Arsenic	**390**	8.3	EPA 200.8	12-6-21	12-6-21	
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Arsenic	**9400**	830	EPA 200.8	12-6-21	12-6-21	
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Arsenic	**ND**	3.3	EPA 200.8	12-6-21	12-6-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL ARSENIC
EPA 200.8
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1206WM1					
Arsenic	**ND**	3.3	EPA 200.8	12-6-21	12-6-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	12-001-01										
	ORIG	DUP									
Arsenic	**13.4**	**13.2**	NA	NA		NA		NA	2	20	
MATRIX SPIKES											
Laboratory ID:	12-001-01										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**131**	**143**	111	111	13.4	**106**	**117**	75-125	9	20	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

DISSOLVED ARSENIC
EPA 200.8

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Arsenic	**330**	7.5	EPA 200.8		12-3-21	

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Arsenic	**9400**	750	EPA 200.8		12-3-21	

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Arsenic	**ND**	3.0	EPA 200.8		12-3-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

DISSOLVED ARSENIC
EPA 200.8
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1203D1					
Arsenic	**ND**	3.0	EPA 200.8		12-3-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	12-028-03										
	ORIG	DUP									
Arsenic	**ND**	**ND**	NA	NA		NA		NA	NA	20	
MATRIX SPIKES											
Laboratory ID:	12-028-03										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**83.6**	**83.6**	80.0	80.0	ND	**105**	**105**	75-125	0	20	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL ALKALINITY
SM 2320B

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Total Alkalinity	**96**	2.0	SM 2320B	12-3-21	12-3-21	
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Total Alkalinity	**170**	2.0	SM 2320B	12-3-21	12-3-21	
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Total Alkalinity	**70**	2.0	SM 2320B	12-3-21	12-3-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL ALKALINITY
SM 2320B
QUALITY CONTROL

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1203W1					
Total Alkalinity	**ND**	2.0	SM 2320B	12-3-21	12-3-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	12-028-01								
	ORIG	DUP							
Total Alkalinity	**96.0**	**94.0**	NA	NA	NA	NA	2	10	
SPIKE BLANK									
Laboratory ID:	SB1203W1								
	SB		SB		SB				
Total Alkalinity	**94.0**		100	NA	94	89-110	NA	NA	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

CARBONATE BICARBONATE
SM 2320B

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	12-3-21	12-3-21	
Bicarbonate Concentration	**96**	2.0	SM 2320B	12-3-21	12-3-21	
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	12-3-21	12-3-21	
Bicarbonate Concentration	**170**	2.0	SM 2320B	12-3-21	12-3-21	
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	12-3-21	12-3-21	
Bicarbonate Concentration	**70**	2.0	SM 2320B	12-3-21	12-3-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

CARBONATE BICARBONATE
SM 2320B
QUALITY CONTROL

Matrix: Water
Units: mg CaCO3/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1203W1					
Carbonate Alkalinity	**ND**	2.0	SM 2320B	12-3-21	12-3-21	
Bicarbonate Concentration	**ND**	2.0	SM 2320B	12-3-21	12-3-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	12-028-01								
	ORIG	DUP							
Total Alkalinity	**96.0**	**94.0**	NA	NA	NA	NA	2	10	
SPIKE BLANK									
Laboratory ID:	SB1203W1								
	SB		SB		SB				
Total Alkalinity	**94.0**		100	NA	94	89-110	NA	NA	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL DISSOLVED SOLIDS
SM 2540C

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Total Dissolved Solids	**190**	13	SM 2540C	12/03//21	12-6-21	
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Total Dissolved Solids	**300**	13	SM 2540C	12/03//21	12-6-21	
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Total Dissolved Solids	**160**	13	SM 2540C	12/03//21	12-6-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL DISSOLVED SOLIDS
SM 2540C
QUALITY CONTROL

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1203W1					
Total Dissolved Solids	**ND**	13	SM 2540C	12/03//21	12-6-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	11-266-02								
	ORIG	DUP							
Total Dissolved Solids	**380**	**371**	NA	NA	NA	NA	2	29	
SPIKE BLANK									
Laboratory ID:	SB1203W1								
	SB		SB		SB				
Total Dissolved Solids	**491**		500	NA	98	84-110	NA	NA	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL SUSPENDED SOLIDS
SM 2540D

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**P3-2-120221**					
Laboratory ID:	12-028-01					
Total Suspended Solids	**ND**	4.0	SM 2540D	12-6-21	12-7-21	
Client ID:	**P3-1-120221**					
Laboratory ID:	12-028-02					
Total Suspended Solids	**ND**	4.0	SM 2540D	12-6-21	12-7-21	
Client ID:	**MW1-120221**					
Laboratory ID:	12-028-03					
Total Suspended Solids	**ND**	4.0	SM 2540D	12-6-21	12-7-21	

Date of Report: December 13, 2021
Samples Submitted: December 2, 2021
Laboratory Reference: 2112-028
Project: USG Puyallup

TOTAL SUSPENDED SOLIDS
SM 2540D
QUALITY CONTROL

Matrix: Water
Units: mg/L

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1206W1					
Total Suspended Solids	**ND**	4.0	SM 2540D	12-6-21	12-7-21	

Analyte	Result		Spike Level	Source Result	Percent Recovery	Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE									
Laboratory ID:	12-047-01								
	ORIG	DUP							
Total Suspended Solids	**10.0**	**11.0**	NA	NA	NA	NA	10	26	
SPIKE BLANK									
Laboratory ID:	SB1206W1								
	SB		SB		SB				
Total Suspended Solids	**88.0**		100	NA	88	67-118	NA	NA	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

OnSite Environmental Inc.
Analytical Laboratory Testing Services
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • www.onsite-env.com

Chain of Custody

Laboratory Number: 12-028

Company: CDM Smith
Project Number: PO # 102063 Line 1
Project Name: USG Puyallup
Project Manager: PAM MORRIL
Sampled by: M. Simon

Turnaround Request (in working days)
(Check One)
- [ ] Same Day
- [ ] 1 Day
- [ ] 2 Days
- [ ] 3 Days
- [x] Standard (7 Days)
- [ ] ______ (other)

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	Number of Containers	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Gx	NWTPH-Dx (☐ Acid / SG Clean-up)	Volatiles 8260D	Halogenated Volatiles 8260D	EDB EPA 8011 (Waters Only)	Semivolatiles 8270E/SIM (with low-level PAHs)	PAHs 8270E/SIM (low-level)	PCBs 8082A	Organochlorine Pesticides 8081B	Organophosphorus Pesticides 8270E/SIM	Chlorinated Acid Herbicides 8151A	Total RCRA Metals	Total MTCA Metals	TCLP Metals	HEM (oil and grease) 1664A	Total Arsenic	Dissolved Arsenic	Total alkalinity	Carbonate, bicarbonate	TDS, TSS
1	P3-2-120221	12/2	1115	GW	3																		X	X	X	X	X
2	P3-1-120221	↓	1215	GW	3																		X	X	X	X	X
3	MW1-120221	↓	1315	GW	3																		X	X	X	X	X

	Signature	Company	Date	Time
Relinquished	[signature]	CDM Smith	12/2/21	1535
Received	Nichole Bfhin	OSE	12/2/21	1535
Relinquished				
Received				
Relinquished				
Received				
Reviewed/Date		Reviewed/Date		

Comments/Special Instructions

Data Package: Standard ☐ Level III ☐ Level IV ☐

Chromatograms with final report ☐ Electronic Data Deliverables (EDDs) ☐

Appendix F

UCS Laboratory Results and Photolog

CDM Smith

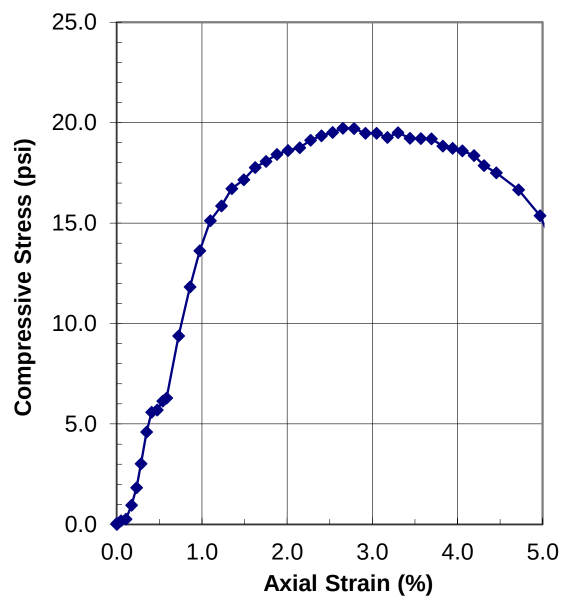
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

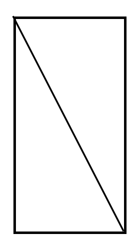
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	9/30/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C2		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**50.5**		
Mass (g):	354.5	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.29
Height (in) :	3.91	Strain at Failure (%):	2.65
Height to Dia. Ratio :	1.91	U. C. Strength (psi) :	**19.7**
Wet Density (pcf) :	**105.3**	Shear Strength (psi):	9.9
Dry Density (pcf) :	**70.0**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.28	0.00	0.00
2	0.000	0.2	3.28	0.00	0.06
5	0.002	0.6	3.28	0.05	0.19
8	0.004	0.9	3.28	0.11	0.26
11	0.007	3.2	3.28	0.17	0.97
14	0.009	6.0	3.28	0.23	1.83
17	0.011	9.9	3.28	0.29	3.03
20	0.014	15.1	3.28	0.35	4.61
23	0.016	18.3	3.28	0.41	5.58
26	0.019	18.7	3.28	0.48	5.69
29	0.021	20.2	3.28	0.54	6.15
32	0.023	20.6	3.28	0.59	6.29
38	0.028	30.8	3.28	0.73	9.38
44	0.034	38.8	3.28	0.86	11.83
50	0.038	44.7	3.28	0.97	13.63
56	0.043	49.6	3.28	1.10	15.13
62	0.048	52.0	3.28	1.23	15.86
68	0.053	54.8	3.28	1.35	16.71
74	0.058	56.3	3.28	1.49	17.16
80	0.063	58.3	3.28	1.62	17.77
86	0.069	59.3	3.28	1.75	18.07
92	0.074	60.4	3.28	1.88	18.42
98	0.079	61.0	3.28	2.01	18.61
104	0.084	61.5	3.28	2.15	18.76
110	0.089	62.8	3.28	2.27	19.13
116	0.094	63.5	3.28	2.40	19.35
122	0.099	64.0	3.28	2.54	19.51
128	0.104	64.7	3.28	2.65	19.72
134	0.109	64.6	3.28	2.79	19.71
140	0.114	63.9	3.28	2.92	19.48
146	0.119	63.9	3.28	3.05	19.48
152	0.124	63.2	3.28	3.18	19.27
158	0.129	64.0	3.28	3.30	19.51
164	0.135	63.1	3.28	3.44	19.22



Failure Sketch



Remarks: None.

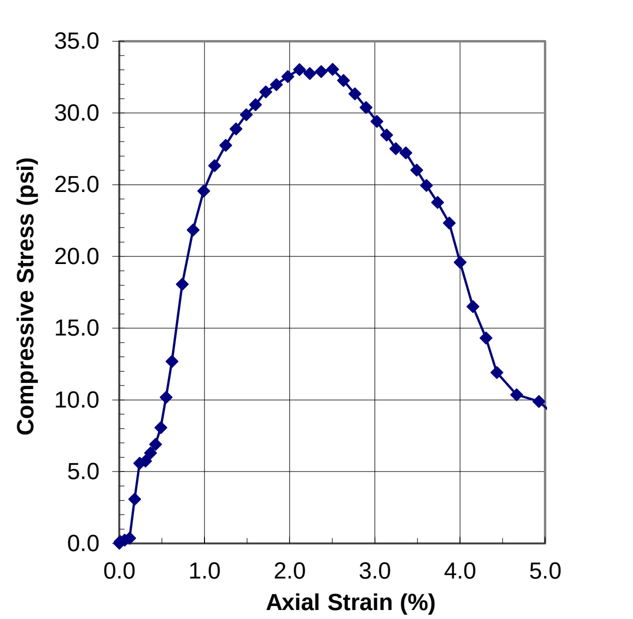
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

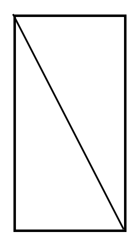
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	9/30/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C12		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**39.2**		
Mass (g):	372.7	Loading Rate (in/min) :	0.05
Area (sq in) :	3.29	Dial Rate :	5.8
Diameter (in) :	2.05	Strain Rate (%/min)	1.26
Height (in) :	3.94	Strain at Failure (%):	2.50
Height to Dia. Ratio :	1.92	U. C. Strength (psi) :	**33.0**
Wet Density (pcf) :	**109.7**	Shear Strength (psi):	16.5
Dry Density (pcf) :	**78.8**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.096	0.1	3.29	0.00	0.02
6	0.096	0.5	3.29	0.01	0.14
8	0.098	0.8	3.29	0.06	0.23
11	0.101	1.2	3.29	0.12	0.37
14	0.103	10.2	3.29	0.18	3.10
17	0.105	18.4	3.29	0.24	5.59
20	0.108	18.9	3.29	0.31	5.74
23	0.110	20.7	3.29	0.37	6.31
26	0.113	22.7	3.29	0.43	6.91
29	0.115	26.6	3.29	0.49	8.08
32	0.118	33.5	3.29	0.55	10.18
35	0.120	41.7	3.29	0.62	12.69
41	0.125	59.4	3.29	0.74	18.07
47	0.130	71.9	3.29	0.87	21.86
53	0.135	80.8	3.29	0.99	24.57
59	0.140	86.6	3.29	1.12	26.34
65	0.145	91.2	3.29	1.25	27.75
71	0.150	95.0	3.29	1.37	28.89
77	0.155	98.2	3.29	1.49	29.88
83	0.159	100.6	3.29	1.60	30.59
89	0.164	103.5	3.29	1.72	31.47
95	0.169	105.1	3.29	1.84	31.98
101	0.174	107.0	3.29	1.98	32.54
107	0.179	108.6	3.29	2.11	33.03
113	0.184	107.7	3.29	2.24	32.76
119	0.189	108.2	3.29	2.37	32.90
125	0.195	108.6	3.29	2.50	33.04
131	0.200	106.1	3.29	2.63	32.27
137	0.205	103.0	3.29	2.77	31.34
143	0.210	99.9	3.29	2.90	30.38
149	0.215	96.7	3.29	3.02	29.42
155	0.219	93.6	3.29	3.14	28.46
161	0.224	90.5	3.29	3.24	27.52
167	0.228	89.5	3.29	3.36	27.23



Failure Sketch



Remarks: None.

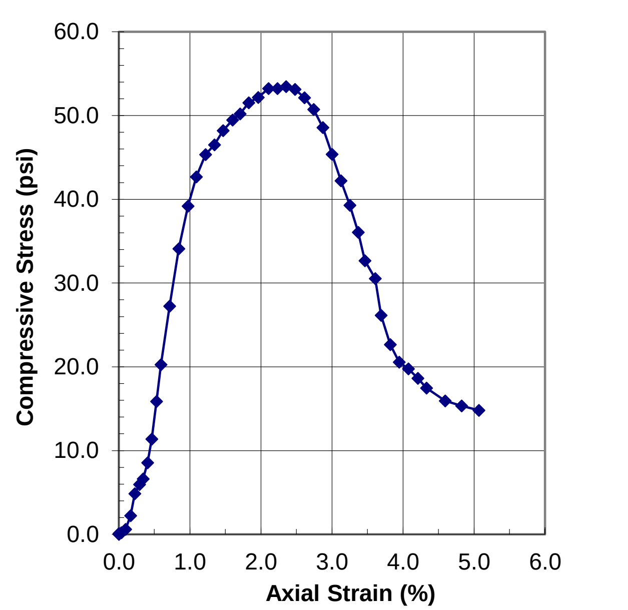
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

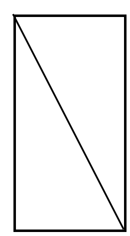
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C22		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**38.5**		
Mass (g):	380.7	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.25
Height (in) :	3.94	Strain at Failure (%):	2.35
Height to Dia. Ratio :	1.93	U. C. Strength (psi) :	**53.5**
Wet Density (pcf) :	**112.3**	Shear Strength (psi):	26.7
Dry Density (pcf) :	**81.1**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.095	0.1	3.28	0.00	0.02
4	0.095	0.3	3.28	0.00	0.11
7	0.096	0.6	3.28	0.03	0.19
10	0.099	2.0	3.28	0.10	0.60
13	0.102	7.3	3.28	0.17	2.22
16	0.104	15.9	3.28	0.22	4.86
19	0.107	19.5	3.28	0.29	5.96
22	0.109	21.8	3.28	0.34	6.64
25	0.111	28.0	3.28	0.41	8.54
28	0.113	37.3	3.28	0.46	11.38
31	0.116	52.0	3.28	0.53	15.87
34	0.119	66.4	3.28	0.59	20.26
40	0.123	89.3	3.28	0.71	27.26
46	0.128	111.8	3.28	0.84	34.11
52	0.133	128.4	3.28	0.97	39.18
58	0.138	139.9	3.28	1.09	42.69
64	0.143	148.6	3.28	1.22	45.36
70	0.148	152.3	3.28	1.34	46.50
76	0.153	157.9	3.28	1.47	48.19
82	0.158	162.1	3.28	1.60	49.47
88	0.162	164.5	3.28	1.71	50.21
94	0.167	168.8	3.28	1.83	51.53
100	0.172	171.0	3.28	1.96	52.18
106	0.178	174.4	3.28	2.11	53.23
112	0.183	174.4	3.28	2.23	53.23
118	0.188	175.1	3.28	2.35	53.46
124	0.193	174.1	3.28	2.48	53.14
130	0.198	170.8	3.28	2.61	52.14
136	0.203	166.2	3.28	2.74	50.73
142	0.208	159.1	3.28	2.87	48.56
148	0.213	148.7	3.28	3.00	45.39
154	0.218	138.3	3.28	3.13	42.22
160	0.223	128.8	3.28	3.25	39.30
166	0.228	118.1	3.28	3.37	36.06



Failure Sketch



Remarks: None.

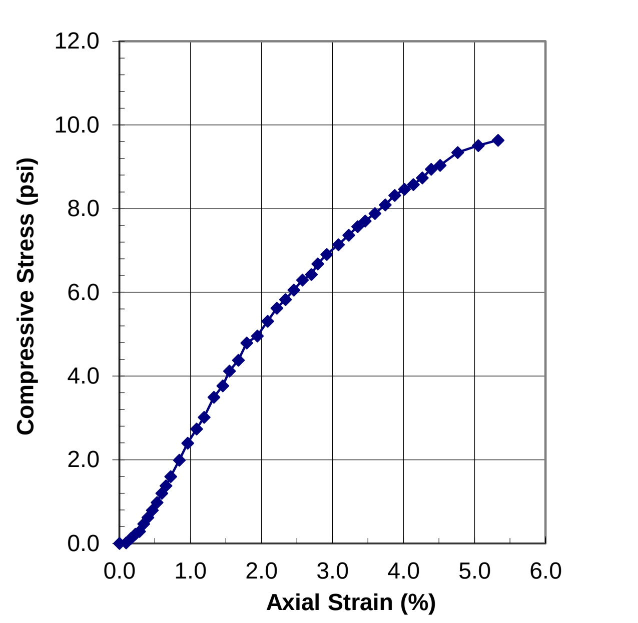
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

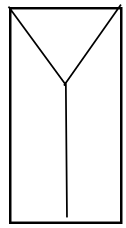
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C32		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**38.5**		
Mass (g):	380.7	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.22
Height (in) :	3.94	Strain at Failure (%):	5.86
Height to Dia. Ratio :	1.93	U. C. Strength (psi) :	**9.6**
Wet Density (pcf) :	**112.3**	Shear Strength (psi):	4.8
Dry Density (pcf) :	**81.1**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.28	0.00	0.00
8	0.004	0.0	3.28	0.09	0.02
11	0.006	0.4	3.28	0.16	0.12
14	0.009	0.7	3.28	0.23	0.22
17	0.011	0.9	3.28	0.28	0.29
20	0.014	1.5	3.28	0.34	0.47
23	0.016	2.0	3.28	0.40	0.62
26	0.018	2.6	3.28	0.46	0.79
29	0.021	3.2	3.28	0.53	0.98
32	0.024	3.9	3.28	0.60	1.20
35	0.026	4.5	3.28	0.66	1.38
38	0.028	5.2	3.28	0.72	1.60
44	0.033	6.5	3.28	0.84	1.99
50	0.038	7.8	3.28	0.96	2.40
56	0.043	9.0	3.28	1.09	2.73
62	0.047	9.9	3.28	1.19	3.02
68	0.052	11.4	3.28	1.33	3.49
74	0.057	12.3	3.28	1.46	3.77
80	0.061	13.5	3.28	1.55	4.12
86	0.066	14.4	3.28	1.68	4.38
92	0.071	15.7	3.28	1.79	4.79
98	0.077	16.2	3.28	1.94	4.96
104	0.082	17.4	3.28	2.09	5.31
110	0.087	18.4	3.28	2.22	5.62
116	0.092	19.1	3.28	2.34	5.83
122	0.097	19.8	3.28	2.45	6.06
128	0.102	20.6	3.28	2.58	6.30
134	0.107	21.1	3.28	2.70	6.43
140	0.110	21.9	3.28	2.80	6.68
146	0.115	22.6	3.28	2.92	6.91
152	0.122	23.4	3.28	3.08	7.14
158	0.127	24.1	3.28	3.23	7.37
164	0.132	24.8	3.28	3.35	7.57
170	0.136	25.2	3.28	3.46	7.71



Failure Sketch



Remarks: None.

