METG
Montana Environmental Trust Group

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May 29, 2015

Betsy Burns
RCRA Project Officer
USEPA Region 8, Montana Operations Office
Federal Building
10 West 15th St., Suite 3200, Mail Code: 8MO
Helena, MT 59626

Dear Betsy:

The Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (the Custodial Trust), respectfully submits the attached, *"Former ASARCO East Helena Facility Interim Measures Work Plan—2015 and 2016 (Final),"* (the IM Work Plan 2015—2016) to the US Environmental Protection Agency (EPA), as Lead Agency for East Helena Site. The Final IM Work Plan 2015—2016 was prepared in accordance with EPA's conditional approval letter of May 1, 2015 and the Custodial Trust's obligations under the Consent Decree and Environmental Settlement Agreement Regarding the Montana Sites and the First Modification to the 1998 Consent Decree (Civil Action No. CV 98-3-H-CCL, US Federal District Court, District of Montana). The Final IM Work Plan 2015—2016 is available in electronic form on the Custodial Trust website (http://www.mtenvironmentaltrust.org/).

Please do not hesitate to contact me with any questions pertaining to this transmittal.

Sincerely,

Cynthia Brooks

Montana Environmental Trust Group, LLC
Trustee of the Montana Environmental Custodial Trust
By: Greenfield Environmental Trust Group, Inc., Member
By: Cynthia Brooks, President

Attachments

cc: With Attachments

Mary Capdeville—MDOJ
Bill Kirley—MDEQ
Denise Kirkpatrick—MDEQ
Kathy Moore—Lewis & Clark County
East Helena Branch of the Lewis & Clark County Library
City of East Helena—Office of the Mayor

cc: Without Attachments

Dean Brockbank—Custodial Trust
Julie DalSoglio—US EPA-8
Chuck Figur—USEPA-8
Lauri Gorton—Custodial Trust
Greg Mullen—MDOJ
Karen Nelson—USFWS
Alan Tenenbaum—USDOJ
Elliot Rockler—USDOJ
Joe Vranka—US EPA-8
Marc Weinreich—Custodial Trust

CERTIFICATION
PURSUANT TO FIRST MODIFICATION TO CONSENT DECREE
Civil Action No. CV 98-3-H-CCL, (US Federal District Court, District of Montana)

"I certify under penalty of law that this document and all attachments, were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations."

Cynthia Brooks

Montana Environmental Trust Group, LLC
Not individually but solely in its representative capacity as
Trustee of the Montana Environmental Custodial Trust
By: Greenfield Environmental Trust Group, Inc., Member
By: Cynthia Brooks, President

Final

Former ASARCO East Helena Facility Interim Measures Work Plan—2015 and 2016

Prepared for

The Montana Environmental Trust Group, LLC

Trustee of the Montana Environmental Custodial Trust

May 2015

CH2MHILL®

7 West 6th Avenue Suite 519
Helena, Montana 59601

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Appendixes

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Acronyms and Abbreviations

AOC	Area of Contamination
APP	Avian Protection Plan
ARM	Administrative Rules of Montana
CAMP	Corrective Action Monitoring Plan
CAMU	Corrective Action Management Unit
CLOMR	Conditional Letter of Map Revision
CMS	Corrective Measures Study
COEH	City of East Helena
COPC	constituent of potential concern
CSM	conceptual site model
Custodial Trust	Montana Environmental Custodial Trust
EHECTIC	East Helena Entire Cleanup Team in Coordination
ERM	Environmentally Regulated Material
ESA	Endangered Species Act
ET	evapotranspiration
F&T	fate and transport
FEMA	Federal Emergency Management Agency
HDS	high-density sludge
HEC-RAS	Hydrologic Engineering Centers River Analysis System
ICS	Interim Cover System
ICS 1	Interim Cover System 1 completed in November 2014
ICS 2	Interim Cover System 2 proposed for completion in 2015
IM	interim measure
IM Work Plan 2012	Interim Measures Work Plan 2012
IM Work Plan 2013	Interim Measures Work Plan 2013
IM Work Plan 2014	Interim Measures Work Plan 2014
IM Work Plan 2015/2016	Interim Measures Work Plan 2015 and 2016
Joint Application	Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and Other Waterbodies
LCCD	Lewis and Clark Conservation District
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MDEQ	Montana Department of Environmental Quality

MDT	Montana Department of Transportation
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MPDES	Montana Pollutant Discharge Elimination System
NOI	Notice of Intent
NWE	NorthWestern Energy
OU	Operable Unit
PCB	polychlorinated biphenyl
PPC	Prickly Pear Creek
QA/QC	quality assurance and quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
ROD	Record of Decision
SPHC	South Plant Hydraulic Control
SWPPP	Stormwater Pollution Prevention Plan
TPA	Tito Park Area
TSCA	Toxic Substances Control Act
ULM	Upper Lake Marsh
UOSA	Upper Ore Storage Area
U.S.	United States
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTP	water treatment plant
yd^3	cubic yard(s)

SECTION 1

Introduction

The purpose of this Interim Measures Work Plan 2015 and 2016 (IM Work Plan 2015/2016) is to provide information to support U.S. Environmental Protection Agency (USEPA) approval of the interim measures (IMs) proposed for implementation in 2015 and 2016 at the East Helena Facility (Facility). This IM Work Plan 2015/2016 focuses on work proposed and, as appropriate, updates information presented in the preceding IM Work Plans submitted from 2012 through 2014 (IM Work Plan 2012, CH2M HILL, 2012a; IM Work Plan 2013, CH2M HILL, 2013; and IM Work Plan 2014, CH2M HILL, 2014a).

An addendum to this IM Work Plan 2015/2016 will be submitted to USEPA, and provided for public comment, in the third or fourth quarter of 2015. The IM Work Plan 2015/2016 Addendum will provide additional details on source control measures that currently are under evaluation for the former Smelter site. The source control measures are planned for implementation in 2016, prior to placement of the Evapotranspiration (ET) Cover System in those areas.

1.1 Summary of Interim Measures

The three interrelated, interdependent IMs were proposed at the Facility in concept in the IM Work Plan 2012 and subsequently approved by USEPA on August 28, 2012. Components of these IMs have been completed as further described in the IM Work Plan 2013 and IM Work Plan 2014 approved by USEPA on January 21, 2013, and April 28, 2014, respectively. The primary purpose of the IMs is to reduce the migration of contaminants in groundwater from the operating area of the former ASARCO Smelter (former Smelter site) in order to protect public health and the environment. The three IMs are summarized as follows:

- The South Plant Hydraulic Control IM (SPHC IM) is proposed to reduce the migration of inorganic contaminants in groundwater by changing the hydrogeologic conditions at the southern end of the former Smelter site.
- The Source Removal IM is proposed to reduce the mass loading of contaminants to groundwater by reducing the volume of soil with high concentrations of inorganic contaminants that are subject to infiltration or flow-through and subsequent leaching to groundwater.
- The ET Cover System IM is proposed to further reduce the potential for inorganic soil contaminants to leach to groundwater by eliminating or substantially reducing the amount of infiltration through contaminated materials and providing a clean surface for runoff. The ET Cover System IM will also eliminate human and ecological receptor exposure to inorganic-contaminated soil.