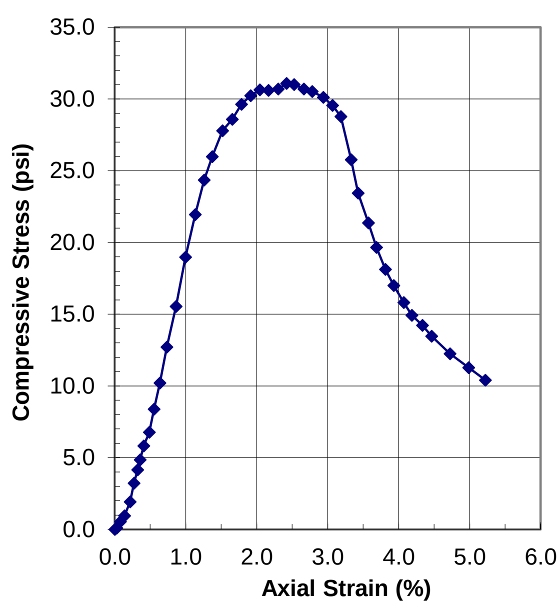
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

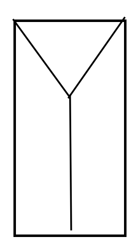
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C42		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**34.0**		
Mass (g):	393.3	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.25
Height (in) :	3.96	Strain at Failure (%):	2.42
Height to Dia. Ratio :	1.93	U. C. Strength (psi) :	**31.1**
Wet Density (pcf) :	**115.5**	Shear Strength (psi):	15.5
Dry Density (pcf) :	**86.2**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.087	0.0	3.28	0.00	0.01
1	0.088	0.3	3.28	0.03	0.10
4	0.090	1.8	3.28	0.08	0.55
7	0.092	3.1	3.28	0.14	0.96
10	0.095	6.3	3.28	0.22	1.93
13	0.098	10.6	3.28	0.27	3.22
16	0.100	13.6	3.28	0.32	4.16
19	0.101	15.9	3.28	0.36	4.86
22	0.103	19.1	3.28	0.41	5.82
25	0.106	22.2	3.28	0.49	6.77
28	0.109	27.5	3.28	0.55	8.39
31	0.112	33.5	3.28	0.63	10.21
37	0.116	41.7	3.28	0.74	12.72
43	0.121	51.0	3.28	0.86	15.54
49	0.126	62.3	3.28	1.00	18.99
55	0.132	72.0	3.28	1.13	21.95
61	0.137	79.9	3.28	1.26	24.35
67	0.141	85.2	3.28	1.37	25.98
73	0.147	91.2	3.28	1.52	27.80
79	0.152	93.8	3.28	1.66	28.59
85	0.157	97.2	3.28	1.78	29.63
91	0.163	99.2	3.28	1.91	30.24
97	0.168	100.5	3.28	2.04	30.65
103	0.173	100.4	3.28	2.17	30.60
109	0.178	100.7	3.28	2.30	30.71
115	0.183	101.9	3.28	2.42	31.08
121	0.187	101.7	3.28	2.53	31.01
127	0.192	100.7	3.28	2.66	30.71
133	0.197	100.1	3.28	2.78	30.52
139	0.203	98.8	3.28	2.94	30.12
145	0.208	96.9	3.28	3.07	29.55
151	0.213	94.4	3.28	3.19	28.78
157	0.219	84.5	3.28	3.33	25.77
163	0.222	76.9	3.28	3.43	23.44



Failure Sketch



Remarks: None.

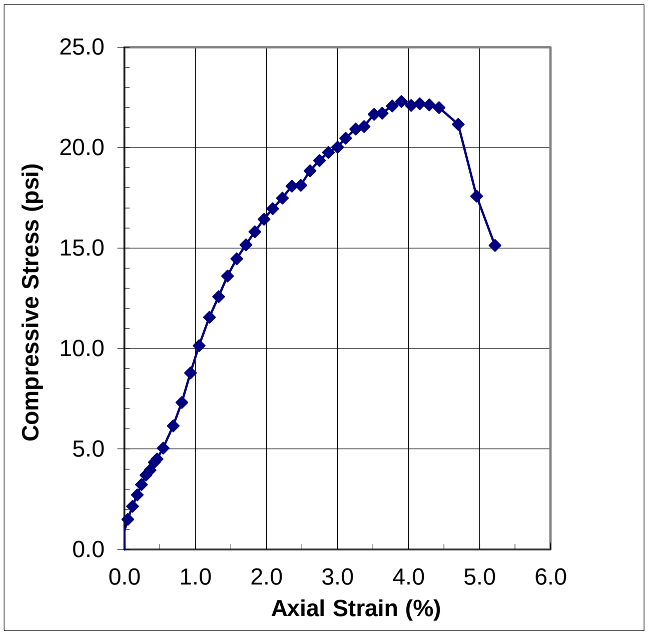
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

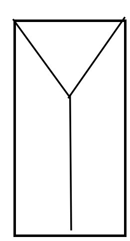
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C52		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**32.4**		
Mass (g):	398.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.30
Height (in) :	3.95	Strain at Failure (%):	3.90
Height to Dia. Ratio :	1.93	U. C. Strength (psi) :	**22.3**
Wet Density (pcf) :	**117.5**	Shear Strength (psi):	11.2
Dry Density (pcf) :	**88.8**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.104	0.0	3.28	0.00	0.00
3	0.104	0.0	3.28	0.00	0.00
6	0.104	2.9	3.28	0.00	0.90
9	0.106	4.9	3.28	0.05	1.50
12	0.109	7.0	3.28	0.12	2.15
15	0.111	8.9	3.28	0.18	2.72
18	0.113	10.6	3.28	0.24	3.23
21	0.116	12.1	3.28	0.30	3.70
24	0.118	13.0	3.28	0.36	3.96
27	0.121	14.2	3.28	0.42	4.34
30	0.122	14.8	3.28	0.46	4.50
33	0.126	16.5	3.28	0.55	5.05
39	0.131	20.2	3.28	0.69	6.15
45	0.136	24.0	3.28	0.81	7.32
51	0.141	28.8	3.28	0.93	8.79
57	0.146	33.2	3.28	1.05	10.14
63	0.151	37.8	3.28	1.20	11.55
69	0.156	41.2	3.28	1.32	12.59
75	0.161	44.6	3.28	1.45	13.61
81	0.166	47.4	3.28	1.58	14.47
87	0.172	49.7	3.28	1.71	15.17
93	0.176	51.8	3.28	1.83	15.82
99	0.182	53.9	3.28	1.97	16.44
105	0.186	55.6	3.28	2.09	16.96
111	0.192	57.3	3.28	2.22	17.49
117	0.197	59.2	3.28	2.36	18.08
123	0.202	59.4	3.28	2.48	18.13
129	0.207	61.8	3.28	2.61	18.85
135	0.212	63.4	3.28	2.75	19.36
141	0.217	64.8	3.28	2.87	19.77
147	0.222	65.6	3.28	3.00	20.04
153	0.227	67.1	3.28	3.12	20.48
159	0.232	68.6	3.28	3.25	20.93
165	0.237	69.0	3.28	3.37	21.06



Failure Sketch



Remarks: None.

CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

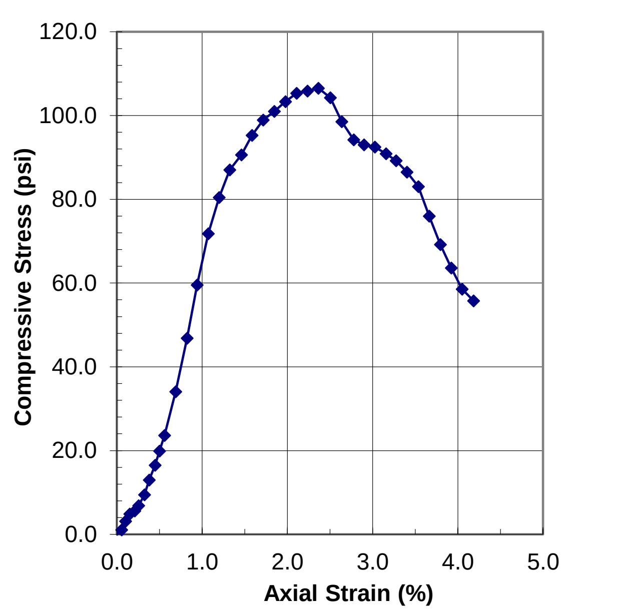
Client: USG
Project Name : Puyallup Pilot Study
Project Location: Puyallup, WA
Project Number: 19921-261175
Sample Material : ISS-A3
Sample Mix: C62
Sample Date: 9/24/2021
Sample Age: 7 days

Test Performed by : AS
Test Date : 10/1/21
Soil Type : Soil - Cement
Preparation Method: Smoothed ends
Pocket Penetrometer:

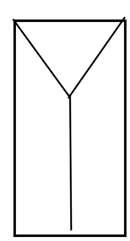
Water Content (%): **32.5**
Mass (g): 397.9
Area (sq in) : 3.29
Diameter (in) : 2.05
Height (in) : 3.96
Height to Dia. Ratio : 1.94
Wet Density (pcf) : **116.4**
Dry Density (pcf) : **87.9**

Loading Rate (in/min) : 0.05
Dial Rate : 5.8
Strain Rate (%/min) 1.28
Strain at Failure (%): 2.36
U. C. Strength (psi) : **106.6**
Shear Strength (psi): 53.3

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.090	-0.2	3.29	0.00	-0.06
7	0.090	0.0	3.29	-0.01	0.01
9	0.092	3.4	3.29	0.06	1.04
12	0.094	10.3	3.29	0.10	3.14
15	0.096	15.9	3.29	0.15	4.85
18	0.098	18.5	3.29	0.21	5.63
21	0.100	22.5	3.29	0.25	6.85
24	0.103	31.1	3.29	0.32	9.45
27	0.105	42.8	3.29	0.38	13.00
30	0.108	54.3	3.29	0.45	16.50
33	0.110	65.5	3.29	0.50	19.93
36	0.112	77.8	3.29	0.56	23.65
42	0.117	112.0	3.29	0.69	34.05
48	0.123	154.1	3.29	0.82	46.87
54	0.127	195.8	3.29	0.94	59.54
60	0.132	236.0	3.29	1.07	71.77
66	0.137	264.5	3.29	1.20	80.45
72	0.142	286.2	3.29	1.33	87.04
78	0.148	298.1	3.29	1.46	90.65
84	0.153	313.2	3.29	1.59	95.26
90	0.158	325.2	3.29	1.72	98.91
96	0.163	332.2	3.29	1.85	101.03
102	0.168	339.9	3.29	1.98	103.35
108	0.173	346.4	3.29	2.11	105.35
114	0.178	348.1	3.29	2.24	105.85
120	0.183	350.4	3.29	2.36	106.55
126	0.189	342.9	3.29	2.51	104.27
132	0.194	323.9	3.29	2.64	98.51
138	0.200	309.8	3.29	2.78	94.21
144	0.205	305.9	3.29	2.90	93.03
150	0.210	304.1	3.29	3.03	92.49
156	0.215	298.9	3.29	3.16	90.91
162	0.220	293.4	3.29	3.27	89.24
168	0.225	284.3	3.29	3.40	86.47



Failure Sketch



Remarks: None.

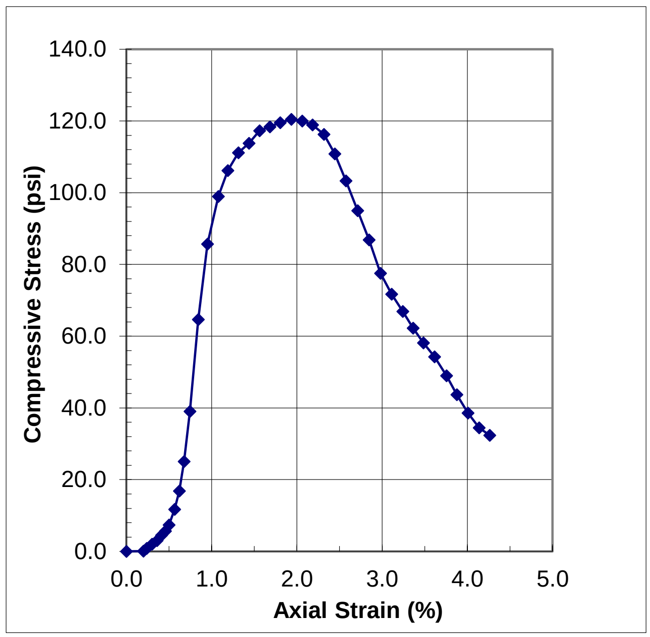
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

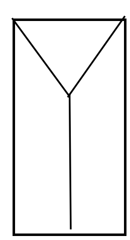
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C72		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**30.0**		
Mass (g):	407.4	Loading Rate (in/min) :	0.05
Area (sq in) :	3.29	Dial Rate :	5.8
Diameter (in) :	2.05	Strain Rate (%/min)	1.14
Height (in) :	4.01	Strain at Failure (%):	1.94
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**120.5**
Wet Density (pcf) :	**117.5**	Shear Strength (psi):	60.2
Dry Density (pcf) :	**90.4**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.29	0.00	0.00
4	0.008	0.3	3.29	0.20	0.08
6	0.010	2.8	3.29	0.24	0.86
9	0.012	6.6	3.29	0.30	2.01
12	0.014	10.0	3.29	0.36	3.05
15	0.017	14.8	3.29	0.41	4.51
18	0.018	18.6	3.29	0.46	5.66
21	0.020	24.3	3.29	0.50	7.38
24	0.023	38.6	3.29	0.57	11.74
27	0.025	55.4	3.29	0.62	16.84
30	0.027	82.5	3.29	0.68	25.08
33	0.030	128.5	3.29	0.75	39.04
39	0.034	212.7	3.29	0.84	64.66
45	0.038	282.0	3.29	0.95	85.70
51	0.043	325.8	3.29	1.08	99.01
57	0.048	349.5	3.29	1.19	106.22
63	0.053	365.7	3.29	1.32	111.14
69	0.058	374.5	3.29	1.44	113.80
75	0.063	386.0	3.29	1.56	117.31
81	0.068	389.4	3.29	1.68	118.34
87	0.072	393.3	3.29	1.81	119.52
93	0.078	396.5	3.29	1.94	120.49
99	0.083	394.9	3.29	2.06	120.01
105	0.088	391.2	3.29	2.18	118.90
111	0.093	382.6	3.29	2.32	116.27
117	0.098	364.8	3.29	2.44	110.88
123	0.103	339.9	3.29	2.58	103.29
129	0.109	312.7	3.29	2.72	95.03
135	0.114	285.8	3.29	2.85	86.86
141	0.120	255.1	3.29	2.98	77.53
147	0.125	236.0	3.29	3.11	71.73
153	0.130	220.2	3.29	3.24	66.92
159	0.135	204.9	3.29	3.36	62.28
165	0.140	191.3	3.29	3.48	58.15



Failure Sketch



Remarks: None.

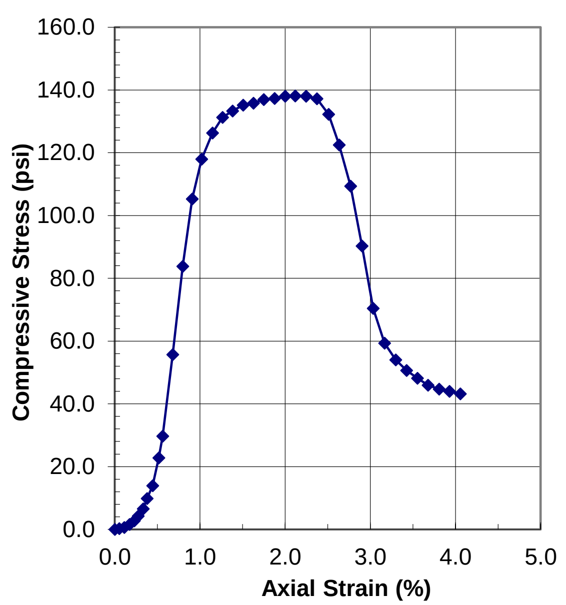
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

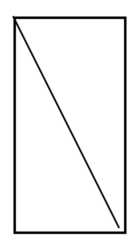
Client:	USG	Test Performed by :	AS
Project Name :	Puyallup Pilot Study	Test Date :	10/1/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C82		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	7 days		
		Pocket Penetrometer:	

Water Content (%):	**31.6**		
Mass (g):	404.9	Loading Rate (in/min) :	0.05
Area (sq in) :	3.25	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.17
Height (in) :	4.02	Strain at Failure (%):	2.12
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**138.2**
Wet Density (pcf) :	**118.0**	Shear Strength (psi):	69.1
Dry Density (pcf) :	**89.7**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.25	0.00	0.00
7	0.000	0.3	3.25	-0.01	0.09
9	0.002	0.9	3.25	0.05	0.29
12	0.005	2.1	3.25	0.11	0.65
15	0.007	5.3	3.25	0.17	1.62
18	0.009	9.0	3.25	0.23	2.76
21	0.011	13.8	3.25	0.27	4.26
24	0.013	21.5	3.25	0.33	6.60
27	0.015	32.0	3.25	0.38	9.83
30	0.018	45.3	3.25	0.44	13.92
33	0.021	74.1	3.25	0.52	22.77
36	0.023	96.7	3.25	0.56	29.73
42	0.027	181.2	3.25	0.68	55.69
48	0.032	272.8	3.25	0.80	83.85
54	0.037	342.6	3.25	0.91	105.31
60	0.041	383.8	3.25	1.02	117.99
66	0.046	410.9	3.25	1.15	126.31
72	0.051	427.2	3.25	1.27	131.33
78	0.056	433.8	3.25	1.38	133.36
84	0.061	439.7	3.25	1.51	135.17
90	0.065	441.7	3.25	1.63	135.79
96	0.070	445.5	3.25	1.75	136.96
102	0.075	446.8	3.25	1.88	137.37
108	0.080	448.9	3.25	2.00	138.00
114	0.085	449.4	3.25	2.12	138.15
120	0.090	449.0	3.25	2.25	138.04
126	0.095	446.4	3.25	2.37	137.22
132	0.101	430.3	3.25	2.51	132.27
138	0.106	398.4	3.25	2.64	122.48
144	0.111	355.9	3.25	2.77	109.40
150	0.117	293.8	3.25	2.90	90.31
156	0.122	229.2	3.25	3.04	70.44
162	0.127	193.0	3.25	3.17	59.34
168	0.132	175.7	3.25	3.30	54.02



Failure Sketch



Remarks: None.

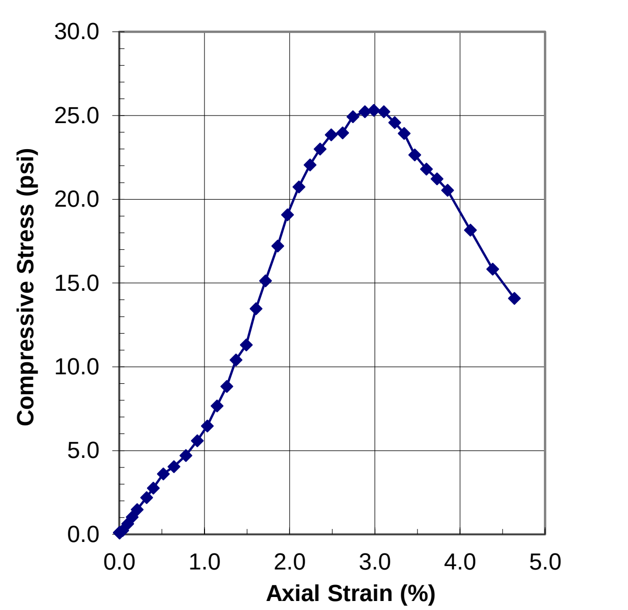
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

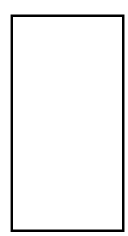
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/7/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**51.0**		
Mass (g):	358.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.25	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.14
Height (in) :	4.00	Strain at Failure (%):	2.99
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**25.3**
Wet Density (pcf) :	**105.3**	Shear Strength (psi):	12.7
Dry Density (pcf) :	**69.7**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.039	0.3	3.25	0.00	0.10
22	0.039	0.3	3.25	0.00	0.10
25	0.039	0.4	3.25	0.00	0.12
28	0.039	0.3	3.25	0.00	0.10
31	0.039	0.4	3.25	0.00	0.12
34	0.039	0.3	3.25	0.00	0.10
37	0.039	0.3	3.25	0.00	0.08
40	0.038	0.2	3.25	-0.02	0.07
43	0.041	0.7	3.25	0.04	0.23
46	0.043	2.0	3.25	0.10	0.63
49	0.045	3.3	3.25	0.15	1.03
52	0.048	4.8	3.25	0.21	1.48
58	0.052	7.1	3.25	0.32	2.20
64	0.055	8.9	3.25	0.40	2.76
70	0.060	11.7	3.25	0.52	3.61
76	0.065	13.1	3.25	0.64	4.04
82	0.070	15.3	3.25	0.78	4.71
88	0.076	18.1	3.25	0.92	5.58
94	0.081	21.0	3.25	1.03	6.48
100	0.085	24.9	3.25	1.15	7.67
106	0.090	28.7	3.25	1.26	8.83
112	0.094	33.8	3.25	1.37	10.41
118	0.099	36.7	3.25	1.49	11.31
124	0.103	43.7	3.25	1.61	13.47
130	0.108	49.2	3.25	1.72	15.15
136	0.114	55.9	3.25	1.86	17.21
142	0.118	61.9	3.25	1.97	19.07
148	0.123	67.4	3.25	2.11	20.75
154	0.129	71.6	3.25	2.24	22.05
160	0.133	74.7	3.25	2.36	23.01
166	0.139	77.4	3.25	2.49	23.85
172	0.144	77.8	3.25	2.62	23.96
178	0.149	81.0	3.25	2.74	24.94
184	0.154	81.9	3.25	2.88	25.24



Failure Sketch



Remarks: None.

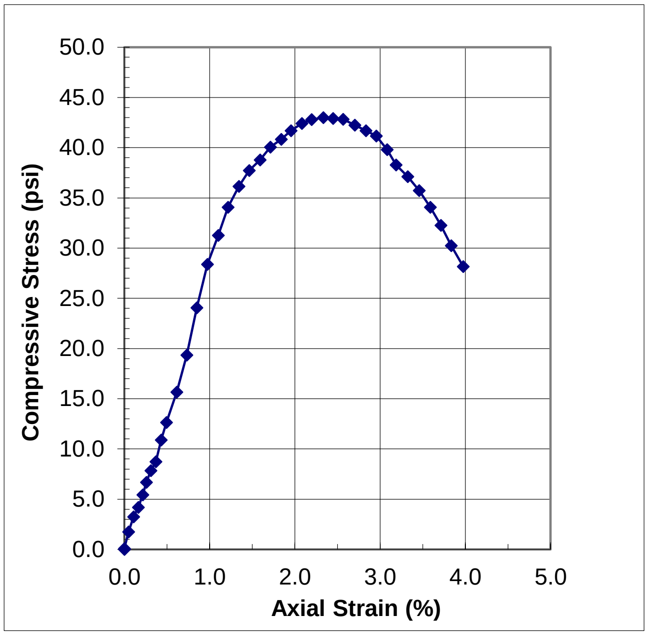
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

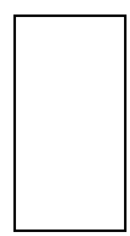
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/7/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C13		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**51.0**		
Mass (g):	358.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.25	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.21
Height (in) :	4.00	Strain at Failure (%):	2.33
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**43.0**
Wet Density (pcf) :	**105.3**	Shear Strength (psi):	21.5
Dry Density (pcf) :	**69.7**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.25	0.00	0.00
8	0.000	0.1	3.25	0.00	0.03
11	0.000	0.3	3.25	0.00	0.10
14	0.002	5.7	3.25	0.05	1.75
17	0.004	10.5	3.25	0.11	3.24
20	0.006	13.6	3.25	0.16	4.18
23	0.008	17.7	3.25	0.21	5.44
26	0.010	21.7	3.25	0.26	6.67
29	0.012	25.5	3.25	0.31	7.86
32	0.015	28.4	3.25	0.37	8.74
35	0.017	35.4	3.25	0.43	10.89
38	0.020	41.1	3.25	0.49	12.65
44	0.024	50.9	3.25	0.61	15.67
50	0.029	62.8	3.25	0.73	19.36
56	0.034	78.2	3.25	0.85	24.07
62	0.039	92.2	3.25	0.97	28.38
68	0.044	101.5	3.25	1.10	31.26
74	0.049	110.7	3.25	1.22	34.08
80	0.054	117.4	3.25	1.34	36.16
86	0.059	122.5	3.25	1.47	37.73
92	0.064	125.9	3.25	1.59	38.79
98	0.068	130.1	3.25	1.71	40.06
104	0.073	132.6	3.25	1.84	40.83
110	0.078	135.3	3.25	1.96	41.68
116	0.083	137.7	3.25	2.08	42.41
122	0.088	139.0	3.25	2.20	42.81
128	0.093	139.6	3.25	2.33	42.99
134	0.098	139.3	3.25	2.45	42.90
140	0.103	139.0	3.25	2.57	42.83
146	0.108	137.1	3.25	2.70	42.24
152	0.113	135.4	3.25	2.83	41.70
158	0.118	133.6	3.25	2.96	41.16
164	0.123	129.2	3.25	3.08	39.80
170	0.127	124.3	3.25	3.19	38.29



Failure Sketch



Remarks: None.

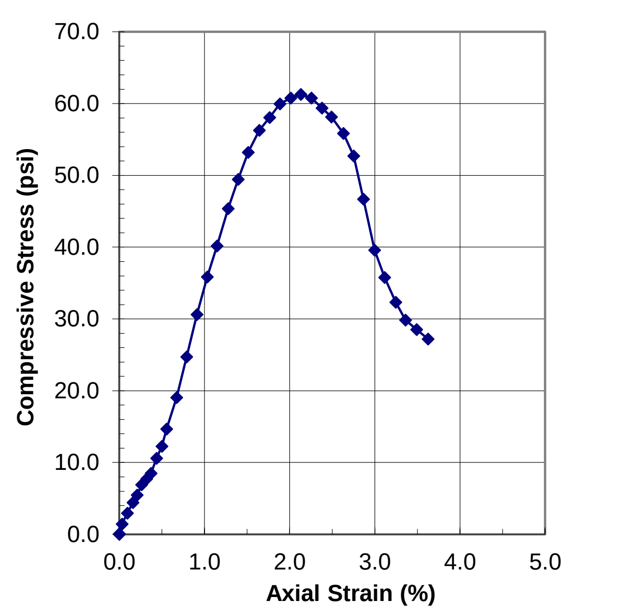
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

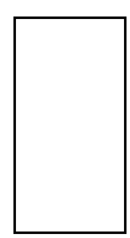
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/7/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C23		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**34.4**		
Mass (g):	385.9	Loading Rate (in/min) :	0.05
Area (sq in) :	3.29	Dial Rate :	5.8
Diameter (in) :	2.05	Strain Rate (%/min)	1.18
Height (in) :	4.02	Strain at Failure (%):	2.13
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**61.3**
Wet Density (pcf) :	**111.1**	Shear Strength (psi):	30.6
Dry Density (pcf) :	**82.6**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.29	0.00	0.00
9	0.000	0.2	3.29	0.00	0.07
12	0.001	4.8	3.29	0.03	1.46
15	0.004	9.8	3.29	0.10	2.97
18	0.006	14.6	3.29	0.16	4.44
21	0.008	18.0	3.29	0.21	5.48
24	0.011	22.7	3.29	0.26	6.91
27	0.013	25.4	3.29	0.32	7.73
30	0.015	28.0	3.29	0.37	8.51
33	0.018	34.9	3.29	0.44	10.62
36	0.020	40.4	3.29	0.50	12.29
39	0.022	48.3	3.29	0.56	14.69
45	0.027	62.7	3.29	0.67	19.05
51	0.032	81.3	3.29	0.79	24.71
57	0.037	100.7	3.29	0.91	30.62
63	0.042	118.0	3.29	1.03	35.86
69	0.046	132.1	3.29	1.15	40.16
75	0.051	149.2	3.29	1.28	45.35
81	0.056	162.7	3.29	1.40	49.46
87	0.061	175.1	3.29	1.51	53.21
93	0.066	185.1	3.29	1.65	56.27
99	0.071	191.1	3.29	1.77	58.07
105	0.076	197.4	3.29	1.89	59.98
111	0.081	200.0	3.29	2.01	60.79
117	0.086	201.7	3.29	2.13	61.29
123	0.091	199.9	3.29	2.26	60.77
129	0.096	195.4	3.29	2.38	59.37
135	0.100	191.3	3.29	2.49	58.13
141	0.106	183.7	3.29	2.63	55.84
147	0.111	173.4	3.29	2.75	52.69
153	0.115	153.7	3.29	2.87	46.71
159	0.121	130.3	3.29	3.00	39.61
165	0.125	117.7	3.29	3.12	35.78
171	0.131	106.3	3.29	3.25	32.31



Failure Sketch



Remarks: None.

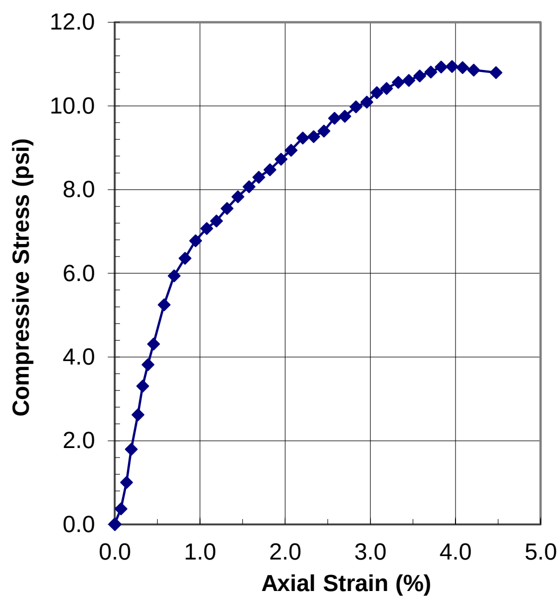
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

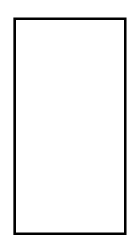
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C33		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**38.5**		
Mass (g):	378.4	Loading Rate (in/min) :	0.05
Area (sq in) :	3.20	Dial Rate :	5.8
Diameter (in) :	2.02	Strain Rate (%/min)	1.25
Height (in) :	3.94	Strain at Failure (%):	3.96
Height to Dia. Ratio :	1.95	U. C. Strength (psi) :	**10.9**
Wet Density (pcf) :	**114.4**	Shear Strength (psi):	5.5
Dry Density (pcf) :	**82.6**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	-0.007	0.0	3.20	0.00	0.00
23	-0.007	0.0	3.20	0.00	0.00
25	-0.007	0.0	3.20	0.00	0.00
28	-0.007	0.0	3.20	0.00	0.00
31	-0.007	0.0	3.20	0.00	0.01
34	-0.004	1.2	3.20	0.07	0.38
37	-0.001	3.2	3.20	0.14	1.00
40	0.001	5.7	3.20	0.19	1.79
43	0.004	8.4	3.20	0.27	2.62
46	0.006	10.6	3.20	0.33	3.31
49	0.009	12.2	3.20	0.39	3.82
52	0.011	13.8	3.20	0.46	4.31
58	0.016	16.8	3.20	0.58	5.25
64	0.021	19.0	3.20	0.70	5.94
70	0.026	20.3	3.20	0.82	6.36
76	0.031	21.7	3.20	0.95	6.78
82	0.036	22.6	3.20	1.08	7.08
88	0.040	23.2	3.20	1.19	7.25
94	0.045	24.2	3.20	1.32	7.55
100	0.050	25.1	3.20	1.45	7.83
106	0.055	25.8	3.20	1.57	8.07
112	0.060	26.5	3.20	1.69	8.30
118	0.065	27.1	3.20	1.82	8.48
124	0.070	27.9	3.20	1.95	8.73
130	0.075	28.6	3.20	2.07	8.95
136	0.080	29.5	3.20	2.21	9.23
142	0.085	29.7	3.20	2.34	9.27
148	0.090	30.1	3.20	2.46	9.40
154	0.095	31.1	3.20	2.58	9.71
160	0.100	31.2	3.20	2.70	9.76
166	0.105	31.9	3.20	2.83	9.98
172	0.110	32.3	3.20	2.96	10.10
178	0.114	33.0	3.20	3.08	10.32
184	0.119	33.3	3.20	3.19	10.42



Failure Sketch



Remarks: None.

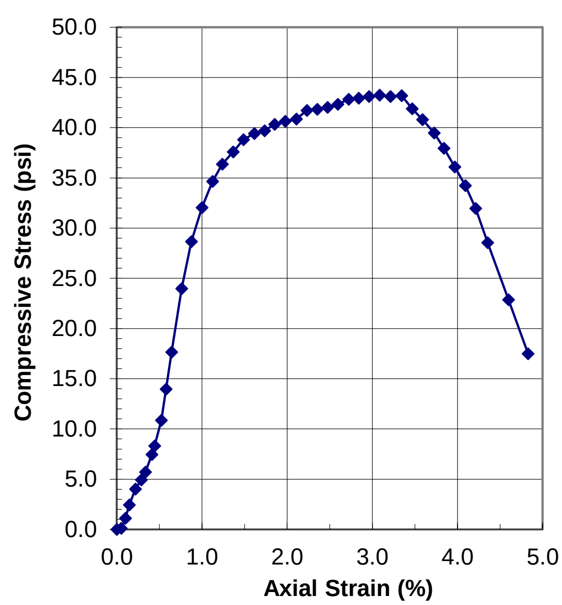
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

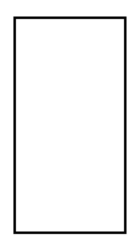
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C43		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**34.4**		
Mass (g):	398.0	Loading Rate (in/min) :	0.05
Area (sq in) :	3.27	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.19
Height (in) :	4.02	Strain at Failure (%):	3.08
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**43.2**
Wet Density (pcf) :	**115.1**	Shear Strength (psi):	21.6
Dry Density (pcf) :	**85.6**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.27	0.00	0.00
11	0.002	0.4	3.27	0.05	0.11
13	0.004	3.7	3.27	0.10	1.12
16	0.006	8.0	3.27	0.15	2.45
19	0.009	13.1	3.27	0.22	4.01
22	0.011	16.2	3.27	0.29	4.94
25	0.013	18.7	3.27	0.34	5.71
28	0.016	24.4	3.27	0.41	7.45
31	0.018	27.2	3.27	0.45	8.32
34	0.021	35.5	3.27	0.52	10.86
37	0.023	45.7	3.27	0.58	13.97
40	0.026	57.8	3.27	0.64	17.65
46	0.031	78.5	3.27	0.76	23.99
52	0.035	93.9	3.27	0.88	28.68
58	0.040	104.9	3.27	1.00	32.05
64	0.045	113.4	3.27	1.12	34.66
70	0.050	119.1	3.27	1.24	36.37
76	0.055	123.0	3.27	1.37	37.59
82	0.060	127.0	3.27	1.49	38.81
88	0.065	129.0	3.27	1.62	39.42
94	0.070	130.0	3.27	1.74	39.70
100	0.074	132.0	3.27	1.85	40.33
106	0.080	133.1	3.27	1.98	40.65
112	0.085	133.8	3.27	2.11	40.87
118	0.090	136.6	3.27	2.23	41.73
124	0.095	136.9	3.27	2.35	41.83
130	0.099	137.6	3.27	2.48	42.03
136	0.104	138.6	3.27	2.59	42.33
142	0.109	140.2	3.27	2.72	42.82
148	0.114	140.5	3.27	2.84	42.93
154	0.119	141.1	3.27	2.96	43.12
160	0.124	141.5	3.27	3.08	43.24
166	0.129	141.1	3.27	3.21	43.12
172	0.135	141.4	3.27	3.35	43.20



Failure Sketch



Remarks: None.

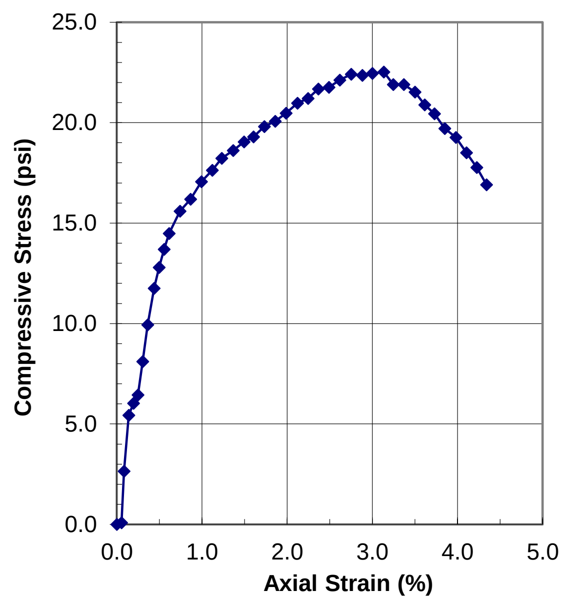
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

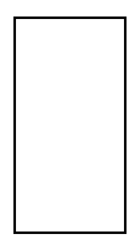
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C53		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**32.5**		
Mass (g):	399.7	Loading Rate (in/min) :	0.05
Area (sq in) :	3.23	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.24
Height (in) :	3.99	Strain at Failure (%):	3.14
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**22.5**
Wet Density (pcf) :	**118.3**	Shear Strength (psi):	11.3
Dry Density (pcf) :	**89.3**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.23	0.00	0.00
9	0.002	0.3	3.23	0.06	0.09
11	0.003	8.5	3.23	0.08	2.64
14	0.006	17.6	3.23	0.14	5.44
17	0.008	19.5	3.23	0.19	6.03
20	0.010	20.8	3.23	0.25	6.44
23	0.012	26.2	3.23	0.30	8.12
26	0.015	32.1	3.23	0.36	9.94
29	0.017	37.9	3.23	0.44	11.75
32	0.020	41.3	3.23	0.50	12.80
35	0.022	44.2	3.23	0.56	13.70
38	0.025	46.7	3.23	0.62	14.48
44	0.030	50.4	3.23	0.74	15.60
50	0.035	52.3	3.23	0.87	16.20
56	0.040	55.1	3.23	1.00	17.07
62	0.045	56.9	3.23	1.12	17.63
68	0.049	58.8	3.23	1.23	18.23
74	0.054	60.1	3.23	1.37	18.62
80	0.060	61.5	3.23	1.49	19.04
86	0.064	62.3	3.23	1.61	19.29
92	0.069	63.9	3.23	1.73	19.81
98	0.074	64.8	3.23	1.86	20.07
104	0.079	66.1	3.23	1.99	20.48
110	0.085	67.7	3.23	2.12	20.98
116	0.090	68.5	3.23	2.25	21.21
122	0.094	70.0	3.23	2.37	21.68
128	0.099	70.3	3.23	2.49	21.77
134	0.104	71.4	3.23	2.62	22.12
140	0.110	72.3	3.23	2.75	22.42
146	0.115	72.2	3.23	2.88	22.36
152	0.120	72.5	3.23	3.00	22.46
158	0.125	72.7	3.23	3.14	22.53
164	0.129	70.7	3.23	3.25	21.91
170	0.134	70.7	3.23	3.37	21.90



Failure Sketch



Remarks: None.

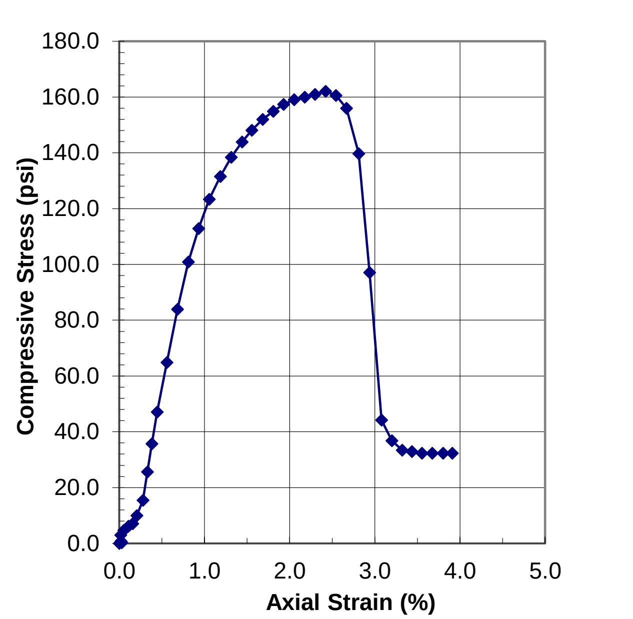
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

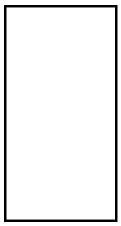
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C63		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**32.5**		
Mass (g):	401.0	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.22
Height (in) :	4.01	Strain at Failure (%):	2.42
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**162.1**
Wet Density (pcf) :	**116.0**	Shear Strength (psi):	81.0
Dry Density (pcf) :	**87.5**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.001	0.0	3.28	0.00	0.00
8	0.002	0.9	3.28	0.03	0.28
10	0.002	2.7	3.28	0.02	0.83
13	0.002	10.0	3.28	0.02	3.05
16	0.003	15.3	3.28	0.05	4.66
19	0.005	20.2	3.28	0.11	6.15
22	0.007	23.3	3.28	0.16	7.10
25	0.009	32.7	3.28	0.21	9.97
28	0.012	51.0	3.28	0.28	15.53
31	0.014	84.2	3.28	0.33	25.66
34	0.017	117.2	3.28	0.38	35.70
37	0.019	154.7	3.28	0.45	47.15
43	0.024	213.0	3.28	0.56	64.91
49	0.029	275.4	3.28	0.68	83.92
55	0.034	331.2	3.28	0.81	100.92
61	0.039	370.4	3.28	0.93	112.86
67	0.044	405.0	3.28	1.06	123.40
73	0.049	431.7	3.28	1.19	131.54
79	0.054	454.4	3.28	1.32	138.47
85	0.059	472.2	3.28	1.44	143.89
91	0.064	486.2	3.28	1.56	148.15
97	0.069	498.9	3.28	1.69	152.02
103	0.074	508.2	3.28	1.81	154.86
109	0.079	516.5	3.28	1.93	157.39
115	0.084	522.2	3.28	2.05	159.13
121	0.089	524.9	3.28	2.18	159.94
127	0.093	528.2	3.28	2.30	160.96
133	0.098	531.9	3.28	2.42	162.07
139	0.103	527.1	3.28	2.54	160.61
145	0.108	511.8	3.28	2.67	155.95
151	0.114	458.5	3.28	2.81	139.70
157	0.119	318.6	3.28	2.94	97.07
163	0.125	145.0	3.28	3.08	44.18
169	0.130	120.7	3.28	3.20	36.79



Failure Sketch



Remarks: None.