1.2 Interim Measures Work Completed to Date

Implementation of the three IMs is occurring in phases over a number of years. The following phases have been implemented since 2012:

- **SPHC IM**: Relocation of utilities and subsequent construction of the Temporary Bypass for Prickly Pear Creek (PPC) (PPC Temporary Bypass) was completed to route PPC flow around Smelter Dam. In addition, Wilson Ditch was decommissioned as an irrigation ditch, but continues to serve a role for stormwater control. The groundwater levels in the South Plant area were lowered substantially, enabling removal of the Tito Park Area (TPA) (see discussion under Source Removal IM below), and potentially enabling construction of the new PPC channel (also referred to as PPC Realignment) in mostly dry conditions. Construction of the PPC Temporary Bypass began in July 2013 and was completed in October 2013.
- **Source Removal IM—Tito Park Area Removal**: Removal of contaminated soil from the TPA, which consists of Tito Park, Upper Ore Storage Area (UOSA), Acid Plant Sediment Drying Area (APSD Area), and Lower Lake. The soil was removed to eliminate the potential for inundation and erosion from potential

PPC flooding, meet the functional needs of the PPC Realignment, support the development of wetland habitat in the PPC floodplain, and reduce the overall footprint of the ET Cover System. The final design of the TPA removal provides flexibility in the construction and ultimate performance of the PPC Realignment, which is critical to the implementation of the SPHC IM. Removal of contaminated soil from the TPA was completed in October 2014.

- **ET Cover System IM**: Phase 1 and Phase 2 demolition of the buildings and infrastructure on the former Smelter site and subsequent construction of the first phase of the ET Cover System (Interim Cover System 1 [ICS 1]) to serve as the foundation layer of the western portion of the ET Cover (referred to as ET Cover West). Phase 1 demolition was completed in July 2013 and Phase 2 demolition was completed in October 2013. The ICS 1 was completed in November 2014.

1.3 Interim Measures Sequencing and Coordination with Corrective Measures Study Evaluations

Information developed during the evaluation, design, implementation, and performance monitoring of the IMs is being integrated with ongoing Corrective Measures Study (CMS) evaluations for the Facility. The IM implementation schedule is being closely coordinated with the source area investigations and the evaluation of source control and removal remedies, which have been underway since 2014. IM plans have been developed with the flexibility to allow for implementation of source control and/or removal remedies on the former Smelter site prior to completion of the ET Cover, as described further in the following sections.

In addition to the interim measures and ongoing source area investigations/remedy development, a petition and technical support document was submitted by the Lewis and Clark City/County Health Department to the Montana Department of Natural Resources and Conservation (DNRC) on August 25, 2014, to designate a Controlled Ground Water Area (CGWA; Hydrometrics, 2014a). The overall objective of the CGWA is to restrict future groundwater withdrawals to the extent necessary to prevent human exposure to contaminants, in particular arsenic and selenium, in groundwater, and to prevent pumping-induced spreading of groundwater contaminants. The proposed CGWA includes those portions of the Helena Valley alluvial aquifer where concentrations of arsenic, selenium, and other potential contaminants attributable to the Facility exceed State of Montana Human Health Standards, plus buffer zones where exceedances could occur in the future. If approved, the CGWA will be incorporated into the CMS evaluation and considered during remedy selection.

Supporting information can be found in the petition (Hydrometrics, Inc., 2014a). For additional information, contact the Lewis and Clark County Public Health Department, attention Kathy Moore, Environmental Services Administrator at 406-457-8926.

1.3.1 Implementation Schedule and Work Planning

The IM phases described in this work plan are proposed for concurrent implementation in 2015 and 2016 to increase the protectiveness, efficiency, and cost-effectiveness of construction activities. The overall schedule for completion is driven by the size and complexity of the PPC Realignment, with consideration of the large volume of material that will be excavated during construction of the new channel. The PPC Realignment work is being done concurrently with the ICS 2 and ET Cover so that materials managed from excavation activities as part of the PPC Realignment may be consolidated within the USEPA-approved AOC as fill to construct the ET Cover System, resulting in the following additional benefits:

- Protection of human health and the environment during construction by decreasing the potential for contact with contaminated media by human and ecological receptors, and stormwater
- Reduction in overall construction cost by minimizing the need to double-handle excavated materials (i.e., eliminating the need to temporarily stockpile soil before placing it in the final location)

- Reduction in the cost of constructing the ET Cover System by using materials excavated from the PPC Realignment as fill

The IM schedules and implementation plans have been and will continue to be adjusted to accommodate the implementation of source control/removal actions currently being evaluated as part of the CMS.

1.3.2 Performance Evaluations to Date

Because the IMs are intended to be part of the final remedy for the Facility, groundwater monitoring is underway to evaluate their performance. To date, monitoring results show that the completed phases of the SPHC IM are meeting the primary design and performance objective to lower groundwater levels in the southern portion of the former Smelter site and reduce mass loading of inorganic contamination to groundwater. Wells located in the South Plant area report an average 7-foot drop in groundwater levels; wells located in the former Acid Plant area near the southern portion of the former Smelter site report an average 5-foot or greater drop in groundwater levels. A sustained drop in groundwater elevations has been noted since inflow to Upper Lake was cut off in 2011 (more detail is provided in Section 3.1). Decreases in arsenic and selenium concentrations are also noted in the former Acid Plant area (a summary is provided in Section 3.2). Continued performance of the IMs will be evaluated as part of the CMS, and long-term monitoring plans will be designed to evaluate IM performance over time.

Additional benefits shown in groundwater evaluations include a reduction in the potential for mass loading to groundwater and a decrease in volumes of contact-stormwater (stormwater that contacts the existing site area and becomes contaminated). The removal of contaminated soil from the TPA has eliminated the potential for direct contact and future flooding to inundate the contaminated soil and subsequently mobilize the inorganic contaminants to groundwater. The majority of the Speiss material, which consists of a high arsenic process waste generated from smelter operations, in the South Plant area was removed and disposed of in the existing Corrective Action Management Unit (CAMU) 2 landfill, eliminating contact and subsequent leaching of contaminants to groundwater. Additional recoverable Speiss will be removed prior to completion of the ET Cover System. Completion of the ICS 1 has reduced the amount of contaminated stormwater collected and treated at the former Smelter site in the range of 500,000 gallons.

1.3.3 Coordination with Corrective Measures Study Evaluations

The CMS remedy identification and evaluation activities for the Facility have been underway since 2012, pursuant to the requirements of the First Modification to the 1998 Resource Conservation and Recovery Act (RCRA) Consent Decree (First Modification; Dreher et al., 2012). The IMs have been developed consistent with the requirements of the First Modification, but also as an integral part of the CMS process. CMS task results (e.g., the 2012 Upper Lake Drawdown Test) have informed IM development as well as remedy evaluations, and IM performance data are being integrated into CMS source control evaluations and groundwater modeling.

Several CMS activities continue to be conducted in parallel and closely coordinated with the IMs. These activities include the following:

- **Groundwater flow, fate, and transport modeling**. Groundwater modeling is being conducted to simulate the potential effects of various source control and removal actions on downgradient groundwater quality, and to predict long-term IM performance. The model is periodically recalibrated with current monitoring data, to incorporate observed effects of the IMs on groundwater levels and quality.

- **Groundwater monitoring**. Since 2012, the primary objectives of groundwater monitoring being conducted by the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (Custodial Trust), have shifted from characterization and delineation of the nature and extent of contamination (documented in the Field Sampling and Analysis Plans for 2012 and 2013 [Hydrometrics, 2012a and 2013b]) to potential remedy assessments and IM performance evaluations.