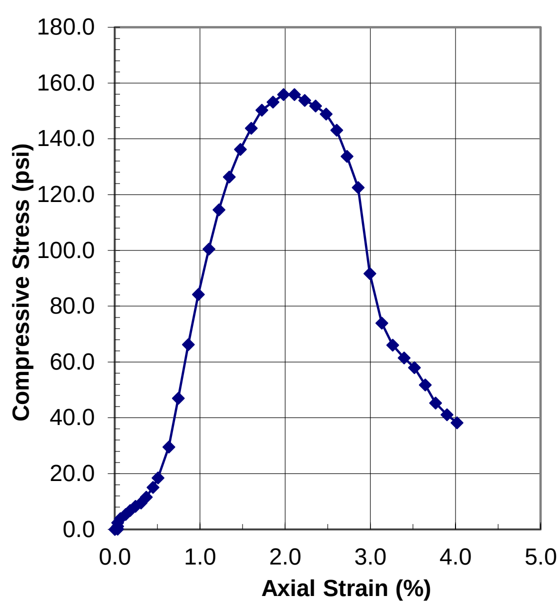
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C73		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**29.3**		
Mass (g):	405.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.27	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.20
Height (in) :	4.01	Strain at Failure (%):	2.11
Height to Dia. Ratio :	1.97	U. C. Strength (psi) :	**155.9**
Wet Density (pcf) :	**117.6**	Shear Strength (psi):	78.0
Dry Density (pcf) :	**91.0**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.27	0.00	0.00
8	0.001	0.4	3.27	0.03	0.11
10	0.001	3.5	3.27	0.03	1.08
13	0.001	7.8	3.27	0.03	2.37
16	0.003	12.7	3.27	0.07	3.88
19	0.005	17.6	3.27	0.13	5.37
22	0.007	22.1	3.27	0.18	6.75
25	0.010	27.1	3.27	0.24	8.27
28	0.012	30.9	3.27	0.31	9.45
31	0.015	37.9	3.27	0.37	11.58
34	0.018	49.3	3.27	0.45	15.06
37	0.020	60.5	3.27	0.51	18.47
43	0.025	96.7	3.27	0.63	29.54
49	0.030	154.0	3.27	0.75	47.03
55	0.035	216.9	3.27	0.86	66.23
61	0.039	275.7	3.27	0.98	84.21
67	0.044	329.2	3.27	1.11	100.53
73	0.049	375.0	3.27	1.22	114.53
79	0.054	413.6	3.27	1.35	126.33
85	0.059	446.0	3.27	1.48	136.20
91	0.064	471.0	3.27	1.60	143.86
97	0.069	492.1	3.27	1.73	150.30
103	0.075	501.5	3.27	1.86	153.16
109	0.079	510.5	3.27	1.98	155.90
115	0.085	510.6	3.27	2.11	155.94
121	0.090	503.5	3.27	2.23	153.78
127	0.095	497.0	3.27	2.36	151.80
133	0.100	487.5	3.27	2.48	148.88
139	0.105	468.6	3.27	2.61	143.11
145	0.109	437.9	3.27	2.73	133.73
151	0.115	401.3	3.27	2.86	122.57
157	0.120	300.3	3.27	2.99	91.71
163	0.126	242.1	3.27	3.14	73.94
169	0.131	216.3	3.27	3.26	66.06



Failure Sketch

Remarks: None.

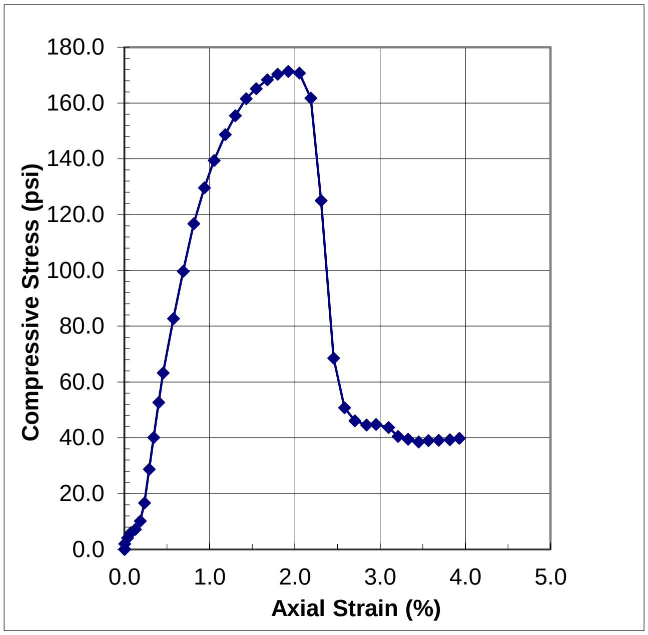
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

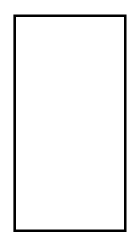
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/8/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C83		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	14 days		
		Pocket Penetrometer:	

Water Content (%):	**31.8**		
Mass (g):	401.1	Loading Rate (in/min) :	0.05
Area (sq in) :	3.28	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.20
Height (in) :	4.02	Strain at Failure (%):	1.92
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**171.4**
Wet Density (pcf) :	**116.0**	Shear Strength (psi):	85.7
Dry Density (pcf) :	**88.0**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.28	0.00	0.00
8	0.000	0.5	3.28	0.00	0.16
10	0.000	6.7	3.28	0.00	2.04
13	0.001	13.5	3.28	0.04	4.11
16	0.003	19.8	3.28	0.08	6.05
19	0.005	23.6	3.28	0.13	7.20
22	0.007	33.3	3.28	0.19	10.16
25	0.009	54.5	3.28	0.24	16.63
28	0.012	94.5	3.28	0.29	28.80
31	0.014	131.8	3.28	0.34	40.18
34	0.016	172.9	3.28	0.40	52.71
37	0.018	207.6	3.28	0.45	63.29
43	0.023	271.5	3.28	0.57	82.79
49	0.028	327.0	3.28	0.69	99.71
55	0.033	383.1	3.28	0.81	116.81
61	0.038	425.2	3.28	0.94	129.64
67	0.042	457.4	3.28	1.05	139.45
73	0.047	487.6	3.28	1.18	148.68
79	0.052	510.1	3.28	1.30	155.53
85	0.057	530.1	3.28	1.43	161.62
91	0.062	541.8	3.28	1.55	165.18
97	0.067	552.1	3.28	1.68	168.33
103	0.072	558.9	3.28	1.80	170.40
109	0.077	562.0	3.28	1.92	171.37
115	0.082	560.0	3.28	2.05	170.75
121	0.088	530.5	3.28	2.19	161.77
127	0.093	410.3	3.28	2.31	125.10
133	0.099	224.9	3.28	2.46	68.56
139	0.104	166.6	3.28	2.58	50.81
145	0.109	151.2	3.28	2.70	46.09
151	0.114	146.2	3.28	2.84	44.58
157	0.119	147.1	3.28	2.95	44.85
163	0.124	143.3	3.28	3.10	43.70
169	0.129	132.8	3.28	3.21	40.49



Failure Sketch



Remarks: None.

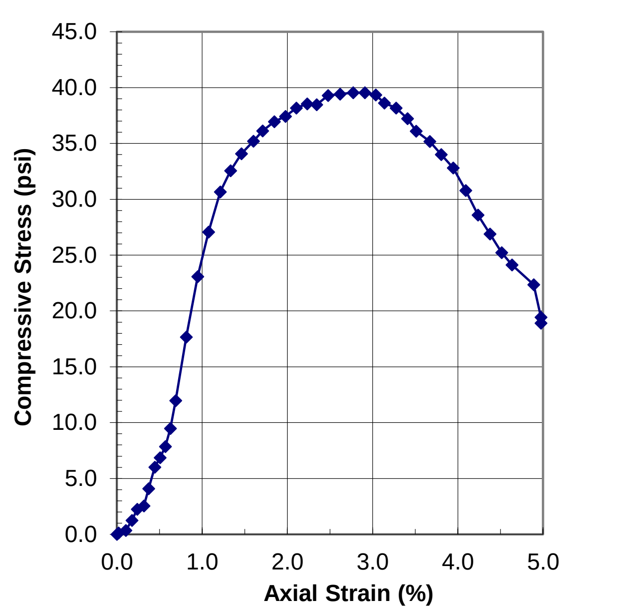
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/21/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C4		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**49.9**		
Mass (g):	343.6	Loading Rate (in/min) :	0.05
Area (sq in) :	3.25	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.29
Height (in) :	3.79	Strain at Failure (%):	2.77
Height to Dia. Ratio :	1.86	U. C. Strength (psi) :	**39.6**
Wet Density (pcf) :	**106.4**	Shear Strength (psi):	19.8
Dry Density (pcf) :	**71.0**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.25	0.00	0.00
10	0.001	0.4	3.25	0.02	0.12
13	0.004	1.1	3.25	0.10	0.35
16	0.007	4.1	3.25	0.18	1.26
19	0.009	7.3	3.25	0.24	2.25
22	0.012	8.3	3.25	0.32	2.56
25	0.014	13.3	3.25	0.37	4.09
28	0.017	19.6	3.25	0.44	6.02
31	0.019	22.3	3.25	0.51	6.86
34	0.022	25.5	3.25	0.57	7.86
37	0.024	30.8	3.25	0.63	9.48
40	0.026	38.9	3.25	0.69	11.97
46	0.031	57.4	3.25	0.81	17.67
52	0.036	75.0	3.25	0.95	23.08
58	0.041	87.9	3.25	1.08	27.07
64	0.046	99.6	3.25	1.21	30.67
70	0.051	105.8	3.25	1.33	32.57
76	0.055	110.7	3.25	1.46	34.09
82	0.061	114.3	3.25	1.60	35.20
88	0.065	117.3	3.25	1.71	36.13
94	0.070	120.0	3.25	1.85	36.95
100	0.075	121.5	3.25	1.98	37.42
106	0.080	123.9	3.25	2.11	38.16
112	0.085	125.2	3.25	2.23	38.54
118	0.089	124.9	3.25	2.34	38.47
124	0.094	127.6	3.25	2.48	39.29
130	0.099	128.0	3.25	2.62	39.42
136	0.105	128.5	3.25	2.77	39.55
142	0.110	128.4	3.25	2.91	39.54
148	0.115	127.8	3.25	3.04	39.34
154	0.119	125.4	3.25	3.14	38.62
160	0.124	123.9	3.25	3.28	38.16
166	0.129	120.9	3.25	3.41	37.24
172	0.133	117.2	3.25	3.51	36.10



Failure Sketch

Remarks: None.

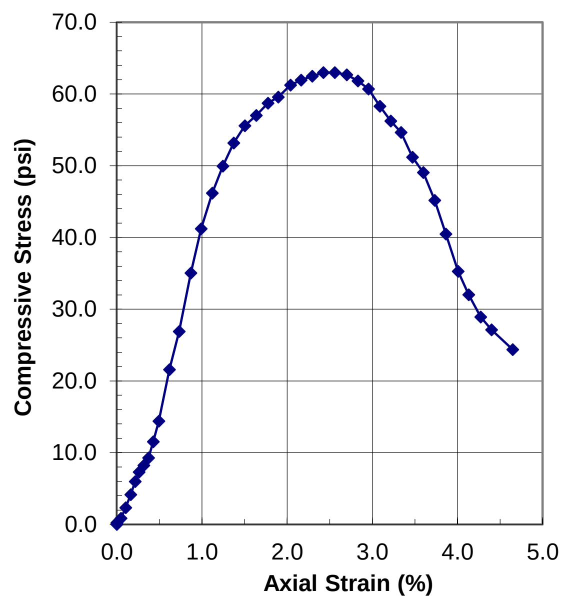
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

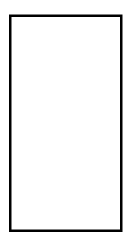
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/21/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A1	Soil Type :	Soil - Cement
Sample Mix:	C14		
Sample Date:	9/23/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**37.5**		
Mass (g):	369.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.24	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.26
Height (in) :	3.86	Strain at Failure (%):	2.43
Height to Dia. Ratio :	1.90	U. C. Strength (psi) :	**63.0**
Wet Density (pcf) :	**112.6**	Shear Strength (psi):	31.5
Dry Density (pcf) :	**81.9**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.24	0.00	0.00
11	0.000	0.8	3.24	0.00	0.24
13	0.000	0.4	3.24	0.00	0.11
16	0.002	2.8	3.24	0.05	0.87
19	0.004	7.6	3.24	0.11	2.33
22	0.006	13.5	3.24	0.16	4.17
25	0.008	19.4	3.24	0.22	5.98
28	0.010	23.6	3.24	0.26	7.29
31	0.012	26.7	3.24	0.32	8.24
34	0.014	30.1	3.24	0.37	9.27
37	0.016	37.4	3.24	0.43	11.54
40	0.019	46.7	3.24	0.49	14.40
46	0.024	70.1	3.24	0.62	21.60
52	0.028	87.3	3.24	0.73	26.92
58	0.033	113.7	3.24	0.87	35.05
64	0.038	133.7	3.24	0.99	41.21
70	0.043	149.9	3.24	1.12	46.19
76	0.048	162.0	3.24	1.25	49.94
82	0.053	172.5	3.24	1.37	53.17
88	0.058	180.3	3.24	1.51	55.56
94	0.063	185.0	3.24	1.64	57.03
100	0.068	190.6	3.24	1.78	58.73
106	0.073	193.3	3.24	1.90	59.59
112	0.079	198.8	3.24	2.04	61.26
118	0.083	201.0	3.24	2.16	61.94
124	0.088	202.7	3.24	2.30	62.49
130	0.094	204.3	3.24	2.43	62.98
136	0.099	204.3	3.24	2.56	62.98
142	0.104	203.4	3.24	2.70	62.68
148	0.109	200.6	3.24	2.83	61.82
154	0.114	197.0	3.24	2.96	60.71
160	0.119	189.1	3.24	3.09	58.30
166	0.124	182.4	3.24	3.22	56.23
172	0.129	177.4	3.24	3.34	54.67



Failure Sketch



Remarks: None.

CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

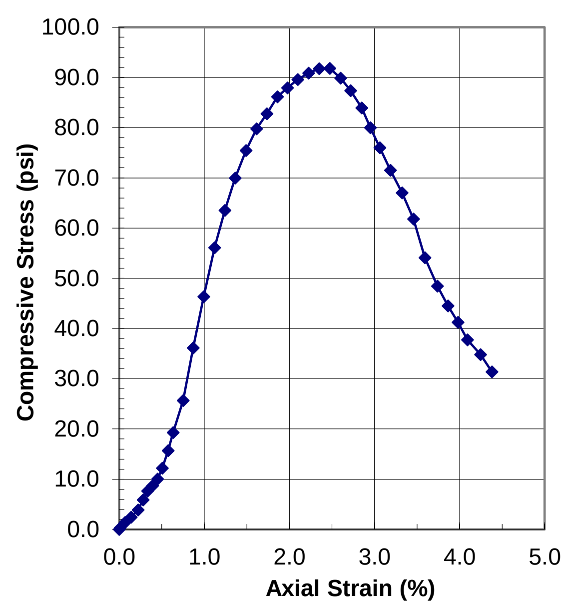
Client: USG
Project Name : Puyallup Pilot Study
Project Location: Puyallup, WA
Project Number: 19921-261175
Sample Material : ISS-A1
Sample Mix: C24
Sample Date: 9/23/2021
Sample Age: 28 days

Test Performed by : MP
Test Date : 10/21/21
Soil Type : Soil - Cement
Preparation Method: Smoothed ends
Pocket Penetrometer:

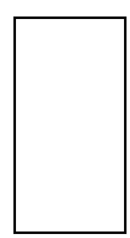
Water Content (%): **33.7**
Mass (g): 387.3
Area (sq in) : 3.25
Diameter (in) : 2.04
Height (in) : 4.00
Height to Dia. Ratio : 1.97
Wet Density (pcf) : **113.5**
Dry Density (pcf) : **84.9**

Loading Rate (in/min) : 0.05
Dial Rate : 5.8
Strain Rate (%/min) 1.22
Strain at Failure (%): 2.48
U. C. Strength (psi) : **91.8**
Shear Strength (psi): 45.9

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.25	0.00	0.01
10	0.000	0.9	3.25	0.01	0.27
13	0.003	4.5	3.25	0.07	1.39
16	0.006	8.0	3.25	0.14	2.45
19	0.009	12.7	3.25	0.22	3.91
22	0.011	19.1	3.25	0.28	5.88
25	0.013	25.0	3.25	0.33	7.68
28	0.016	28.3	3.25	0.39	8.70
31	0.018	32.6	3.25	0.45	10.04
34	0.020	39.8	3.25	0.51	12.23
37	0.023	51.0	3.25	0.58	15.69
40	0.025	62.7	3.25	0.64	19.30
46	0.030	83.5	3.25	0.75	25.69
52	0.035	117.5	3.25	0.87	36.15
58	0.040	150.7	3.25	1.00	46.36
64	0.045	182.4	3.25	1.12	56.11
70	0.050	206.6	3.25	1.24	63.54
76	0.055	227.5	3.25	1.36	69.98
82	0.060	245.3	3.25	1.49	75.47
88	0.065	259.5	3.25	1.61	79.81
94	0.069	269.1	3.25	1.74	82.79
100	0.074	280.1	3.25	1.86	86.17
106	0.079	285.9	3.25	1.98	87.94
112	0.084	291.2	3.25	2.10	89.58
118	0.089	295.4	3.25	2.23	90.86
124	0.094	298.2	3.25	2.35	91.74
130	0.099	298.5	3.25	2.48	91.82
136	0.104	292.2	3.25	2.60	89.88
142	0.109	284.1	3.25	2.72	87.40
148	0.114	272.8	3.25	2.85	83.92
154	0.118	260.1	3.25	2.95	80.02
160	0.122	247.1	3.25	3.06	76.01
166	0.127	232.6	3.25	3.19	71.55
172	0.133	217.9	3.25	3.33	67.02



Failure Sketch



Remarks: None.

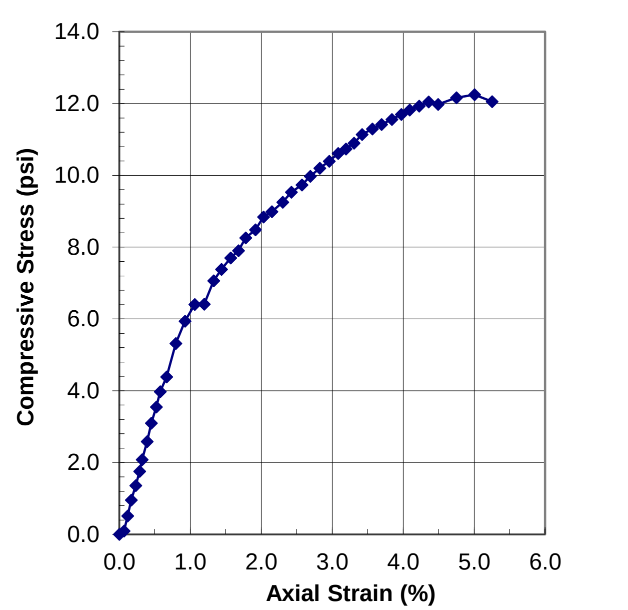
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

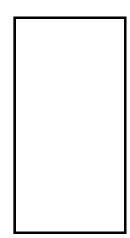
Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/22/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C34		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**37.3**		
Mass (g):	382.3	Loading Rate (in/min) :	0.05
Area (sq in) :	3.25	Dial Rate :	5.8
Diameter (in) :	2.03	Strain Rate (%/min)	1.32
Height (in) :	3.94	Strain at Failure (%):	5.01
Height to Dia. Ratio :	1.94	U. C. Strength (psi) :	**12.2**
Wet Density (pcf) :	**113.7**	Shear Strength (psi):	6.1
Dry Density (pcf) :	**82.8**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.25	0.00	0.00
5	0.003	0.3	3.25	0.07	0.09
7	0.005	1.7	3.25	0.12	0.52
10	0.007	3.1	3.25	0.17	0.96
13	0.009	4.4	3.25	0.23	1.36
16	0.011	5.7	3.25	0.29	1.75
19	0.013	6.8	3.25	0.32	2.08
22	0.016	8.4	3.25	0.39	2.58
25	0.018	10.1	3.25	0.45	3.10
28	0.021	11.5	3.25	0.52	3.55
31	0.023	12.9	3.25	0.58	3.98
34	0.026	14.2	3.25	0.67	4.38
40	0.031	17.3	3.25	0.80	5.32
46	0.037	19.3	3.25	0.93	5.94
52	0.042	20.8	3.25	1.06	6.40
58	0.047	20.8	3.25	1.20	6.41
64	0.052	22.9	3.25	1.33	7.07
70	0.057	24.0	3.25	1.44	7.38
76	0.062	25.0	3.25	1.57	7.70
82	0.066	25.6	3.25	1.68	7.90
88	0.070	26.8	3.25	1.78	8.26
94	0.076	27.5	3.25	1.92	8.48
100	0.080	28.7	3.25	2.03	8.84
106	0.085	29.2	3.25	2.15	8.99
112	0.091	30.0	3.25	2.30	9.25
118	0.096	31.0	3.25	2.42	9.53
124	0.101	31.6	3.25	2.57	9.73
130	0.106	32.4	3.25	2.69	9.98
136	0.111	33.1	3.25	2.82	10.20
142	0.117	33.7	3.25	2.96	10.39
148	0.122	34.5	3.25	3.08	10.61
154	0.126	34.8	3.25	3.19	10.73
160	0.130	35.4	3.25	3.31	10.89
166	0.135	36.2	3.25	3.42	11.14



Failure Sketch



Remarks: None.