- **Source area investigations and source control evaluations**. Data developed from additional field investigations, groundwater modeling, and engineering evaluations are being used to assess the potential benefits of source control actions to the primary source areas at the former Smelter site. Evaluation of source control actions (which include removal, containment, and treatment) for the West Selenium Area, North Plant Arsenic Area, Speiss-Dross Area, and Acid Plant are underway and will be completed prior to installation of the ET Cover over these areas of the former Smelter site. An IM Work Plan 2015/2016 Addendum will be issued to describe the specific plans for source control or removal actions, and overall IM implementation schedules will be adjusted if and as necessary to accommodate these actions.
- **Short- and long-term water treatment**. The Custodial Trust continues to evaluate the most protective and cost-effective means of managing stormwater, remediation water, and CAMU leachate. To date, these waters have been treated at the onsite high-density sludge water treatment plant (HDS WTP). The Custodial Trust has submitted a Montana Pollutant Discharge Elimination System (MPDES) Permit Renewal Application to allow continued operation of the HDS WTP after August 1, 2015, when final effluent limits must be met. Water treatment needs are expected to change significantly in 2015 and beyond and therefore plans for HDS WTP operation and eventual decommissioning and demolition are being closely coordinated with IM implementation and potential source control/removal actions to provide flexibility and options for treating water in 2016 and beyond.

The results of these CMS activities will be documented in a CMS report and submitted to USEPA for review and selection of the final remedy(ies). The CMS report will also be provided for public review and comment, prior to final USEPA approval.

1.4 Proposed Activities

Figures 1-1 and 1-2 show the phases to be completed in 2015 and 2016, respectively, with the exception of the Phase 3 demolition activities; those are presented in **Figure 1-3**. The activities presented herein are submitted for USEPA review and approval as well as public review and comment:

- **PPC Realignment and Wetlands Establishment**: In 2015 and 2016, the PPC channel will be realigned to lower the groundwater table, and wetlands along the southern portion of PPC will be established. Materials excavated during construction of the PPC Realignment will be used to construct the ET Cover System. The PPC Temporary Bypass will remain in place until 2023 to aid in controlling stream flow and reducing the risk for flooding. After 2023, the wetlands will be sufficiently established to provide flooding protection and maintain stream flow.
- **ICS 2 and ET Cover System IM:** In addition to its protectiveness function, the ET Cover System IM has been designed to manage the excess borrow soil generated by the PPC Realignment excavation activities. The ICS 2 and ET Cover construction is therefore being scheduled and coordinated with the PPC Realignment activities, potential source control remedy implementation, and potential continued operation of the HDS WTP. In 2015, the ET Cover System will be completed over the ICS 1 (ET Cover West), and the second phase of the ICS (referred to as ICS 2) will be constructed over the eastern portion of the former Smelter site. An open corridor (the central corridor) will be maintained for additional investigative work in support of the on-going source control measures/groundwater remedy evaluation (**Figure 1-1**). If source control measures/groundwater remedies are projected to be of significant additional benefit to downgradient groundwater quality, they will be integrated with the three planned IMs. Any remedy proposed for the former Smelter site that would require excavation will be implemented prior to installation of the ET Cover in that area. The ICS 2 will establish the subgrade for the eastern portion of the ET Cover System (referred to as ET Cover East) and protectively manage soil and sediment removed during construction of the PPC Realignment until the final ET Cover surface layer is in place. In 2016, the ET Cover East will be completed over the ICS 2. The final ET Cover will not

be placed over the central corridor (**Figure 1-2**) until source control measures which require excavation have either been implemented or determined to be unnecessary.

- **Phase 3 Demolition**: The primary purpose of Phase 3 demolition activities is to provide a clear footprint in which to construct the ICS 2 and ET Cover East. In 2015, infrastructure within the ICS 2 footprint will be demolished to provide sufficient time to complete ICS 2 construction. In 2016, infrastructure within the central corridor will be demolished to accommodate the ET Cover East (**Figure 1-3**). Demolition activities associated with components of the high-density sludge (HDS) water treatment plant (WTP) will be sequenced to maintain functionality of the HDS WTP through 2016 or longer, if necessary to accommodate the overall site needs and project schedule. The building, structures, and utilities will be removed by a qualified demolition subcontractor, except for the overhead 69-kilovolt (kV) power line, associated poles, and substation, which NorthWestern Energy (NWE) will remove as part of relocating this utility to a new alignment along the perimeter access road of the ET Cover East.

1.5 Work Plan Summary

The Custodial Trust is submitting this IM Work Plan 2015/2016 in compliance with Paragraph 14 of the First Modification.

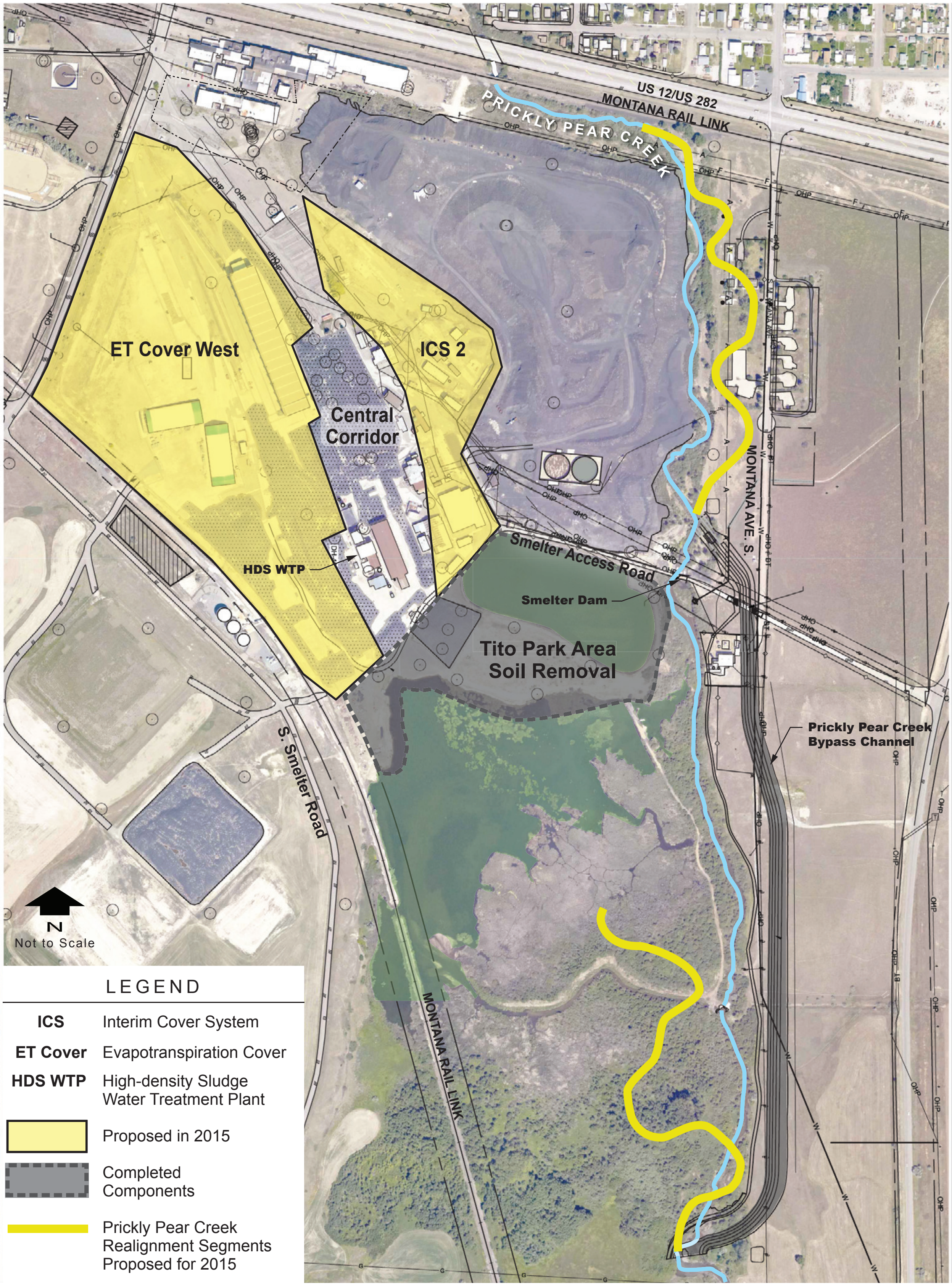
This IM Work Plan 2015/2016 builds on information presented in the previous IM Work Plans, and additional reports and technical memorandums prepared by the Custodial Trust. General background information on site history and conditions is presented in the *Phase II RCRA Facility Investigation—East Helena Facility* (Phase II RFI; GSI Water Solutions, Inc., 2014). An updated understanding of groundwater flow and water quality, integrating data collected and evaluations performed since the Phase II RFI, is summarized in Section 3. A complete list of references is provided in Section 9 of this IM Work Plan 2015/2016. Relevant documents are located on the Custodial Trust Web site: http://www.mtenvironmentaltrust.org/.

The IM Work Plan 2015/2016 is organized into the following sections:

- **Section 1: Introduction**.
- **Section 2: Overview of Proposed 2015 and 2016 Interim Measures Implementation** provides a summary-level description of the IMs proposed for implementation in 2015 and 2016 and how they fit into the overall IM concept for the Facility.
- **Section 3: Updated Conceptual Site Model** presents data and results of evaluations conducted that augment the existing conceptual site model (CSM) and may impact the proposed work.
- **Section 4: Data Sufficiency** summarizes the existing data used in the development of the work proposed for 2015 and 2016.
- **Section 5: Engineering Design and Construction Information for Proposed 2015 and 2016 Projects** provides conceptual design information and outlines construction and implementation requirements to complete the IMs and associated demolition activities proposed for 2015 and 2016. Additional design details are provided in Appendix A.
- **Section 6: Remediation Waste Management** describes how hazardous and nonhazardous remediation waste will be managed during implementation of the IMs and demolition activities described herein.
- **Section 7: Status of Permitting Activities and Approvals** provides an update on relevant activities associated with permitting and licensing requirements necessary to complete the 2015 and 2016 activities.
- **Section 8: Project Management and Schedule** provides an overview of project management activities and the proposed schedule for IM implementation. Updates to the organizational structure, lines of communication, public participation, documentation and reporting, and the schedule are described in this section.

- **Section 9: References** contains a bibliography of documents cited in text.

Supporting information is provided in three appendixes. **Appendix A** contains design details and supporting documentation. **Appendix B** contains a technical memorandum describing the results of the ET Cover System design evaluation. **Appendix C** contains public comments received on the IM Work Plan 2015/2016, with USEPA responses and a conditional letter of approval. **Appendix D** contains the Custodial Trust's response to comments from the Montana Department of Justice on the IM Work Plan 2015/2016.



Note: Phase 3 Demolition activities proposed in 2015 are shown in Figure 1-3.

FIGURE 1-1
Interim Measures Components Proposed for Implementation in 2015
Interim Measures Work Plan–2015/2016
East Helena, Montana

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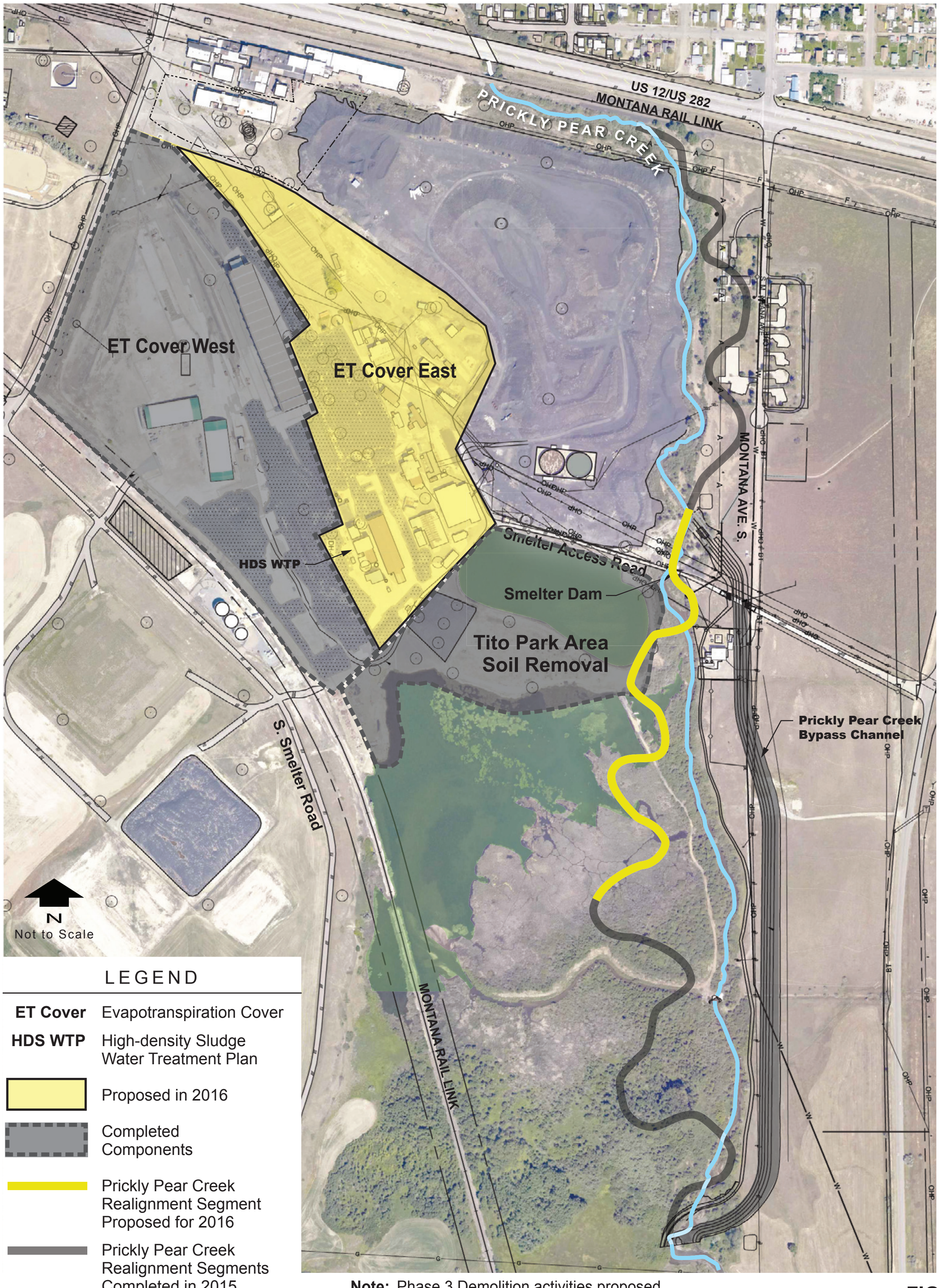


Note: Phase 3 Demolition activities proposed in 2016 are shown in Figure 1-3

FIGURE 1-2
Interim Measures Components Proposed for Implementation in 2016
Interim Measures Work Plan–2015/2016
East Helena, Montana