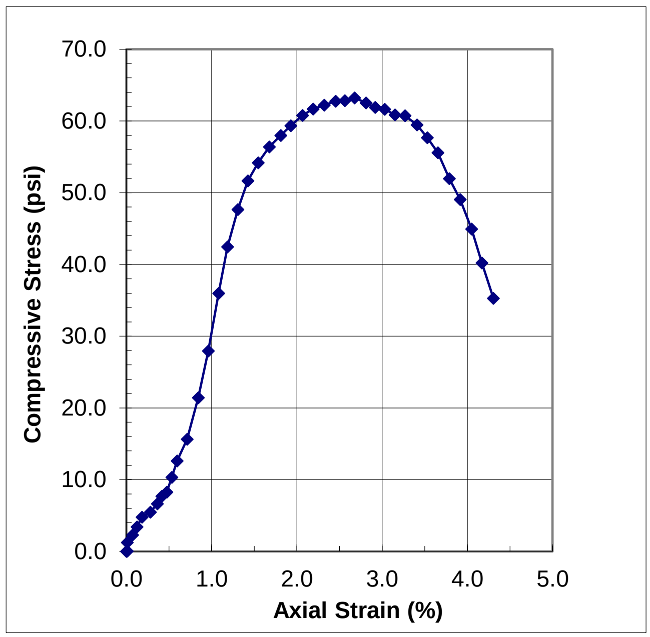
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/22/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C44		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**33.5**		
Mass (g):	397.2	Loading Rate (in/min) :	0.05
Area (sq in) :	3.26	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.18
Height (in) :	4.00	Strain at Failure (%):	2.68
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**63.2**
Wet Density (pcf) :	**115.9**	Shear Strength (psi):	31.6
Dry Density (pcf) :	**86.8**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.26	0.00	0.00
10	0.000	0.2	3.26	0.01	0.06
13	0.000	4.1	3.26	0.01	1.25
16	0.003	7.5	3.26	0.07	2.30
19	0.005	11.2	3.26	0.13	3.42
22	0.007	15.6	3.26	0.18	4.78
25	0.011	17.9	3.26	0.28	5.48
28	0.015	21.7	3.26	0.36	6.65
31	0.017	25.1	3.26	0.41	7.69
34	0.019	27.0	3.26	0.47	8.29
37	0.021	33.7	3.26	0.53	10.32
40	0.024	41.2	3.26	0.60	12.62
46	0.029	51.0	3.26	0.71	15.64
52	0.034	69.9	3.26	0.85	21.42
58	0.038	91.2	3.26	0.96	27.94
64	0.043	117.4	3.26	1.08	35.97
70	0.047	138.6	3.26	1.19	42.46
76	0.052	155.6	3.26	1.31	47.67
82	0.057	168.6	3.26	1.43	51.67
88	0.062	176.9	3.26	1.55	54.19
94	0.067	184.1	3.26	1.68	56.40
100	0.072	189.3	3.26	1.81	57.99
106	0.077	193.7	3.26	1.93	59.35
112	0.083	198.4	3.26	2.07	60.80
118	0.088	201.3	3.26	2.19	61.69
124	0.093	203.0	3.26	2.32	62.20
130	0.098	204.9	3.26	2.45	62.77
136	0.103	205.0	3.26	2.56	62.82
142	0.107	206.4	3.26	2.68	63.24
148	0.112	204.1	3.26	2.81	62.53
154	0.117	202.1	3.26	2.92	61.92
160	0.121	201.1	3.26	3.03	61.63
166	0.126	198.6	3.26	3.15	60.85
172	0.131	198.2	3.26	3.27	60.74



Failure Sketch

Remarks: None.

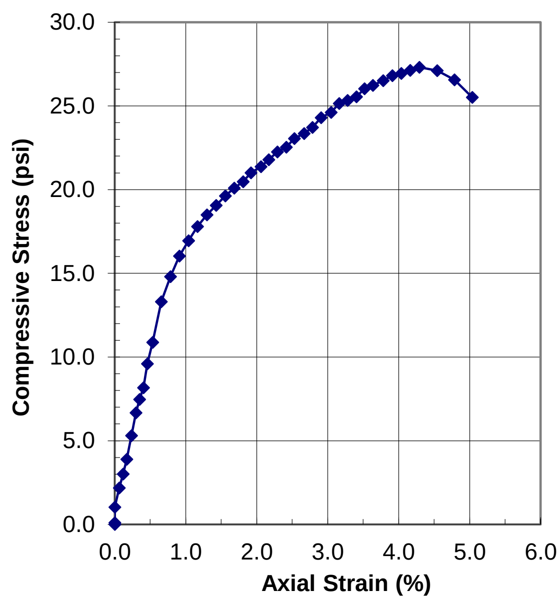
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/22/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A2	Soil Type :	Soil - Cement
Sample Mix:	C54		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**32.2**		
Mass (g):	401.4	Loading Rate (in/min) :	0.05
Area (sq in) :	3.27	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.27
Height (in) :	4.00	Strain at Failure (%):	4.29
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**27.3**
Wet Density (pcf) :	**117.0**	Shear Strength (psi):	13.7
Dry Density (pcf) :	**88.5**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.27	0.00	0.00
9	0.000	0.3	3.27	0.00	0.10
12	0.000	3.4	3.27	0.00	1.04
15	0.003	7.1	3.27	0.06	2.18
18	0.005	9.9	3.27	0.12	3.02
21	0.007	12.7	3.27	0.17	3.89
24	0.010	17.3	3.27	0.24	5.30
27	0.012	21.8	3.27	0.30	6.67
30	0.014	24.4	3.27	0.35	7.47
33	0.016	26.7	3.27	0.40	8.17
36	0.018	31.4	3.27	0.46	9.60
39	0.021	35.5	3.27	0.53	10.88
45	0.026	43.5	3.27	0.66	13.31
51	0.031	48.4	3.27	0.78	14.81
57	0.036	52.4	3.27	0.91	16.03
63	0.042	55.4	3.27	1.04	16.96
69	0.047	58.2	3.27	1.17	17.80
75	0.052	60.4	3.27	1.30	18.49
81	0.057	62.3	3.27	1.43	19.06
87	0.062	64.1	3.27	1.56	19.62
93	0.067	65.6	3.27	1.68	20.09
99	0.072	66.9	3.27	1.81	20.48
105	0.077	68.6	3.27	1.92	21.00
111	0.082	69.8	3.27	2.06	21.37
117	0.087	71.2	3.27	2.17	21.79
123	0.092	72.7	3.27	2.29	22.26
129	0.097	73.6	3.27	2.42	22.53
135	0.101	75.3	3.27	2.53	23.05
141	0.107	76.3	3.27	2.67	23.36
147	0.111	77.5	3.27	2.78	23.72
153	0.116	79.4	3.27	2.91	24.30
159	0.122	80.4	3.27	3.05	24.61
165	0.126	82.2	3.27	3.16	25.16
171	0.131	82.8	3.27	3.28	25.34



Failure Sketch

Remarks: None.

CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client: USG
Project Name : Puyallup Pilot Study
Project Location: Puyallup, WA
Project Number: 19921-261175
Sample Material : ISS-A3
Sample Mix: C64
Sample Date: 9/24/2021
Sample Age: 28 days

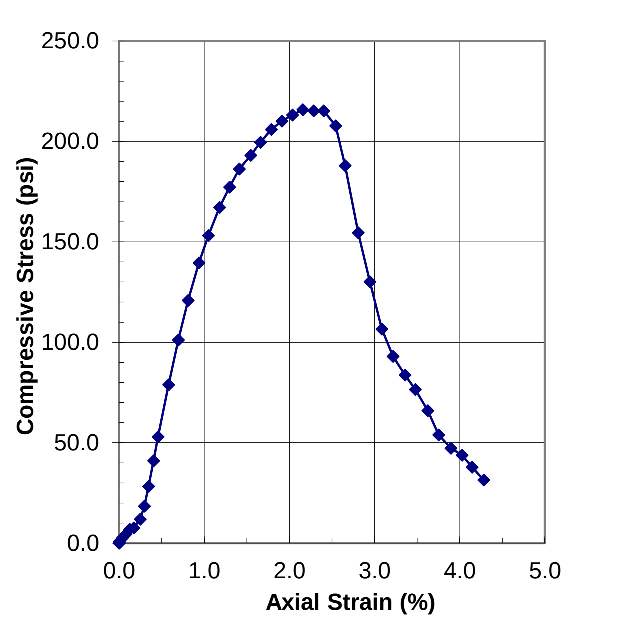
Test Performed by : MP
Test Date : 10/22/21

Soil Type : Soil - Cement
Preparation Method: Smoothed ends
Pocket Penetrometer:

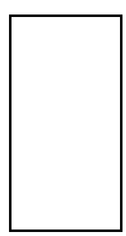
Water Content (%): **31.5**
Mass (g): 403.2
Area (sq in) : 3.27
Diameter (in) : 2.04
Height (in) : 4.01
Height to Dia. Ratio : 1.96
Wet Density (pcf) : **117.1**
Dry Density (pcf) : **89.1**

Loading Rate (in/min) : 0.05
Dial Rate : 5.8
Strain Rate (%/min) 1.18
Strain at Failure (%): 2.16
U. C. Strength (psi) : **215.8**
Shear Strength (psi): 107.9

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.27	0.00	0.00
6	0.000	0.3	3.27	0.00	0.09
9	0.000	2.9	3.27	0.00	0.87
12	0.002	8.2	3.27	0.04	2.49
15	0.003	14.9	3.27	0.08	4.56
18	0.005	22.9	3.27	0.12	7.00
21	0.007	25.1	3.27	0.17	7.66
24	0.010	39.1	3.27	0.25	11.93
27	0.012	60.2	3.27	0.30	18.40
30	0.014	92.7	3.27	0.35	28.31
33	0.016	134.4	3.27	0.40	41.06
36	0.018	173.5	3.27	0.46	53.01
42	0.023	258.4	3.27	0.58	78.95
48	0.028	331.2	3.27	0.70	101.20
54	0.032	395.7	3.27	0.81	120.88
60	0.038	456.9	3.27	0.94	139.60
66	0.042	501.2	3.27	1.05	153.11
72	0.047	547.0	3.27	1.18	167.11
78	0.052	580.4	3.27	1.30	177.31
84	0.057	609.9	3.27	1.41	186.33
90	0.062	632.1	3.27	1.55	193.12
96	0.067	653.3	3.27	1.66	199.60
102	0.072	674.4	3.27	1.79	206.04
108	0.077	687.7	3.27	1.91	210.10
114	0.082	697.8	3.27	2.04	213.19
120	0.087	706.3	3.27	2.16	215.78
126	0.092	704.6	3.27	2.28	215.27
132	0.096	704.6	3.27	2.40	215.26
138	0.102	680.2	3.27	2.54	207.81
144	0.106	615.1	3.27	2.66	187.91
150	0.112	505.9	3.27	2.81	154.55
156	0.118	425.9	3.27	2.95	130.11
162	0.124	349.1	3.27	3.09	106.66
168	0.129	304.6	3.27	3.22	93.05



Failure Sketch



Remarks: None.

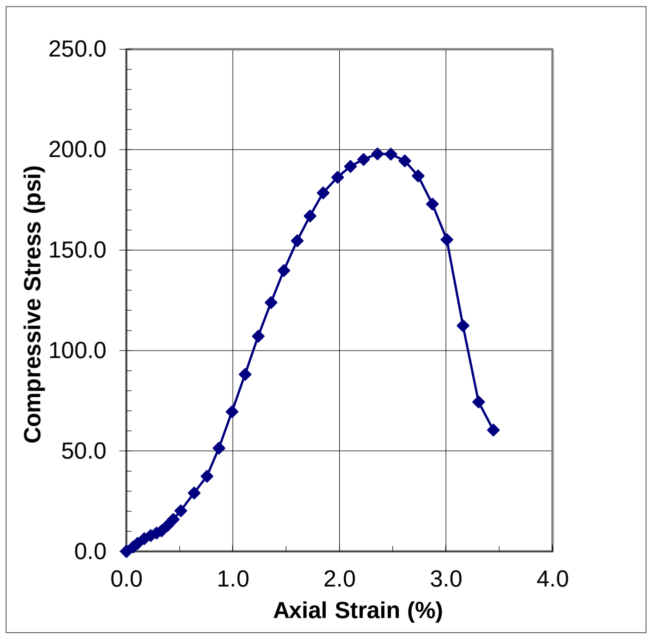
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/22/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C74		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**29.6**		
Mass (g):	405.8	Loading Rate (in/min) :	0.05
Area (sq in) :	3.27	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.21
Height (in) :	4.01	Strain at Failure (%):	2.36
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**197.9**
Wet Density (pcf) :	**118.2**	Shear Strength (psi):	99.0
Dry Density (pcf) :	**91.2**		

Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.27	0.00	0.00
8	0.000	0.1	3.27	0.00	0.02
10	0.000	0.4	3.27	0.00	0.11
13	0.002	7.3	3.27	0.06	2.23
16	0.004	13.3	3.27	0.10	4.08
19	0.007	20.8	3.27	0.17	6.38
22	0.009	25.8	3.27	0.23	7.91
25	0.011	30.1	3.27	0.28	9.22
28	0.013	33.5	3.27	0.33	10.27
31	0.016	42.5	3.27	0.39	13.01
34	0.018	52.3	3.27	0.44	16.00
37	0.020	66.4	3.27	0.51	20.32
43	0.025	95.3	3.27	0.64	29.18
49	0.030	122.3	3.27	0.76	37.45
55	0.035	168.1	3.27	0.87	51.45
61	0.040	227.4	3.27	0.99	69.60
67	0.045	288.0	3.27	1.11	88.15
73	0.050	350.0	3.27	1.24	107.15
79	0.054	404.7	3.27	1.36	123.89
85	0.059	457.0	3.27	1.48	139.90
91	0.064	505.3	3.27	1.60	154.69
97	0.069	545.6	3.27	1.72	167.00
103	0.074	583.2	3.27	1.85	178.51
109	0.079	608.5	3.27	1.98	186.26
115	0.084	626.1	3.27	2.10	191.65
121	0.089	637.8	3.27	2.23	195.22
127	0.094	646.6	3.27	2.36	197.91
133	0.099	646.3	3.27	2.48	197.82
139	0.105	635.3	3.27	2.61	194.48
145	0.110	611.0	3.27	2.74	187.04
151	0.115	565.4	3.27	2.87	173.06
157	0.120	507.0	3.27	3.01	155.19
163	0.127	367.3	3.27	3.16	112.42
169	0.132	243.0	3.27	3.31	74.40



Failure Sketch

Remarks: None.

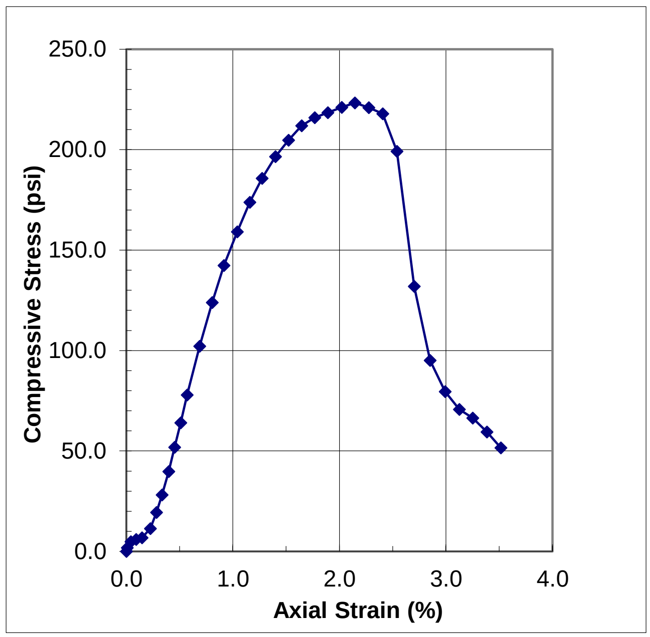
CDM Smith
Geotechnical Engineering Laboratory

Unconfined Compressive Strength (ASTM D1633)

Client:	USG	Test Performed by :	MP
Project Name :	Puyallup Pilot Study	Test Date :	10/22/21
Project Location:	Puyallup, WA		
Project Number:	19921-261175		
Sample Material :	ISS-A3	Soil Type :	Soil - Cement
Sample Mix:	C84		
Sample Date:	9/24/2021	Preparation Method:	Smoothed ends
Sample Age:	28 days		
		Pocket Penetrometer:	

Water Content (%):	**31.2**		
Mass (g):	401.2	Loading Rate (in/min) :	0.05
Area (sq in) :	3.26	Dial Rate :	5.8
Diameter (in) :	2.04	Strain Rate (%/min)	1.17
Height (in) :	4.00	Strain at Failure (%):	2.15
Height to Dia. Ratio :	1.96	U. C. Strength (psi) :	**223.3**
Wet Density (pcf) :	**117.1**	Shear Strength (psi):	111.7
Dry Density (pcf) :	**89.2**		

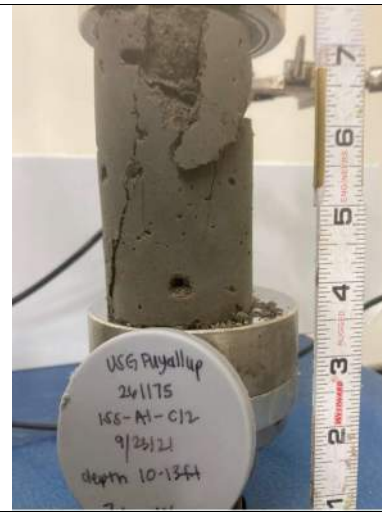
Time (sec)	Displ. (in)	Load (lbs)	Cross Sectional Area (in^2)	Axial Strain (%)	Compress Strength (psi)
0	0.000	0.0	3.26	0.00	0.00
12	0.000	6.1	3.26	0.01	1.87
14	0.002	15.9	3.26	0.04	4.89
17	0.004	19.3	3.26	0.09	5.92
20	0.006	22.4	3.26	0.15	6.87
23	0.009	37.4	3.26	0.22	11.45
26	0.011	63.6	3.26	0.28	19.48
29	0.013	91.8	3.26	0.34	28.12
32	0.016	129.8	3.26	0.40	39.75
35	0.018	169.3	3.26	0.45	51.84
38	0.020	209.1	3.26	0.51	64.05
41	0.023	254.3	3.26	0.57	77.90
47	0.027	333.5	3.26	0.69	102.16
53	0.032	404.6	3.26	0.80	123.92
59	0.037	464.8	3.26	0.92	142.37
65	0.042	519.4	3.26	1.04	159.08
71	0.046	567.3	3.26	1.16	173.77
77	0.051	606.4	3.26	1.27	185.76
83	0.056	641.9	3.26	1.40	196.61
89	0.061	668.5	3.26	1.52	204.77
95	0.066	691.8	3.26	1.65	211.91
101	0.071	705.1	3.26	1.77	215.96
107	0.076	713.4	3.26	1.89	218.51
113	0.081	721.7	3.26	2.02	221.07
119	0.086	729.1	3.26	2.15	223.34
125	0.091	721.4	3.26	2.27	220.95
131	0.096	711.5	3.26	2.41	217.95
137	0.102	650.4	3.26	2.54	199.22
143	0.108	431.1	3.26	2.70	132.03
149	0.114	310.4	3.26	2.85	95.08
155	0.120	260.0	3.26	2.99	79.63
161	0.125	230.7	3.26	3.12	70.67
167	0.130	216.6	3.26	3.25	66.36
173	0.135	194.3	3.26	3.38	59.51



Failure Sketch

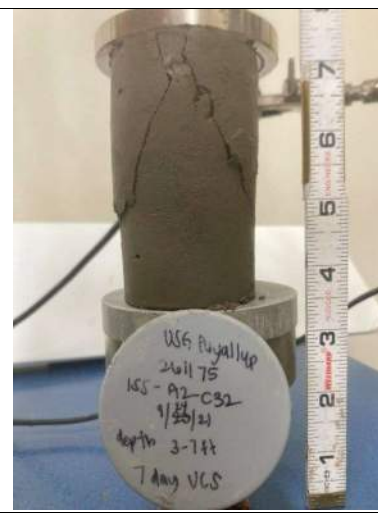
Remarks: None.