LEGEND

ICS	Interim Cover System
ET Cover	Evapotranspiration Cover
HDS WTP	High-density Sludge Water Treatment Plant
(dashed box)	Interim Measure
(hatched box)	Demolished Structure
(green box)	Building Proposed for Demolition in 2015
(orange box)	Building Proposed for Demolition in 2016
(blue line)	Prickly Pear Creek Realignment Proposed for 2015/2016

2015 DEMOLITION

No.	General Description
9	LMPT Building
10	Dispensary/First Aid Building
11	Change House
12	Thornock Tank & Collection Piping
13	Pump House & Diesel Fuel Tank
35	MPC Transformers/ NWE Substation

2016 DEMOLITION

No.	General Description
4	Warehouse Annex
39	Powerhouse Transformer Room
40	Electric Shop
42	Pump House
49	Sampling & Monitoring Building
53	Meter House
54	Acid Plant Drain Water Sump Pump
65	Water Vault & Sump
73	Neutralization Building
74	MCC Building
75	HDS Water Treatment Building
76	Sludge Recovery Building
77	Lime Silo
78	HERO Building & Associated Tank
79	Equipment Washing Building
80	Soda Ash Silo
83	HDS Storage Tanks
81	Rodeo Tank (near METG Office)

FIGURE 1-3
Phase 3 Demolition Activities
Interim Measures Work Plan–2015/2016
East Helena, Montana

CH2MHILL.

SECTION 2

Overview of Proposed 2015 and 2016 Interim Measures Implementation

This section provides an overview of the next phases of IM activities proposed for implementation in 2015 and 2016. Engineering details for the work summarized in this section are provided in Section 5.

2.1 South Plant Hydraulic Control Interim Measure: Prickly Pear Creek Realignment

The next phase of the SPHC IM proposed for construction in 2015 and 2016 is the PPC Realignment. The PPC Temporary Bypass will remain in service to allow for concurrent operation and protection of the completed PPC Realignment. This section describes proposed activities.

Activities proposed in 2015 and 2016 are the excavation and construction of portions of the PPC Realignment as shown in **Figure 1-1**, completion of the PPC Realignment as shown in **Figure 1-2**, and establishment of wetlands, including vegetation of the PPC Realignment channel bank and floodplain, to replace those affected by IM activities.

2.1.1 PPC Realignment

Objectives. The objectives of the PPC Realignment are as follows:

- Lower PPC elevation by more than 10 feet in places (south of the Smelter Dam). This will reduce leakage to groundwater as a result of PPC transitioning some PPC segments from a losing to a gaining stream, thus reducing groundwater levels beneath the southern portion of the former Smelter site by 1 to 2 feet in the South Plant area and an additional foot beneath the former Acid Plant area.
- Eliminate further undercutting of the eastern edge of the slag pile by moving the PPC channel 100 to 300 feet to the east of the toe of the slag pile.

Description. Activities proposed in 2015 as part of the PPC Realignment include excavation and backfill in the southern segment of the project area, west of the present stream channel (**Figure 2-1**). Material excavated from the southern segment of the project area will be placed on the main plant site as a portion of the ICS 2. Material will also be excavated from the East Bench east of the slag pile in the northern segment, below Smelter Dam **(Figure 2-1**). This excavated material will be used as streambed and floodplain substrate to replace the sandy material accumulated in the southern segment through the former Upper Lake Complex. Channel and floodplain features will be excavated and constructed generally as shown on the drawings provided in Appendix A. The stream will remain in the PPC Temporary Bypass channel around the southern segment and in the existing channel through the northern segment for the duration of the 2015 construction season. A berm will be constructed in the northern segment to isolate the existing channel from excavation activities.

In 2016, excavation and channel and floodplain construction will be completed in both the northern and southern segments, including regrading of the former TPA and Lower Lake area **(Figure 2-2**). When ready, the stream north of Smelter Dam will be rerouted into the new PPC channel, allowing for excavation and backfilling adjacent to the slag pile **(Figure 2-2**). The temporary bridge previously installed across Smelter Dam will be reset to allow for transport of excavated materials across the new PPC channel to be used in construction of the ET Cover System. An inlet structure to regulate flows into the southern end of the new PPC channel will be constructed near the present PPC Temporary Bypass channel inlet. Once all segments of the PPC channel are ready to receive water, flows will be diverted into the new channel through the southern segment and the remaining edges of the floodplain will be completed.

Construction of the PPC channel is slated to be completed in 2016 to avoid the estimated 6 percent to 8 percent increase in total construction costs associated with extending construction beyond 2016.

2.1.2 Wetlands Establishment

Objectives. The wetlands proposed as part of the PPC Realignment are designed to provide habitat restoration or replacement to at least a 1:1 ratio (impacted to mitigated) to comply with natural resource protection permitting requirements for remediation work. The wetlands are designed to provide mitigation for wetlands disturbed by the IMs being implemented. Under the monitoring and maintenance plan included in the Joint Application No. 2 (see Section 7.2.1), routine inspections will occur for at least 10 years to ensure compliance with the 1:1 ratio requirement.

Description. More than 42 acres of jurisdictional wetlands impacted by the PPC Realignment will be replaced with approximately 48 acres of similar habitat (constructed wetlands). Approximately 18 of the constructed acres will be classified as submergent/emergent habitat type and approximately 24 acres will be classified as scrub-shrub (sapling/shrub stratum). **Figure 2-3** shows the designed replacement wetlands.

Technical Evaluations. The PPC Realignment design basis documents provide a comprehensive summary of the calculations, memorandums, and reports used to develop the design and specifications of the PPC Realignment and wetlands establishment (Pioneer Technical Services, 2014). Evaluations have included stream assessments, design criteria calculations, analyses of sediment transport, construction sequencing, bypass usage, slag pile options, wetland delineations, wildlife documentation, sediment transport analyses, and plant salvage options. A list of the available documents used in the design basis is provided in Appendix A; electronic copies of the documents are available on request.

2.2 ET Cover System Interim Measure: Interim Cover System 2 and ET Cover East and West Construction

The next phase of the ET Cover System IM proposed for construction in 2015 and 2016 includes demolition of remaining structures and construction of the remaining components of the ET Cover System. Modification of the monitoring well network is proposed to decommission or protect existing wells located within the ET Cover System footprint.

An addendum to this IM Work Plan 2015/2016 will be prepared to present information to support USEPA’s approval of one or more source control remedies to be implemented as IMs prior to the completion of the ET Cover System. This addendum currently is expected to be submitted in 2015 for USEPA review and approval, and public comment. Construction is scheduled for 2016.

2.2.1 Proposed Activities

Activities proposed in 2015 and 2016 are Phase 3 demolition, construction of the ICS 2, and construction of the ET Cover West and East over the foundation layers provided by the ICSs 1 and 2. The construction schedule for the ET Cover System may be extended beyond 2016, if necessary to implement source control measures.

2.2.1.1 Phase 3 Demolition

The buildings, structures, utilities, and other features proposed for demolition are shown in Figure 1-3 and summarized in Section 5.2.2. Activities for 2015 are proposed to remove remaining infrastructure (building, structures, debris, and utilities) within the ICS 2 while providing continuous functionality and vehicle access to the onsite HDS WTP (through 2016, or longer if needed), groundwater monitoring, and asset recovery operations at the slag pile. The building, structures, and utilities in the footprint will be removed by a qualified demolition subcontractor except for the overhead 69-kV power line, associated poles, and substation, which NWE will remove and relocate to a new alignment in coordination with ICS 2. In 2016, all remaining infrastructure (with the possible exception of the HDS WTP) within the ET Cover East footprint will be demolished. As proposed in 2015, functionality and vehicle access for groundwater monitoring and asset recovery operations at the slag pile will be maintained during construction and after 2016 construction is complete.

Objectives. The objective of this work is to remove utilities and infrastructure that interfere with the location of the ICS 2 and ET Cover East on the former Smelter site. The work will be sequenced and controlled to remove the features in support of the ICS 2 and ET Cover East construction activities and allow continued operation of the HDS WTP through 2016, or longer if needed, while preventing stormwater and associated sediment from running offsite.

Description. Demolition of currently remaining facilities, buildings, structures, and utilities located within the ET Cover East footprint will be performed in phases to support construction of the ICS 2 and ET Cover East. Under the current schedule, the HDS WTP will remain operational until mid-2016, or longer if necessary. Removal of the HDS WTP will be required if source control measures are implemented in the Acid Plant area as well as to complete the ET Cover East. Demolition debris such as broken concrete, pavements, and brick will be placed in the ICS 2. Suitable materials will be sent to recycling facilities. Remaining demolition debris will be disposed of offsite at appropriate facilities, depending on the nature of the waste.

Technical Evaluations. Technical requirements for demolition include sequencing activities, categorizing waste as recycled (requiring offsite disposal) or appropriate for disposal under the ET Cover System IM, establishing management, transportation, and disposal protocols for each waste type, managing stormwater, and establishing abandonment guidelines for underground utilities.

NWE is coordinating with the Custodial Trust to decommission and demolish the substation and to relocate the 69-kV transmission line. These engineering evaluations for substation demolition and 69-kV transmission line relocation will address removal, cleanup, and line relocation. The relocated 69-kV line will follow the permanent perimeter road, which runs along the eastern border of ICS 2/ET Cover East. Construction of the ICS 2 will be coordinated with this relocation construction process.

2.2.1.2 ICS 2 Construction

The ICS 2 will consolidate and protectively manage materials excavated in 2015 from the PPC Realignment. These excavated materials will function as engineered fill within the ET Cover East footprint, and will be protected by a cap consisting of a temporary low-permeability soil cover and the biobarrier layer of the ET Cover East. **Figure 2-4** provides a cross-sectional view of the ICS 2. To allow continued access for construction personnel and ongoing activities, design of the ICS 2 includes an access road around the proposed footprint of the ET Cover East.

Objectives. The primary purpose of the ICS 2 is to function as the subgrade and biobarrier portion of the final ET Cover System. In the interim condition, the ICS will protectively manage materials excavated during the PPC Realignment until the ET Cover East can be constructed. Objectives of the ICS 2 design are as follows:

- Allow the materials excavated by the PPC Realignment construction to be excavated and immediately consolidated within the Area of Contamination (AOC), minimizing the environmental considerations and costs of stockpiling and “double handling.”
- Establish grades to drain noncontact stormwater runoff to a new temporary infiltration basin on the former TPA.
- Provide a native soil cap on the fill to prevent stormwater from contacting contaminated soil. This action will eliminate the need to collect and treat stormwater from this portion of the site.
- Sequence access road construction to allow continued asset recovery from the slag pile and construction by NWE of a new, overhead, 69-kV transmission line along the road.
- Sequence construction to leave open the central corridor between the ICS 1 and the ICS 2, for potential implementation of future source control measures and other groundwater remedy actions, if any.

- Limit the extent of the ICS 2 to allow continued operation of the HDS WTP through 2016, or longer if needed.
- Accept the excess volume of soil that is expected to be generated by the PPC Realignment in 2015.

Description. As with the ICS 1, the ICS 2 will form the foundation layer, or subgrade, of the ET Cover East. The ICS 2 will cover the soil and sediment removed during the PPC Realignment and consolidated within the AOC, protectively managing them during the interim period between excavation and construction of the final layers of the ET Cover East. ICS 2 will allow "noncontact" stormwater runoff to be shed to offsite drainage structures. The proposed areal extent of ICS 2 is shown in **Figure 1-1**.

Technical Evaluations. Technical evaluations have been completed for the ET Cover System IM to evaluate whether the cover system meets remedy performance standards, and to provide background information needed in the ICS 2 design. In addition, information obtained from the following activities performed during the ICS 1 construction will be incorporated into the ICS 2 design:

- Developed the required volumetric fill capacity for the ICS 2 and the ET Cover System by analyzing the cut and fill balance. This included performing laboratory tests to assess the shrink and swell characteristics of borrow soil.
- Performed three-dimensional topographic modeling to develop the ICS 2 grading plans that provide the required volumetric fill capacity and slopes that meet requirements for stormwater management, slope stability, and erosion control.
- Performed slope stability analyses of the ICS 2 slopes to verify that finish grades have acceptable factors of safety against slope instability.
- Performed hydraulic analyses to size stormwater management structures for the ICS 2. Also performed erosion analyses to develop maximum and minimum slopes and armoring requirements.
- Evaluated existing infrastructure to select sequencing and extent of the ICS 2, as well as the need for temporary infrastructure to support Facility operations during construction.
- Evaluated implementation of quality control requirements from the ICS 1 construction to refine the ICS 2 quality control requirements.
- Conducted the ICS cover soil borrow source evaluations to define the physical and chemical properties of the soil sources.
- Completed drainage option analyses to identify the design elements needed for runoff management; the objective was to accommodate design flows from the ET Cover System while minimizing runoff contribution from the former Smelter site to adjacent Custodial Trust properties.
- Evaluated the moisture balance effects and potential impacts to groundwater of the ICS 2 during its interim functional time period.

2.2.1.3 ET Cover East and West Construction

In 2015, the ET Cover West will be placed over the foundation provided by the ICS 1. In 2016, the ET Cover East will be placed over the ICS 2. The remaining portion of the ET Cover will be placed over the central corridor when source removal and/or control measures, including additional Speiss removal, have been completed in this area. **Figure 2-4** provides a cross-sectional view of the ET Cover System, with details of the ICSs and the final ET Cover layers.

Objectives. Both the ET Cover East and West will be constructed to meet the same major objectives. In addition, the ET Cover East will include grading within the central corridor to accept the excess volume of soil that is expected to be generated by the PPC Realignment in 2016. The major objectives of the ET Cover East and West are as follows:

- Reduce the infiltration of precipitation and associated leaching of inorganic contaminants in surface soil to groundwater, which will further reduce the volume of contaminant mass being mobilized to groundwater and transported offsite.
- Replace the existing interim cover system.
- Reduce the volume of contaminated stormwater that is being collected and treated by the HDS WTP.
- Eliminate the potential for people and wildlife to have direct contact with contaminated surface soil.

Description. The ET Cover West will be placed over the existing biobarrier (the existing surface layer of the ICS 1), and consists of an amended storage/topsoil layer, storage layer, and capillary break layer. The ET Cover East will be completed over the ICS 2 and the central corridor by incorporating an amended storage layer/topsoil, storage layer, capillary break layer, and biobarrier layer over the central corridor fill and final layer planned over the ICS 2.