Picture Date:	Thursday 09/30/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C2 UCS 7-day break



Picture Date:	Thursday 09/30/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C12 UCS 7-day break

Picture Date:	Thursday 09/30/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C22 UCS 7-day break



Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C32 UCS 7-day break

Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C42 UCS 7-day break

Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C52 UCS 7-day break

Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C62 UCS 7-day break

Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C72 UCS 7-day break

Picture Date:	Friday 10/01/2021
Picture Taken By:	Alan Smith
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C82 UCS 7-day break

Picture Date:	Thursday 10/07/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C3 UCS 14-day break

Picture Date:	Thursday 10/07/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C13 UCS 14-day break

Picture Date:	Thursday 10/07/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C23 UCS 14-day break

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Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C33 UCS 14-day break

Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C43 UCS 14-day break

Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C53 UCS 14-day break

Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C63 UCS 14-day break

Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C73 UCS 14-day break

Picture Date:	Friday 10/08/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C83 UCS 14-day break

Picture Date:	Thursday 10/21/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C4 UCS 28-day break

Picture Date:	Thursday 10/21/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C14 UCS 28-day break

Picture Date:	Thursday 10/21/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C24 UCS 28-day break

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C34 UCS 28-day break

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C44 UCS 28-day break

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A2-C54 UCS 28-day break

CDM Smith

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C64 UCS 28-day break

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C74 UCS 28-day break

Picture Date:	Friday 10/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A3-C84 UCS 28-day break

Appendix G

Permeability Results and Photolog

CDM Smith

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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/22/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A1	Sample Preparation Procedures:	
Sample Location:	C5		
Depth (ft):	0-3		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

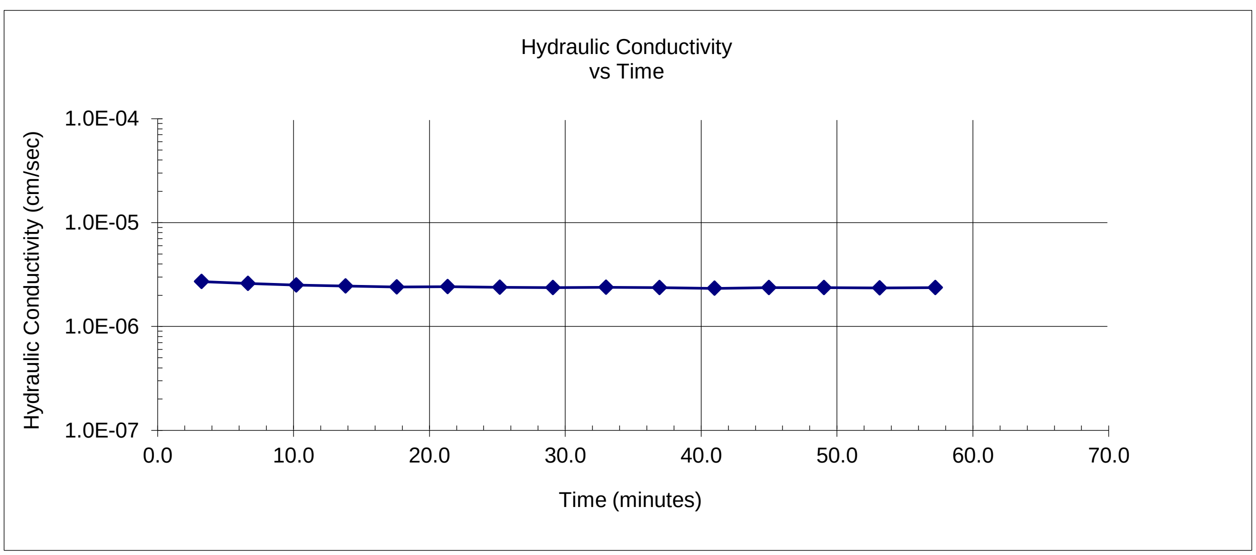
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	1.84	1.84
Avg. dia. of specimen (in)	3.01	3.01
Area (sq in)	7.10	7.10
Volume (cubic in)	13.06	13.06
Moist mass (g)	363.7	366.1
Moist unit weight (pcf)	106.1	106.8
Moisture content (%)	49.8	50.8
Dry density (pcf)	70.9	70.9
Specific gravity (assumed)	2.68	2.68
Void ratio	1.36	1.36

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	20.4
Cell pressure (psi):	75.0
Head pressure (psi):	71.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	4.0

Comments:

Hydraulic Conductivity at 20 ^{o}C = **2.36E-06** cm/sec

Average of last 8 readings



CDM Smith

Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/18/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A1	Sample Preparation Procedures:	
Sample Location:	C15		
Depth (ft):	44482		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

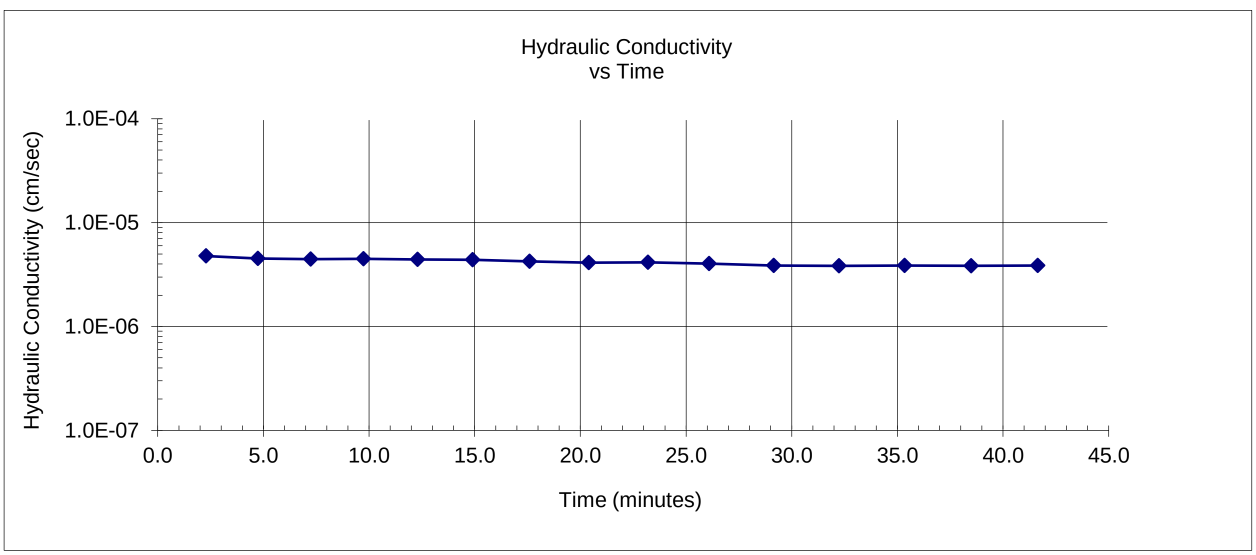
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	2.28	2.28
Avg. dia. of specimen (in)	3.01	3.01
Area (sq in)	7.12	7.12
Volume (cubic in)	16.24	16.24
Moist mass (g)	474.1	479.3
Moist unit weight (pcf)	111.2	112.4
Moisture content (%)	39.1	40.6
Dry density (pcf)	79.9	79.9
Specific gravity (assumed)	2.68	2.68
Void ratio	1.09	1.09

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	16.3
Cell pressure (psi):	75.0
Head pressure (psi):	71.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	4.0

Comments: ______________________

Hydraulic Conductivity at 20 °C = **3.86E-06** cm/sec

Average of last 5 readings



CDM Smith

Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/18/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A1	Sample Preparation Procedures:	
Sample Location:	C25		
Depth (ft):	20-23		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

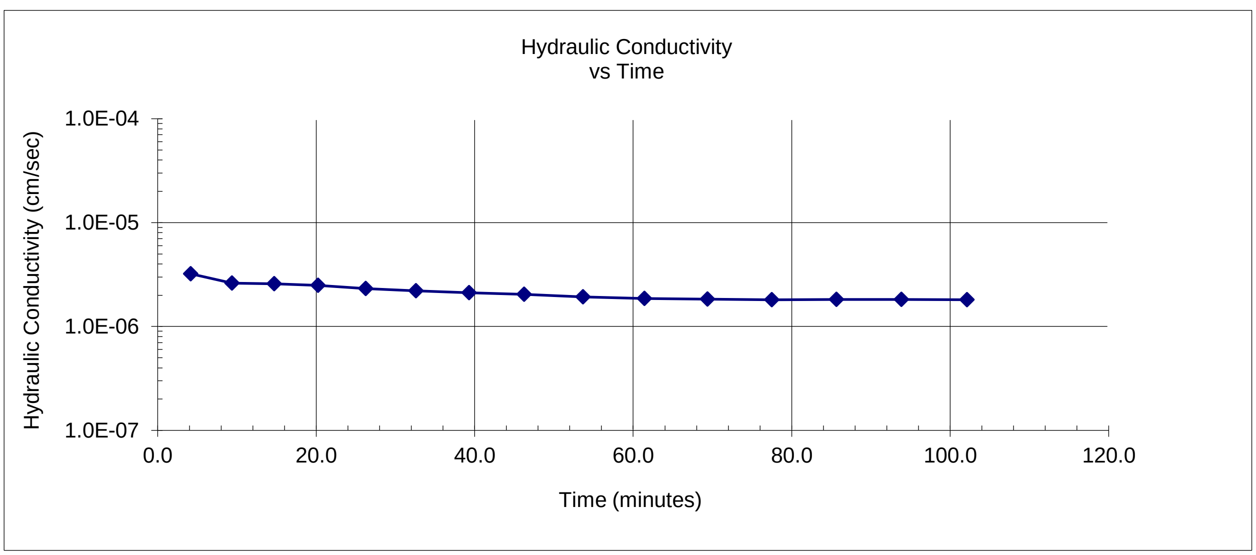
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	2.73	2.73
Avg. dia. of specimen (in)	3.01	3.01
Area (sq in)	7.13	7.13
Volume (cubic in)	19.49	19.49
Moist mass (g)	580.4	588.6
Moist unit weight (pcf)	113.4	115.0
Moisture content (%)	34.5	36.4
Dry density (pcf)	84.3	84.3
Specific gravity (assumed)	2.68	2.68
Void ratio	0.98	0.98

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	13.5
Cell pressure (psi):	75.0
Head pressure (psi):	71.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	4.0

Comments:

Hydraulic Conductivity at 20 ^{o}C = **1.82E-06** cm/sec

Average of last 5 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/22/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A2	Sample Preparation	
Sample Location:	C35	Procedures:	
Depth (ft):	3-7		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

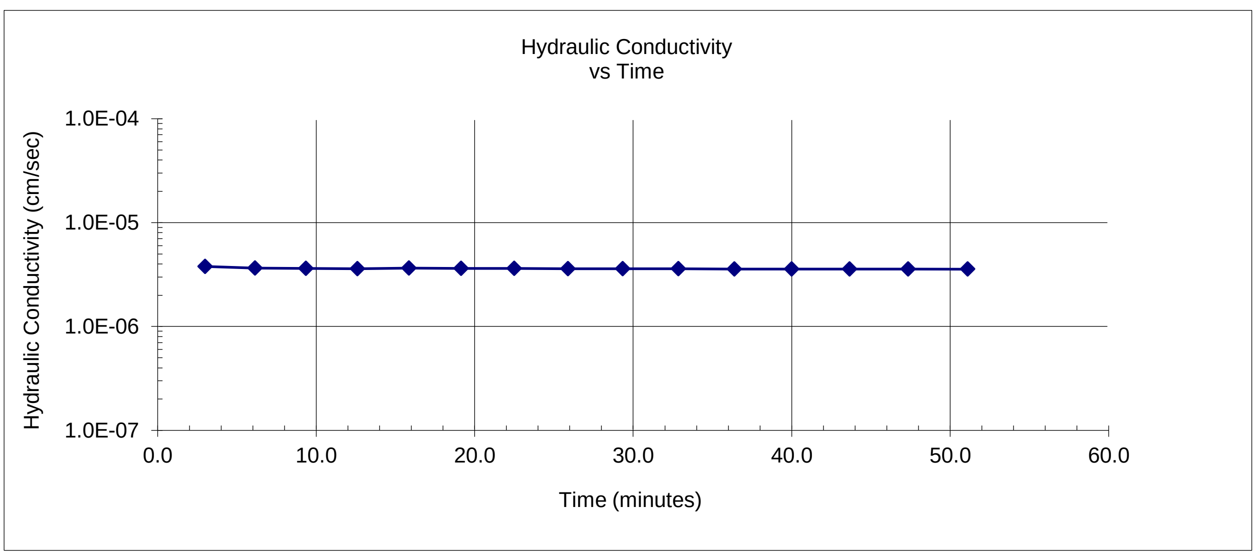
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	1.47	1.47
Avg. dia. of specimen (in)	2.99	2.99
Area (sq in)	7.02	7.02
Volume (cubic in)	10.35	10.35
Moist mass (g)	306.7	307.2
Moist unit weight (pcf)	112.9	113.1
Moisture content (%)	39.0	39.3
Dry density (pcf)	81.2	81.2
Specific gravity (assumed)	2.68	2.68
Void ratio	1.06	1.06

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	16.0
Cell pressure (psi):	75.0
Head pressure (psi):	70.5
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	4.5

Comments: ______________________

Hydraulic Conductivity at 20 ^{o}C = **3.57E-06** cm/sec

Average of last 5 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/18/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A2	Sample Preparation Procedures:	
Sample Location:	C45		
Depth (ft):	13-17		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

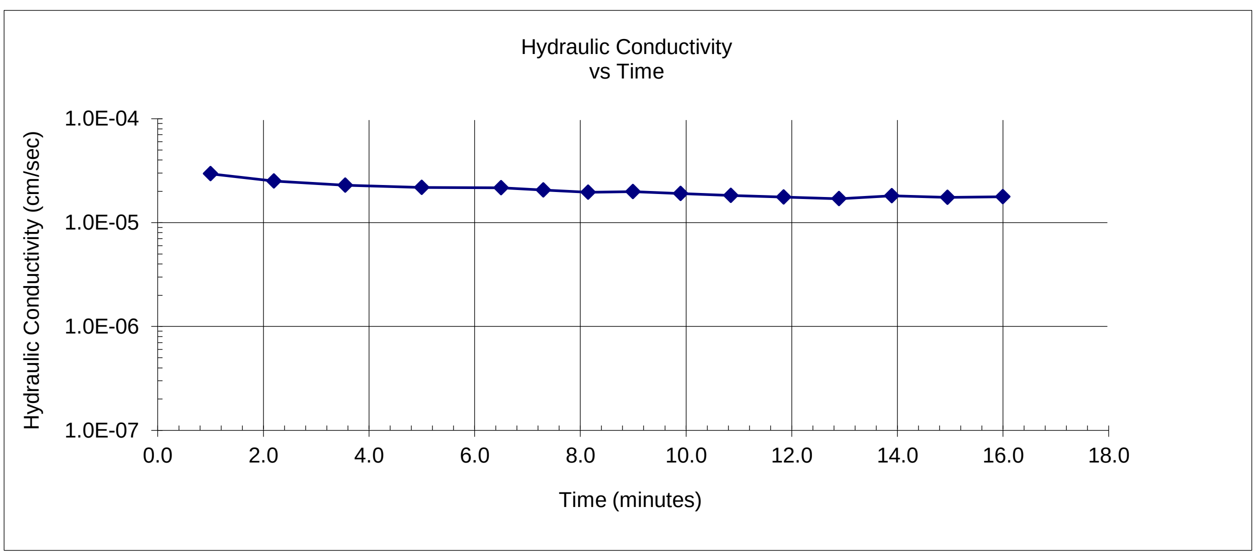
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	1.90	1.90
Avg. dia. of specimen (in)	3.01	3.01
Area (sq in)	7.12	7.12
Volume (cubic in)	13.53	13.53
Moist mass (g)	407.3	410.8
Moist unit weight (pcf)	114.7	115.7
Moisture content (%)	33.6	34.7
Dry density (pcf)	85.9	85.9
Specific gravity (assumed)	2.68	2.68
Void ratio	0.95	0.95

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	12.3
Cell pressure (psi):	75.0
Head pressure (psi):	70.5
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	4.5

Comments:

Hydraulic Conductivity at 20 ^{o}C = **1.77E-05** cm/sec

Average of last 6 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/19/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A2	Sample Preparation Procedures:	
Sample Location:	C55		
Depth (ft):	23-27		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

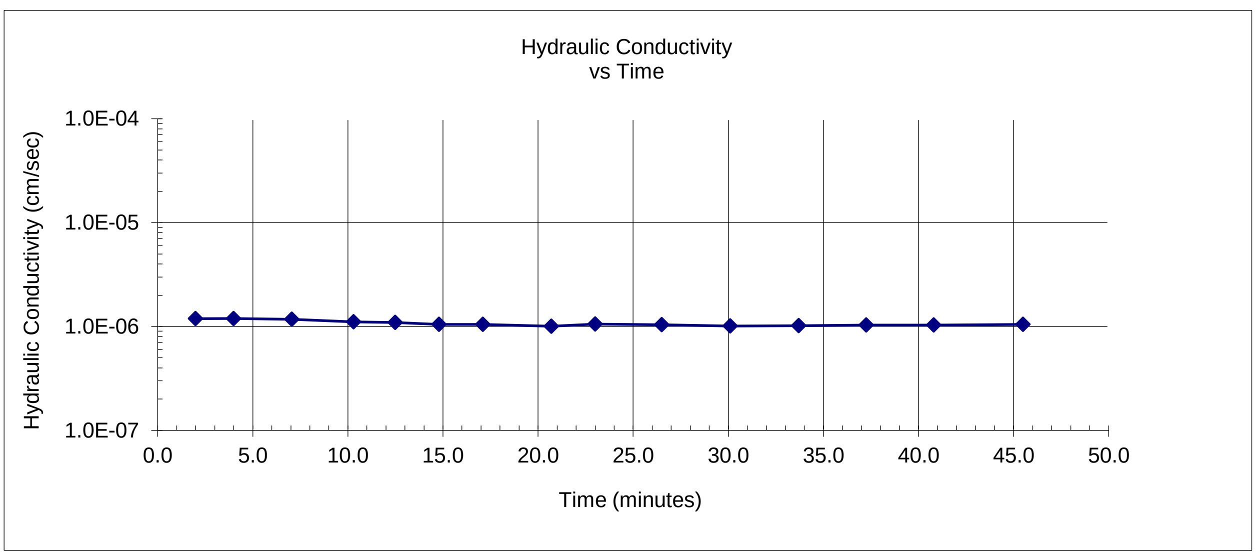
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	2.18	2.18
Avg. dia. of specimen (in)	3.00	3.00
Area (sq in)	7.09	7.09
Volume (cubic in)	15.42	15.42
Moist mass (g)	474.6	477.1
Moist unit weight (pcf)	117.2	117.9
Moisture content (%)	32.9	33.6
Dry density (pcf)	88.2	88.2
Specific gravity (assumed)	2.68	2.68
Void ratio	0.90	0.90

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	29.9
Cell pressure (psi):	75.0
Head pressure (psi):	72.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	3.0

Comments:

Hydraulic Conductivity at 20 ^{o}C = **1.03E-06** cm/sec

Average of last 10 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/22/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A3	Sample Preparation	
Sample Location:	C65	Procedures:	
Depth (ft):	7-10		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

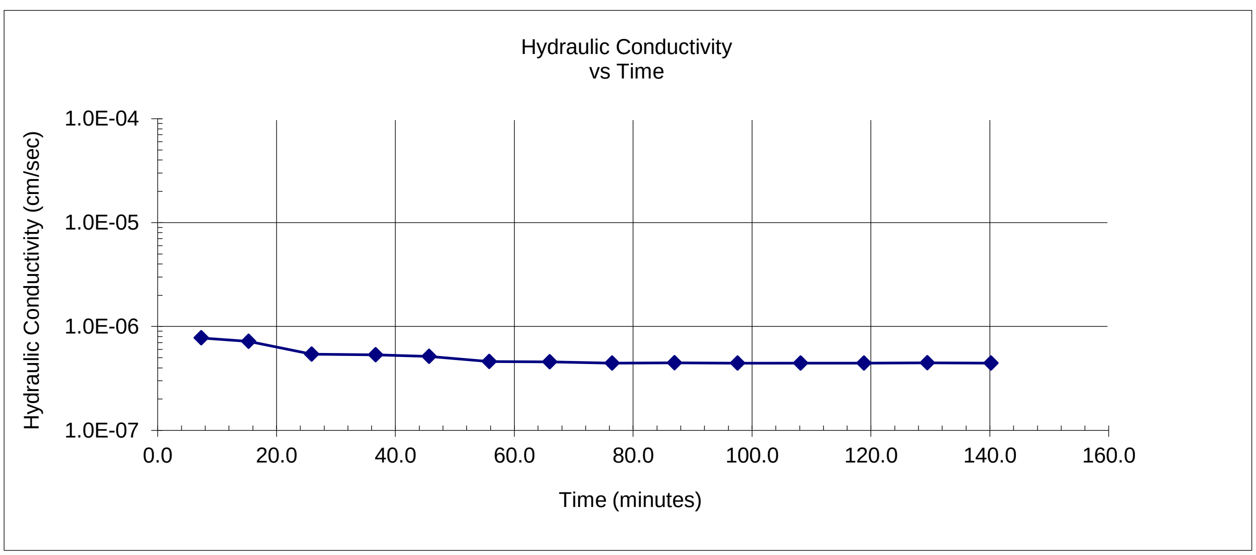
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	2.09	2.09
Avg. dia. of specimen (in)	3.02	3.02
Area (sq in)	7.14	7.14
Volume (cubic in)	14.95	14.95
Moist mass (g)	454.0	459.4
Moist unit weight (pcf)	115.7	117.1
Moisture content (%)	32.5	34.1
Dry density (pcf)	87.3	87.3
Specific gravity (assumed)	2.68	2.68
Void ratio	0.92	0.92