Technical Evaluations. Technical evaluations completed to design the ET Cover East and West are summarized as follows:

- Water balance modeling was conducted in 2012 and 2013 to establish the feasibility of the ET Cover System.
- Evaluated different cover options to conclude that the ET Cover System was the most cost-effective option for meeting performance objectives.
- Conducted a borrow-material investigation to locate and assess the physical and hydraulic properties of potential borrow soil. A second and more extensive borrow investigation was conducted in 2014 as part of the ET Cover System design.
- Evaluated borrow soil gradations, local animals, and similar ET Cover Systems to develop requirements for a biobarrier layer to inhibit bioturbation of burrowing animals.
- Performed hydraulic modeling in 2013 and 2014 to establish soil types and layer thicknesses used for design. In addition, used modeling to develop a conceptual plant community and alternative ET Cover cross-sections and layering systems.
- Conducted both water balance and hydraulic modeling to finalize the ET Cover section (soil types, soil characteristics, and layer thicknesses).
- Conducted Upper Lake Marsh (ULM) top soil sampling to assess the chemical characteristics of soil that would be used for the surface layer of the ET Cover System. This included performing laboratory and bench-scale tests to develop agronomic properties of surface soil layer required to establish a plant community.
- Calculated the volumetric fill capacity for the ET Cover System by analyzing the cut and fill balance. This included performing laboratory tests to assess the shrink and swell characteristics of borrow soil.
- Performed three-dimensional topographic modeling to develop ET Cover System grading plans that provide the required volumetric fill capacity and assure that slopes meet requirements for stormwater management, slope stability, and erosion control.
- Performed slope stability analyses of the ET Cover System slopes to verify that finish grades have acceptable factors of safety against slope instability.
- Performed hydraulic analyses to size stormwater management structures for the ET Cover System. Also performed erosion analyses to develop maximum and minimum slopes and armoring requirements.
- Evaluated similar ET Cover System projects and USEPA guidance documents to develop detailed criteria for the design, construction, and operations and maintenance of the ET Cover System in 2014. In

addition, the ET Cover East will incorporate technical specifications developed during the ET Cover West construction.

2.2.2 Monitoring Network Modification

Similar to work completed in 2014 for the ICS 1, the objective of the monitoring network modification is to decommission or protect existing wells that are located within the ET Cover East footprint. Wells that are necessary for future monitoring will be extended to be functional; wells that are not needed for future monitoring will be decommissioned. Experience gained from more than 30 years of monitoring and evaluation at the former Smelter site indicates that a number of wells have not been sampled in years or are no longer needed to provide an effective monitoring network. To evaluate wells for decommissioning or protection, historical and current groundwater monitoring data, the results of efficacy studies that have been ongoing since 2011, and predictions from the groundwater fate and transport model, were reviewed with a focus on the remedy performance standards presented in the draft *Former ASARCO East Helena Facility Corrective Measures Study Work Plan 2013* (CH2M HILL, 2014b). The overall plan and strategy for monitoring the performance of the IMs and their effects on groundwater quality are incorporated into the Corrective Action Monitoring Plan (CAMP; Hydrometrics, 2014b).

The groundwater monitoring network not only continues to provide information on the nature and extent of contamination, but is used to support the ongoing source control/removal evaluations, and to evaluate the effects on groundwater flow and quality resulting from IM implementation. In the future, the CAMP will include performance monitoring of the IMs and corrective measures implemented as final remedies.

One well located within the footprint of the Change House (Building 11) has been identified for abandonment. The well will be abandoned in accordance with Administrative Rule of Montana (ARM) 36.21.810.

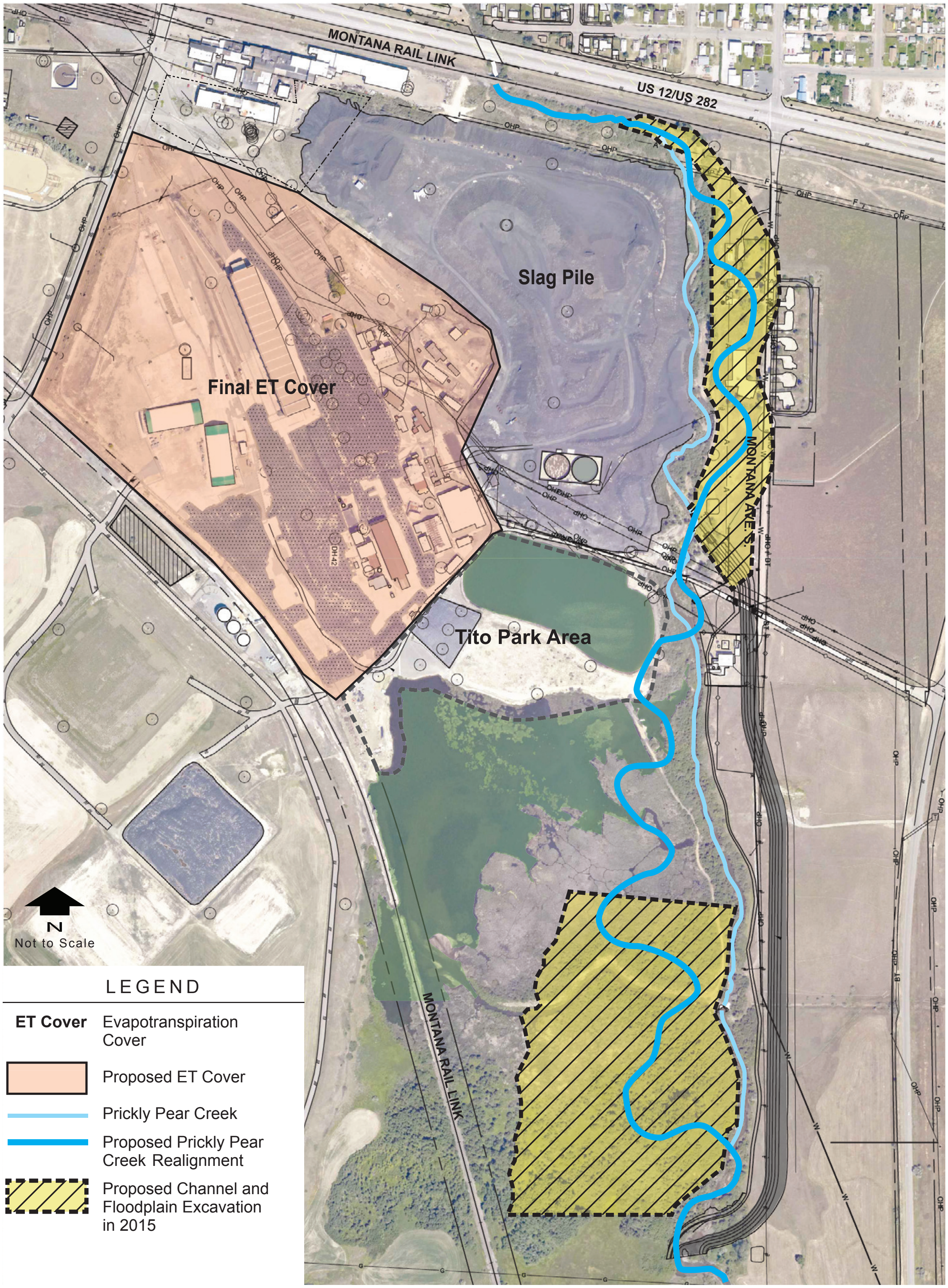


FIGURE 2-1
Channel and Floodplain Areas of Excavation Proposed in 2015
Interim Measures Work Plan–2015/2016
East Helena, Montana