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	31.1
Cell pressure (psi):	75.0
Head pressure (psi):	72.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	3.0

Comments:

Hydraulic Conductivity at 20 °C = **4.45E-07** cm/sec

Average of last 7 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/18/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A3	Sample Preparation	
Sample Location:	C75	Procedures:	
Depth (ft):	17-20		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

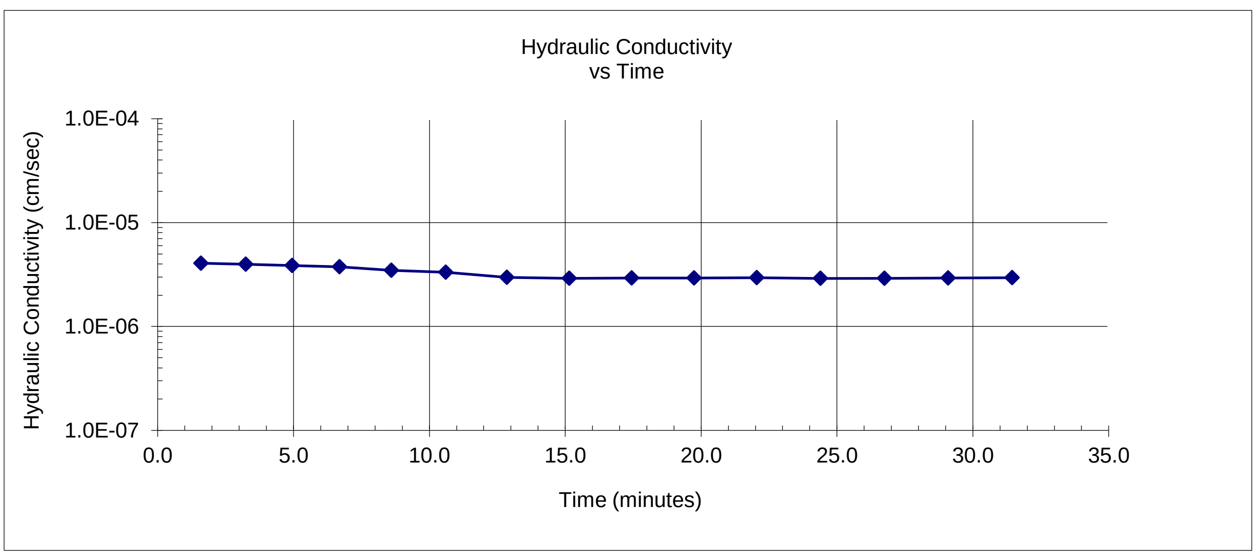
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	2.39	2.39
Avg. dia. of specimen (in)	3.02	3.02
Area (sq in)	7.14	7.14
Volume (cubic in)	17.07	17.07
Moist mass (g)	520.0	528.1
Moist unit weight (pcf)	116.0	117.8
Moisture content (%)	29.5	31.5
Dry density (pcf)	89.6	89.6
Specific gravity (assumed)	2.68	2.68
Void ratio	0.87	0.87

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	27.3
Cell pressure (psi):	75.0
Head pressure (psi):	72.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	3.0

Comments: ______________________

Hydraulic Conductivity at 20 ^{o}C = **2.93E-06** cm/sec

Average of last 9 readings



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Geotechnical Engineering Laboratory

Hydraulic Conductivity Using Flexible Wall Permeameter (ASTM D5084)

Client:	USG	Tested by:	ACS
Project Name:	Puyallup Pilot Study	Checked by:	MBP
Project Location:	Puyallup, WA	Start Test Date:	11/19/2021
Project Number:	19921-261175	Permeant Fluid:	De-aired water
Sample Number:	ISS-A3	Sample Preparation Procedures:	
Sample Location:	C85		
Depth (ft):	27-30		
Sample Description:	Soil-cement		
Test Type:	ASTM D5084		

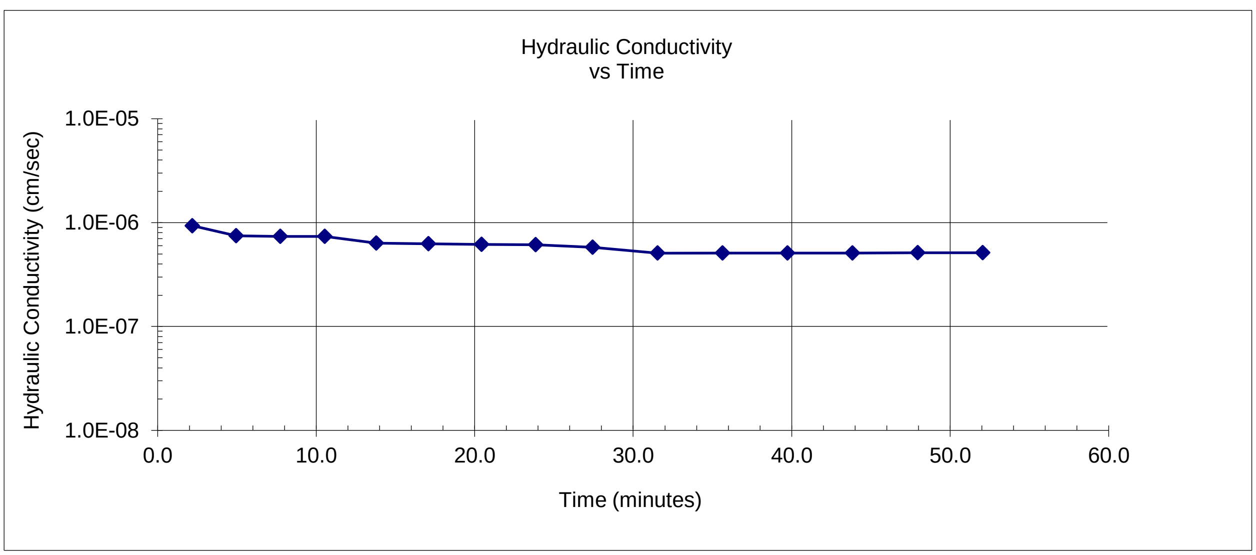
Sample Characteristics	Initial	Final
Avg. length of specimen (in)	1.89	1.89
Avg. dia. of specimen (in)	3.01	3.01
Area (sq in)	7.13	7.13
Volume (cubic in)	13.45	13.45
Moist mass (g)	409.3	414.1
Moist unit weight (pcf)	116.0	117.3
Moisture content (%)	32.1	33.6
Dry density (pcf)	87.8	87.8
Specific gravity (assumed)	2.68	2.68
Void ratio	0.91	0.91

Test Specifications	
B-Value (%):	
Consolidation stress (psi):	5.0
Gradient (in/in):	34.5
Cell pressure (psi):	75.0
Head pressure (psi):	72.0
Tail pressure (psi):	70.0
Max effective stress (psi):	5.0
Min effective stress (psi):	3.0

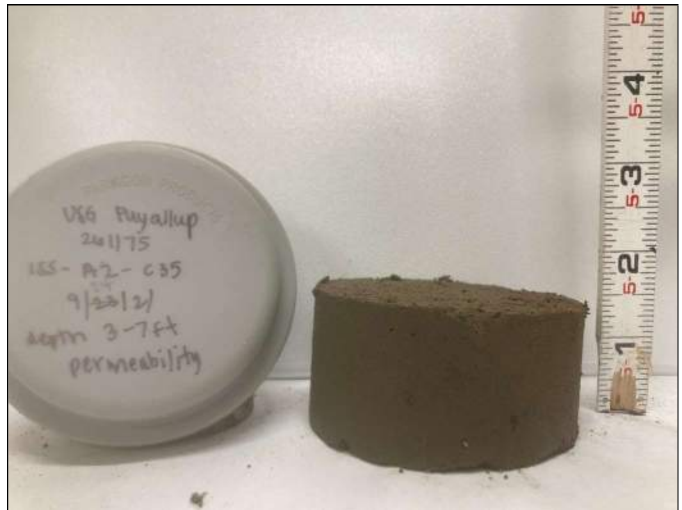
Comments:

Hydraulic Conductivity at 20 ^{o}C = **5.10E-07** cm/sec

Average of last 6 readings

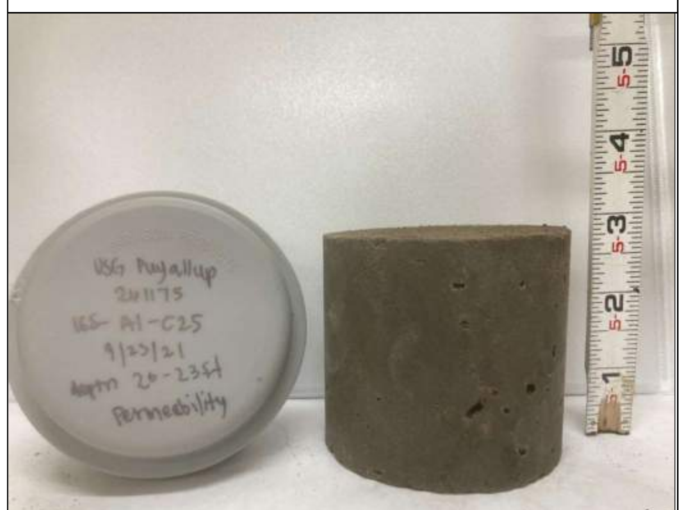


Picture Date:	Monday 11/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C5 Permeability Test



Picture Date:	Monday 11/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C35 Permeability Test

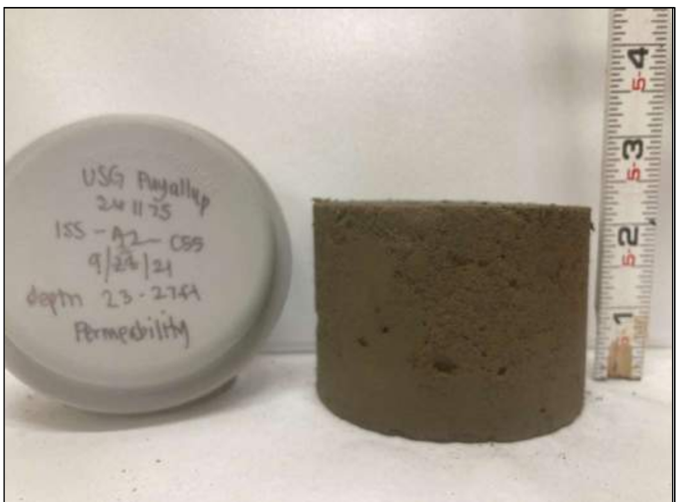
Picture Date:	Thursday 11/18/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C15 Permeability Test



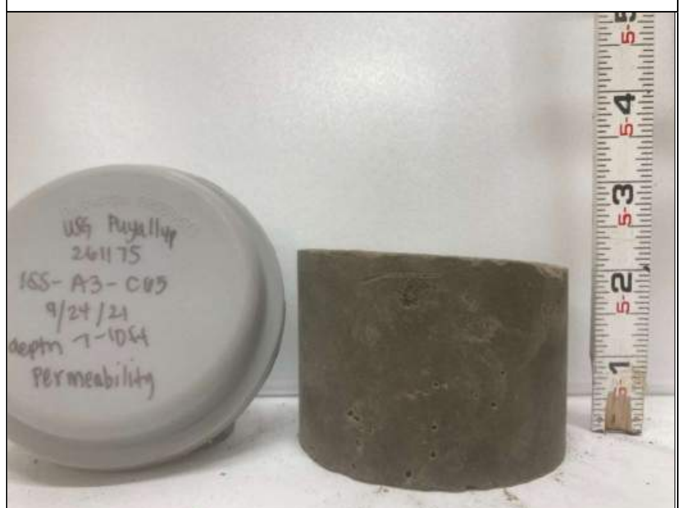
Picture Date:	Tuesday 11/16/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C25 Permeability Test

Picture Date:	Tuesday 11/16/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C45 Permeability Test

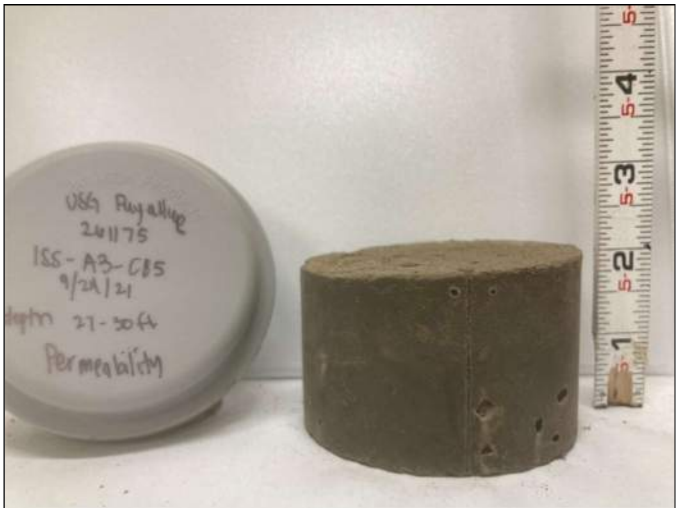
Picture Date:	Tuesday 11/16/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C75 Permeability Test



Picture Date:	Friday 11/19/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C55 Permeability Test



Picture Date:	Monday 11/22/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C65 Permeability Test



Picture Date:	Friday 11/19/2021
Picture Taken By:	Matt Polsky
Picture Location:	Chelmsford, Massachusetts
Project Name:	USG Puyallup Pilot Study
Project Description:	ISS-A1-C85 Permeability Test

CDM Smith

Appendix H

SPLP and SDL Laboratory Test Results

CDM Smith

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

October 28, 2021

Pam Morrill
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project 261175-TK3
Laboratory Reference No. 2110-164

Dear Pam:

Enclosed are the analytical results and associated quality control data for samples submitted on October 20, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: October 28, 2021
Samples Submitted: October 20, 2021
Laboratory Reference: 2110-164
Project: 261175-TK3

Case Narrative

Samples were collected on September 23 and 24, 2021 and received by the laboratory on October 20, 2021. They were maintained at the laboratory at a temperature of 2°C to 6°C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: October 28, 2021
Samples Submitted: October 20, 2021
Laboratory Reference: 2110-164
Project: 261175-TK3

SPLP ARSENIC
EPA 1312/6020B

Matrix: SPLP Extract
Units: mg/L (ppm)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**ISS-A1-C26**					
Laboratory ID:	10-164-01					
Arsenic	**ND**	0.0050	EPA 6020B	10-28-21	10-28-21	
Client ID:	**ISS-A2-C46**					
Laboratory ID:	10-164-02					
Arsenic	**0.0053**	0.0050	EPA 6020B	10-28-21	10-28-21	
Client ID:	**ISS-A3-C76**					
Laboratory ID:	10-164-03					
Arsenic	**ND**	0.0050	EPA 6020B	10-28-21	10-28-21	

Date of Report: October 28, 2021
Samples Submitted: October 20, 2021
Laboratory Reference: 2110-164
Project: 261175-TK3

SPLP ARSENIC
EPA 1312/6020B
QUALITY CONTROL

Matrix: SPLP Extract
Units: mg/L (ppm)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1028SPM1					
Arsenic	**ND**	0.0050	EPA 6020B	10-28-21	10-28-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	10-164-01										
	ORIG	DUP									
Arsenic	**ND**	**ND**	NA	NA		NA		NA	NA	20	
MATRIX SPIKES											
Laboratory ID:	10-164-01										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**0.229**	**0.227**	0.222	0.222	ND	**103**	**102**	75-125	1	20	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

OnSite Environmental Inc.
Analytical Laboratory Testing Services
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • www.onsite-env.com

Chain of Custody

Laboratory Number: 10-164

Company: CDM Smith
Project Number: 261175-TK3
Project Name: USG Puyallup Pilot Study
Project Manager: Pam Morrill
Sampled by: Haley Provinsal

Turnaround Request (in working days)
(Check One)
- [ ] Same Day
- [ ] 1 Day
- [ ] 2 Days
- [ ] 3 Days
- [x] Standard (7 Days)
- [ ] ______ (other)

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	Number of Containers	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Gx	NWTPH-Dx (☐ Acid / SG Clean-up)	Volatiles 8260D	Halogenated Volatiles 8260D	EDB EPA 8011 (Waters Only)	Semivolatiles 8270E/SIM (with low-level PAHs)	PAHs 8270E/SIM (low-level)	PCBs 8082A	Organochlorine Pesticides 8081B	Organophosphorus Pesticides 8270E/SIM	Chlorinated Acid Herbicides 8151A	Total RCRA Metals	Total MTCA Metals	TCLP Metals	HEM (oil and grease) 1664A	SPLP - Arsenic	% Moisture
1	ISS-A1-C24	9/23/21	1720	Soil	1																		X	X
2	ISS-A2-C46	9/24/21	1235	|	1																		X	X
3	ISS-A3-C76	9/24/21	1535	|	1																		X	X

	Signature	Company	Date	Time
Relinquished	HKP	CDM Smith	10/20/21	1025
Received	Nicole [illegible]	OSE	10/20/21	1025
Relinquished				
Received				
Relinquished				
Received				

Reviewed/Date

Reviewed/Date

Comments/Special Instructions

PO# 102063

Data Package: Standard ☐ Level III ☐ Level IV ☐

Chromatograms with final report ☐ Electronic Data Deliverables (EDDs) ☐

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

November 30, 2021

Todd Burgesser
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project USG Puyallup Pilot Study
Laboratory Reference No. 2111-189

Dear Todd:

Enclosed are the analytical results and associated quality control data for samples submitted on November 18, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-189
Project: USG Puyallup Pilot Study

Case Narrative

Samples were collected on October 25, 26, 27, 28, November 1, 8, and 15, 2021 and received by the laboratory on November 18, 2021. They were maintained at the laboratory at a temperature of 2°C to 6°C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-189
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**Puyallup-SDL1-2-HOUR**					
Laboratory ID:	11-189-01					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-24-HOUR**					
Laboratory ID:	11-189-02					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-48-HOUR**					
Laboratory ID:	11-189-03					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-72-HOUR**					
Laboratory ID:	11-189-04					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-7-DAY**					
Laboratory ID:	11-189-05					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-14-DAY**					
Laboratory ID:	11-189-06					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-14-DAY-DUP**					
Laboratory ID:	11-189-07					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL1-21-DAY**					
Laboratory ID:	11-189-08					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-189
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1129D1					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	11-189-04										
	ORIG	DUP									
Arsenic	**ND**	**ND**	NA	NA		NA		NA	NA	20	
MATRIX SPIKES											
Laboratory ID:	11-189-04										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**84.6**	**81.2**	80.0	80.0	ND	**106**	**102**	75-125	4	20	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

CHAIN OF CUSTODY RECORD 11-189 (STA)

CDM Smith | USG Puyallup

NOTES:
Report to Todd Burgesserte@cdmsmith.com

TAT: STANDARD

COC #: 209

USG Puyallup Pilot Study PO # 102063

	SAMPLE NUMBER	DATE	TIME	MATRIX	Preservative	No. of Containers	Analysis: Dissolved Arsenic by 6020 MB								Comments
1	Puyallup-SDL1-2-HOUR	10/25/2021	15:00	AQ	ice/HNO3	1	X								
2	Puyallup-SDL1-24-HOUR	10/26/2021	13:00	AQ	ice/HNO3	1	X								
3	Puyallup-SDL1-48-HOUR	10/27/2021	13:00	AQ	ice/HNO3	1	X								
4	Puyallup-SDL1-72-HOUR	10/28/2021	13:00	AQ	ice/HNO3	1	X								
5	Puyallup-SDL1-7-DAY	11/1/2021	13:00	AQ	ice/HNO3	1	X								
6	Puyallup-SDL1-14-DAY	11/8/2021	13:00	AQ	ice/HNO3	1	X								
7	Puyallup-SDL1-14-DAY-DUP	11/8/2021	13:00	AQ	ice/HNO3	1	X								
8	Puyallup-SDL1-21-DAY	11/15/2021	13:00	AQ	ice/HNO3	1	X								

Relinquished by: (*Signature*)	Date/Time	Received for Laboratory by: (*Signature*)	
[signature]	11/16/21 1300	[signature] OSE 11/18/21 1130	**Laboratory: Onsite**
Received by: (*Signature*)	**Date/Time**	**Airbill No.(s)** NA	Charge Code: 261175-TK3

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

November 30, 2021

Todd Burgesser
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project USG Puyallup Pilot Study
Laboratory Reference No. 2111-190

Dear Todd:

Enclosed are the analytical results and associated quality control data for samples submitted on November 18, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-190
Project: USG Puyallup Pilot Study

Case Narrative

Samples were collected on October 25, 26, 27, 28, November 1, 8, and 15, 2021 and received by the laboratory on November 18, 2021. They were maintained at the laboratory at a temperature of 2°C to 6°C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-190
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**Puyallup-SDL2-2-HOUR**					
Laboratory ID:	11-190-01					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-24-HOUR**					
Laboratory ID:	11-190-02					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-48-HOUR**					
Laboratory ID:	11-190-03					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-72-HOUR**					
Laboratory ID:	11-190-04					
Arsenic	**3.2**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-7-DAY**					
Laboratory ID:	11-190-05					
Arsenic	**3.4**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-14-DAY**					
Laboratory ID:	11-190-06					
Arsenic	**3.8**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL2-21-DAY**					
Laboratory ID:	11-190-07					
Arsenic	**3.6**	3.0	EPA 6020B		11-29-21	

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-190
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1129D2					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	11-191-07										
	ORIG	DUP									
Arsenic	**3.88**	**3.96**	NA	NA		NA		NA	2	20	
MATRIX SPIKES											
Laboratory ID:	11-191-07										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**83.4**	**83.6**	80.0	80.0	3.88	**99**	**100**	75-125	0	20	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

CHAIN OF CUSTODY RECORD 11-190 (STA)

CDM Smith — USG Puyallup

NOTES:
Report to Todd Burgesserte@cdmsmith.com

TAT: STANDARD

COC #: 210

USG Puyallup Pilot Study PO # 102063

Analysis: Dissolved Arsenic by 6020 MS

	SAMPLE NUMBER	DATE	TIME	MATRIX	Preservative	No. of Containers	Dissolved Arsenic by 6020 MS							Comments
1	Puyallup-SDL2-2-HOUR	10/25/2021	15:00	AQ	ice/HNO3	1	X							
2	Puyallup-SDL2-24-HOUR	10/26/2021	13:00	AQ	ice/HNO3	1	X							
3	Puyallup-SDL2-48-HOUR	10/27/2021	13:00	AQ	ice/HNO3	1	X							
4	Puyallup-SDL2-72-HOUR	10/28/2021	13:00	AQ	ice/HNO3	1	X							
5	Puyallup-SDL2-7-DAY	11/1/2021	13:00	AQ	ice/HNO3	1	X							
6	Puyallup-SDL2-14-DAY	11/8/2021	13:00	AQ	ice/HNO3	1	X							
7	Puyallup-SDL2-21-DAY	11/15/2021	13:00	AQ	ice/HNO3	1	X							

Relinquished by: (*Signature*)	Date/Time	Received for Laboratory by: (*Signature*)	Laboratory: Onsite
[signature]	11/16/21 1500	[signature] 11/18/21 1130 OSE	
Received by: (*Signature*)	**Date/Time**	**Airbill No.(s)** NA	Charge Code: 261175-TK3

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

November 30, 2021

Todd Burgesser
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project USG Puyallup Pilot Study
Laboratory Reference No. 2111-191

Dear Todd:

Enclosed are the analytical results and associated quality control data for samples submitted on November 18, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-191
Project: USG Puyallup Pilot Study

Case Narrative

Samples were collected on October 25, 26, 27, 28, November 1, 8, and 15, 2021 and received by the laboratory on November 18, 2021. They were maintained at the laboratory at a temperature of 2^oC to 6^oC.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-191
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**Puyallup-SDL3-2-HOUR**					
Laboratory ID:	11-191-01					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-24-HOUR**					
Laboratory ID:	11-191-02					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-48-HOUR**					
Laboratory ID:	11-191-03					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-72-HOUR**					
Laboratory ID:	11-191-04					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-7-DAY**					
Laboratory ID:	11-191-05					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-14-DAY**					
Laboratory ID:	11-191-06					
Arsenic	**3.4**	3.0	EPA 6020B		11-29-21	
Client ID:	**Puyallup-SDL3-21-DAY**					
Laboratory ID:	11-191-07					
Arsenic	**3.9**	3.0	EPA 6020B		11-29-21	

Date of Report: November 30, 2021
Samples Submitted: November 18, 2021
Laboratory Reference: 2111-191
Project: USG Puyallup Pilot Study

DISSOLVED ARSENIC
EPA 6020B
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1129D2					
Arsenic	**ND**	3.0	EPA 6020B		11-29-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	11-191-07										
	ORIG	DUP									
Arsenic	**3.88**	**3.96**	NA	NA		NA		NA	2	20	
MATRIX SPIKES											
Laboratory ID:	11-191-07										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**83.4**	**83.6**	80.0	80.0	3.88	**99**	**100**	75-125	0	20	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

CHAIN OF CUSTODY RECORD 11-191 (STA)

CDM Smith | **USG Puyallup**

NOTES:
Report to Todd Burgesserte@cdmsmith.com TAT: STANDARD

COC #: 211 **USG Puyallup Pilot Study PO # 102063**

	SAMPLE NUMBER	DATE	TIME	MATRIX	Preservative	No. of Containers	Dissolved Arsenic by 6020 MB							Comments
1	Puyallup-SDL3-2-HOUR	10/25/2021	15:00	AQ	ice/HNO3	1	X							
2	Puyallup-SDL3-24-HOUR	10/26/2021	13:00	AQ	ice/HNO3	1	X							
3	Puyallup-SDL3-48-HOUR	10/27/2021	13:00	AQ	ice/HNO3	1	X							
4	Puyallup-SDL3-72-HOUR	10/28/2021	13:00	AQ	ice/HNO3	1	X							
5	Puyallup-SDL3-7-DAY	11/1/2021	13:00	AQ	ice/HNO3	1	X							
6	Puyallup-SDL3-14-DAY	11/8/2021	13:00	AQ	ice/HNO3	1	X							
7	Puyallup-SDL3-21-DAY	11/15/2021	13:00	AQ	ice/HNO3	1	X							

Relinquished by: (*Signature*)	Date/Time	Received for Laboratory by: (*Signature*)	
[signature] 11/16/21 1000		Nichelle Bhuri OSE 11/18/21 1130	**Laboratory: Onsite**
Received by: (*Signature*)	**Date/Time**	**Airbill No.(s)** NA	Charge Code: 261175-TK3

OnSite Environmental Inc.
14648 NE 95th Street, Redmond, WA 98052 • (425) 883-3881

December 15, 2021

Todd Burgesser
CDM Smith, Inc.
14432 SE Eastgate Way, Suite 100
Bellevue, WA 98007-6493

Re: Analytical Data for Project 261175-TK3
Laboratory Reference No. 2112-079

Dear Todd:

Enclosed are the analytical results and associated quality control data for samples submitted on December 8, 2021.

The standard policy of OnSite Environmental, Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: December 15, 2021
Samples Submitted: December 8, 2021
Laboratory Reference: 2112-079
Project: 261175-TK3

Case Narrative

Samples were collected on November 22 and December 6, 2021 and received by the laboratory on December 8, 2021. They were maintained at the laboratory at a temperature of 2°C to 6°C.

Please note that any and all soil sample results are reported on a dry-weight basis, unless otherwise noted below.

General QA/QC issues associated with the analytical data enclosed in this laboratory report will be indicated with a reference to a comment or explanation on the Data Qualifier page. More complex and involved QA/QC issues will be discussed in detail below.

Date of Report: December 15, 2021
Samples Submitted: December 8, 2021
Laboratory Reference: 2112-079
Project: 261175-TK3

DISSOLVED ARSENIC
EPA 6020B

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
Client ID:	**Puyallup-SDL1-28-Day**					
Laboratory ID:	12-079-01					
Arsenic	**ND**	3.0	EPA 6020B		12-14-21	
Client ID:	**Puyallup-SDL1-42-Day**					
Laboratory ID:	12-079-02					
Arsenic	**ND**	3.0	EPA 6020B		12-14-21	
Client ID:	**Puyallup-SDL2-28-Day**					
Laboratory ID:	12-079-03					
Arsenic	**3.8**	3.0	EPA 6020B		12-14-21	
Client ID:	**Puyallup-SDL2-42-Day**					
Laboratory ID:	12-079-04					
Arsenic	**3.4**	3.0	EPA 6020B		12-14-21	
Client ID:	**Puyallup-SDL3-28-Day**					
Laboratory ID:	12-079-05					
Arsenic	**3.9**	3.0	EPA 6020B		12-14-21	
Client ID:	**Puyallup-SDL3-42-Day**					
Laboratory ID:	12-079-06					
Arsenic	**4.4**	3.0	EPA 6020B		12-14-21	

Date of Report: December 15, 2021
Samples Submitted: December 8, 2021
Laboratory Reference: 2112-079
Project: 261175-TK3

DISSOLVED ARSENIC
EPA 6020B
QUALITY CONTROL

Matrix: Water
Units: ug/L (ppb)

Analyte	Result	PQL	Method	Date Prepared	Date Analyzed	Flags
METHOD BLANK						
Laboratory ID:	MB1214D1					
Arsenic	**ND**	3.0	EPA 6020B		12-14-21	

Analyte	Result		Spike Level		Source Result	Percent Recovery		Recovery Limits	RPD	RPD Limit	Flags
DUPLICATE											
Laboratory ID:	12-079-06										
	ORIG	DUP									
Arsenic	**4.38**	**3.98**	NA	NA		NA		NA	10	20	
MATRIX SPIKES											
Laboratory ID:	12-079-06										
	MS	MSD	MS	MSD		MS	MSD				
Arsenic	**82.4**	**82.6**	80.0	80.0	4.38	**98**	**98**	75-125	0	20	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

E - The value reported exceeds the quantitation range and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeneity. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range are impacting the diesel range result.

M1 - Hydrocarbons in the gasoline range (toluene-naphthalene) are present in the sample.

N - Hydrocarbons in the lube oil range are impacting the diesel range result.

N1 - Hydrocarbons in diesel range are impacting lube oil range results.

O - Hydrocarbons indicative of heavier fuels are present in the sample and are impacting the gasoline result.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

U1 - The practical quantitation limit is elevated due to interferences present in the sample.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a mercury cleanup procedure.

X1- Sample extract treated with a sulfuric acid/silica gel cleanup procedure.

Y - The calibration verification for this analyte exceeded the 20% drift specified in methods 8260 & 8270, and therefore the reported result should be considered an estimate. The overall performance of the calibration verification standard met the acceptance criteria of the method.

Y1 - Negative effects of the matrix from this sample on the instrument caused values for this analyte in the bracketing continuing calibration verification standard (CCVs) to be outside of 20% acceptance criteria. Because of this, quantitation limits and sample concentrations should be considered estimates.

Z -

ND - Not Detected at PQL
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

CHAIN OF CUSTODY RECORD 12-079

CDM Smith — USG Puyallup

NOTES:
Report to Todd Burgesserte@cdmsmith.com

COC #: 214

USG Puyallup Pilot Study PO # 102063 Line 2
261175-TK3

	SAMPLE NUMBER	DATE	TIME	MATRIX	Preservative	No. of Containers	Dissolved Arsenic (method 6020)							Comments
1	Puyallup-SDL1-28-Day	11/22/2021	13:00	AQ	HNO3	1	X							
2	Puyallup-SDL1-42-Day	12/6/2021	13:00	AQ	HNO3	1	X							
3	Puyallup-SDL2-28-Day	11/22/2021	13:00	AQ	HNO3	1	X							
4	Puyallup-SDL2-42-Day	12/6/2021	13:00	AQ	HNO3	1	X							
5	Puyallup-SDL3-28-Day	11/22/2021	13:00	AQ	HNO3	1	X							
6	Puyallup-SDL3-42-Day	12/6/2021	13:00	AQ	HNO3	1	X							

Relinquished by: (*Signature*)	Date/Time	Received for Laboratory by: (*Signature*)	
[signature]	12/7/21	[signature] O&E 12/8/21 1145	**Laboratory: Onsite**
Received by: (*Signature*)	Date/Time	Airbill No.(s) NA	Charge Code: 261175-TK3

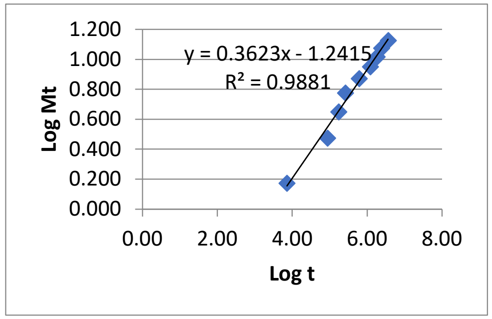
Appendix I

SDL Data Evaluation

CDM
Smith

Puyallup SDL1 Arsenic

D_{obs} =	**Observed diffusivity**	**0.00E+00**	m^2/s
ρ =	Density of the sample	1767	kg/m^3
SA =	Surface area of sample	0.0203	m^2
V =	Volume of Solution	20.2	L
C_0 =	Constituent in solid (weighted avg.)	101	mg/kg
π =		3.14	



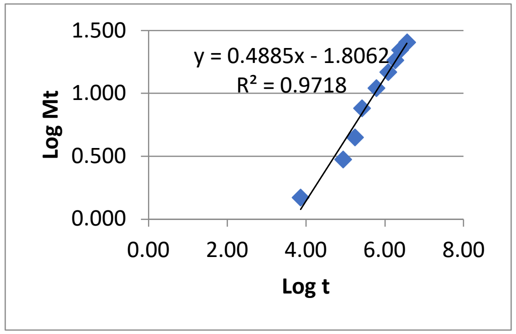
EU Tank Leaching Mechanisms

Increment	CFa-b	EPA Slope	Std Dev rc	Conclusion
2 - 7	3.00	0.260	0.077	Surface Wash Off
5 - 8	3.00	0.679	0.076	Dissolution
4 - 7	3.00	-0.030	0.063	Depletion
3 - 6	3.00	0.218	0.076	Depletion
2 - 5	3.00	0.373	0.107	Diffusion
1 - 4	3.00	0.424	0.100	Diffusion

Interval	t (sec interval)	t (sec cumulative)	Days	M_{ti} (E^*_i)	Mt-cumlt (ε^*_n)	Log[Mt]	Log t	C(soln) mg/L	C(soln) ug/L	D_i^{obs}	EPA slope	ε_n (mg/m^2)	log ε_n (mg/m^2)
1	7200	7200	0.083333	1.493	1.493	0.174	3.86	0.00150	1.5	7.63E-15		1.493	0.174
2	79200	86400	1	1.493	2.985	0.475	4.94	0.00150	1.5	1.26E-15	0.279	2.098	0.322
3	86400	172800	2	1.493	4.478	0.651	5.24	0.00150	1.5	3.70E-15	0.585	5.096	0.707
4	86400	259200	3	1.493	5.970	0.776	5.41	0.00150	1.5	6.29E-15	0.710	8.134	0.910
5	345600	604800	7	1.493	7.463	0.873	5.78	0.00150	1.5	7.61E-16	0.263	4.322	0.636
6	604800	1209600	14	1.493	8.956	0.952	6.08	0.00150	1.5	5.29E-16	0.263	5.096	0.707
7	604800	1814400	21	1.493	10.448	1.019	6.26	0.00150	1.5	8.99E-16	0.380	8.134	0.910
8	604800	2419200	28	1.493	11.941	1.077	6.38	0.00150	1.5	1.26E-15	0.464	11.141	1.047
9	1209600	3628800	42	1.493	13.433	1.128	6.56	0.00150	1.5	4.49E-16	0.290	8.134	0.910
		31536000	365	32.162	45.595	1.659	7.50	0.00013					
		63072000	730	22.045	67.641	1.830	7.80	0.00008					
		157680000	1825	46.289	113.929	2.057	8.20	0.00006					
		315360000	3650	55.084	169.013	2.228	8.50	0.00004					

Puyallup SDL2 Arsenic

D_{obs} =	**Observed diffusivity**	**0.00E+00**	**m^2/s**
ρ =	Density of the sample	1803	kg/m^3
SA =	Surface area of sample	0.0203	m^2
V =	Volume of Solution	20.2	L
C_0 =	Constituent in solid (weighted avg.)	130	mg/kg
π =		3.14	



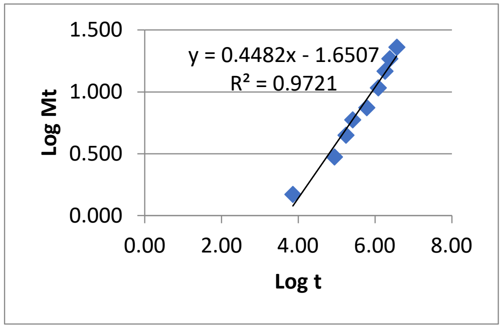
EU Tank Leaching Mechanisms

Increment	CFa-b	EPA Slope	Std Dev rc	Conclusion
2 - 7	5.67	0.584	0.077	Diffusion
5 - 8	7.30	0.745	0.076	Dissolution
4 - 7	7.00	0.046	0.063	Depletion
3 - 6	5.95	0.609	0.076	Diffusion
2 - 5	4.80	0.854	0.107	Dissolution
1 - 4	3.85	0.548	0.100	Diffusion

Interval	t (sec interval)	t (sec cumulative)	Days	M_{ti} (E^*_i)	Mt-cumlt (ε^*_n)	Log[Mt]	Log t	C(soln) mg/L	C(soln) ug/L	D_i^{obs}	EPA slope	ε_n (mg/m^2)	log ε_n (mg/m^2)
1	7200	7200	0.083333	1.493	1.493	0.174	3.86	0.00150	1.5	4.42E-15		1.493	0.174
2	79200	86400	1	1.493	2.985	0.475	4.94	0.00150	1.5	7.28E-16	0.279	2.098	0.322
3	86400	172800	2	1.493	4.478	0.651	5.24	0.00150	1.5	2.15E-15	0.585	5.096	0.707
4	86400	259200	3	3.184	7.662	0.884	5.41	0.00320	3.2	1.66E-14	1.325	17.352	1.239
5	345600	604800	7	3.383	11.045	1.043	5.78	0.00340	3.4	2.27E-15	0.432	9.797	0.991
6	604800	1209600	14	3.781	14.827	1.171	6.08	0.00380	3.8	1.97E-15	0.425	12.910	1.111
7	604800	1814400	21	3.582	18.409	1.265	6.26	0.00360	3.6	3.00E-15	0.534	19.522	1.291
8	604800	2419200	28	3.781	22.190	1.346	6.38	0.00380	3.8	4.70E-15	0.649	28.224	1.451
9	1209600	3628800	42	3.383	25.573	1.408	6.56	0.00340	3.4	1.34E-15	0.350	18.437	1.266
		31536000	365	20.022	45.595	1.659	7.50	0.00008					
		63072000	730	22.045	67.641	1.830	7.80	0.00008					
		157680000	1825	46.289	113.929	2.057	8.20	0.00006					
		315360000	3650	55.084	169.013	2.228	8.50	0.00004					

Puyallup SDL3 Arsenic

D_{obs} =	**Observed diffusivity**	**0.00E+00**	m^2/s
ρ =	Density of the sample	1795	kg/m^3
SA =	Surface area of sample	0.0203	m^2
V =	Volume of Solution	20.2	L
C_0 =	Constituent in solid (weighted avg.)	170	mg/kg
π =		3.14	



EU Tank Leaching Mechanisms

Increment	CFa-b	EPA Slope	Std Dev rc	Conclusion
2 - 7	4.43	0.591	0.077	Diffusion
5 - 8	6.35	1.392	0.076	Dissolution
4 - 7	5.15	0.520	0.063	Diffusion
3 - 6	3.95	0.477	0.076	Diffusion
2 - 5	3.00	0.373	0.107	Diffusion
1 - 4	3.00	0.424	0.100	Diffusion

Interval	t (sec interval)	t (sec cumulative)	Days	M_{ti} (E^*_i)	Mt-cumlt (ε^*_n)	Log[Mt]	Log t	C(soln) mg/L	C(soln) ug/L	D_i^{obs}	EPA slope	ε_n (mg/m^2)	log ε_n (mg/m^2)
1	7200	7200	0.083333	1.493	1.493	0.174	3.86	0.00150	1.5	2.61E-15		1.493	0.174
2	79200	86400	1	1.493	2.985	0.475	4.94	0.00150	1.5	4.30E-16	0.279	2.098	0.322
3	86400	172800	2	1.493	4.478	0.651	5.24	0.00150	1.5	1.27E-15	0.585	5.096	0.707
4	86400	259200	3	1.493	5.970	0.776	5.41	0.00150	1.5	2.15E-15	0.710	8.134	0.910
5	345600	604800	7	1.493	7.463	0.873	5.78	0.00150	1.5	2.60E-16	0.263	4.322	0.636
6	604800	1209600	14	3.383	10.846	1.035	6.08	0.00340	3.4	9.30E-16	0.539	11.551	1.063
7	604800	1814400	21	3.881	14.727	1.168	6.26	0.00390	3.9	2.08E-15	0.754	21.148	1.325
8	604800	2419200	28	3.881	18.608	1.270	6.38	0.00390	3.9	2.92E-15	0.813	28.967	1.462
9	1209600	3628800	42	4.378	22.986	1.361	6.56	0.00440	4.4	1.32E-15	0.521	23.860	1.378
		31536000	365	22.609	45.595	1.659	7.50	0.00009					
		63072000	730	22.045	67.641	1.830	7.80	0.00008					
		157680000	1825	46.289	113.929	2.057	8.20	0.00006					
		315360000	3650	55.084	169.013	2.228	8.50	0.00004					