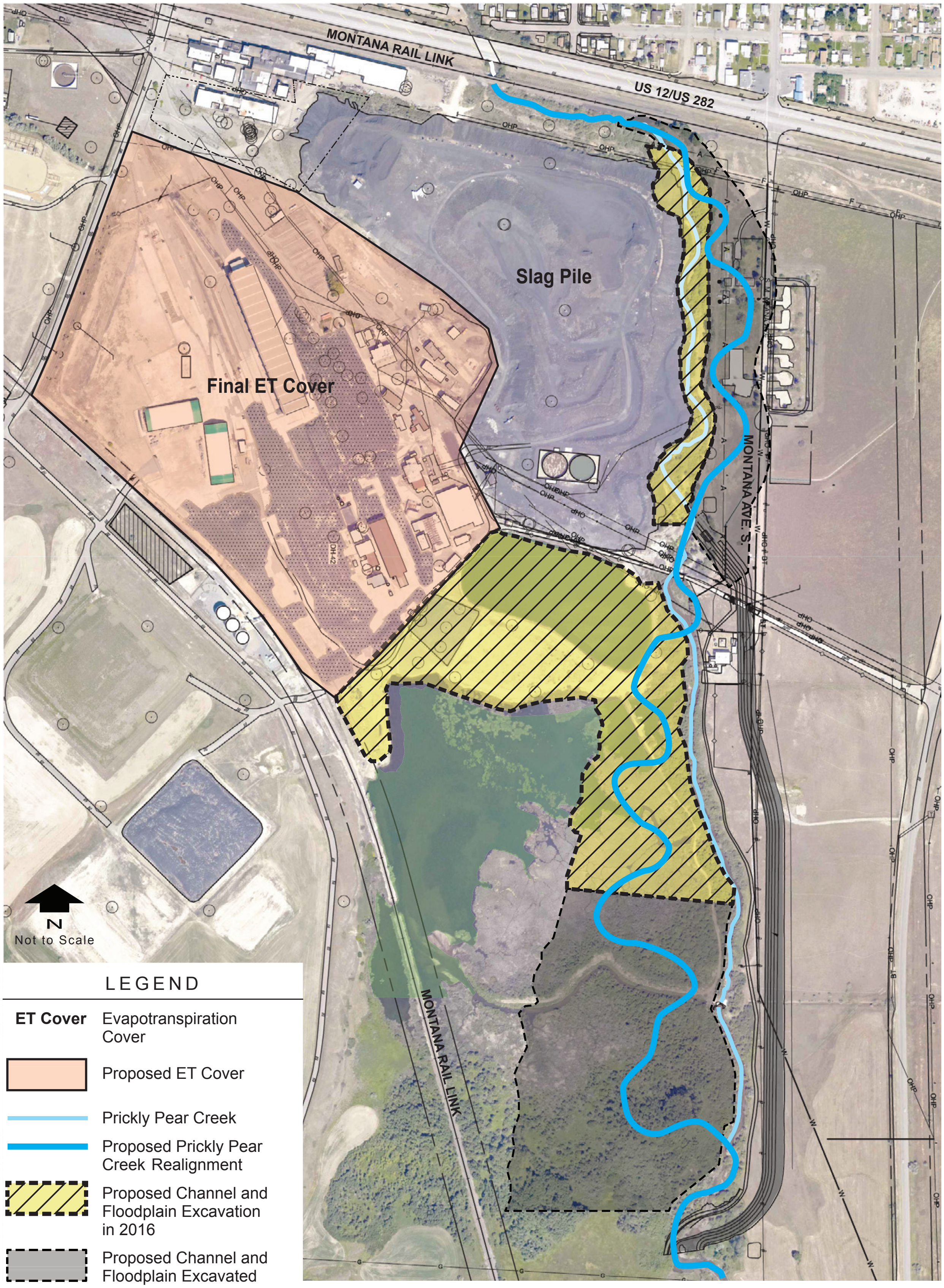
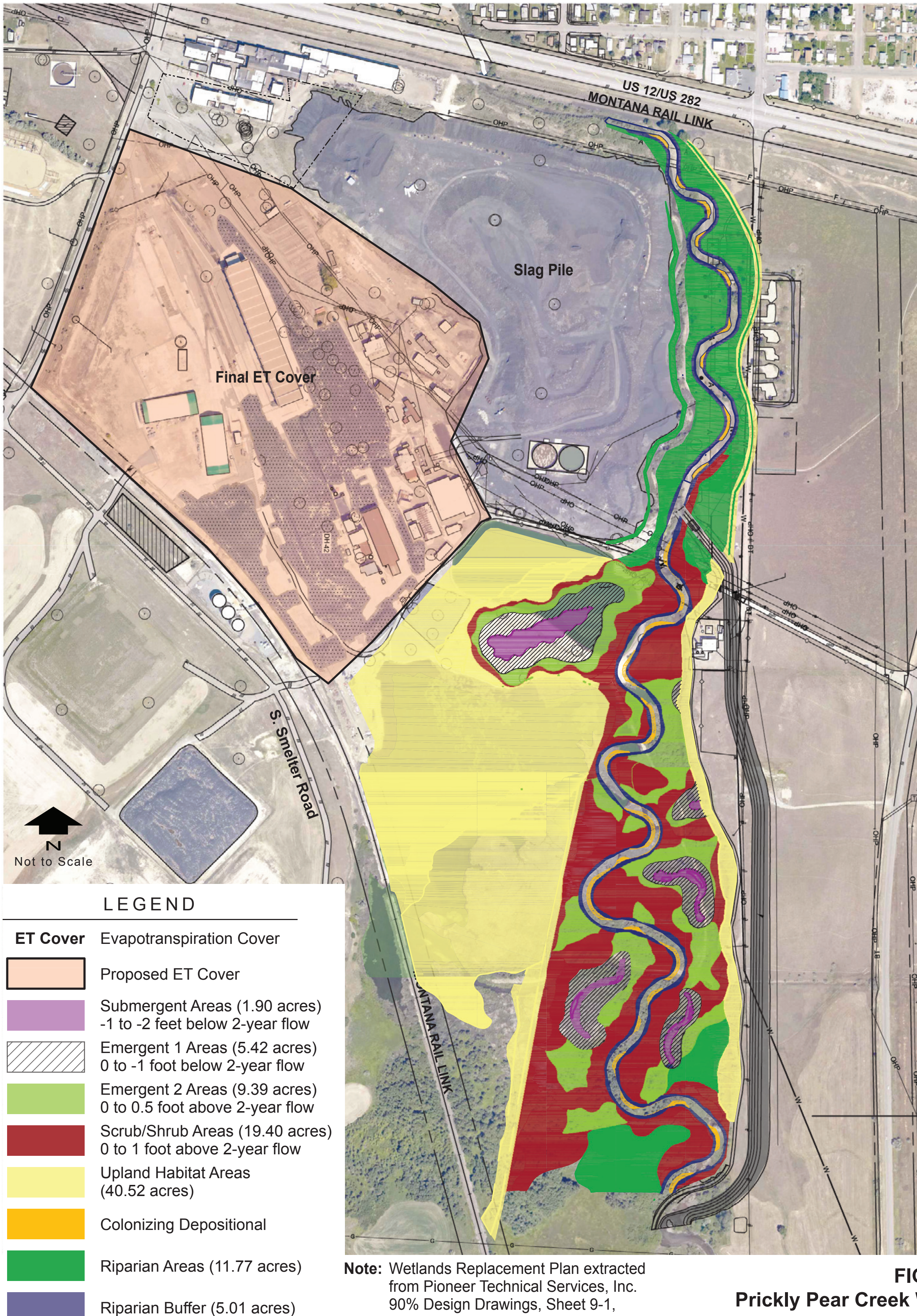
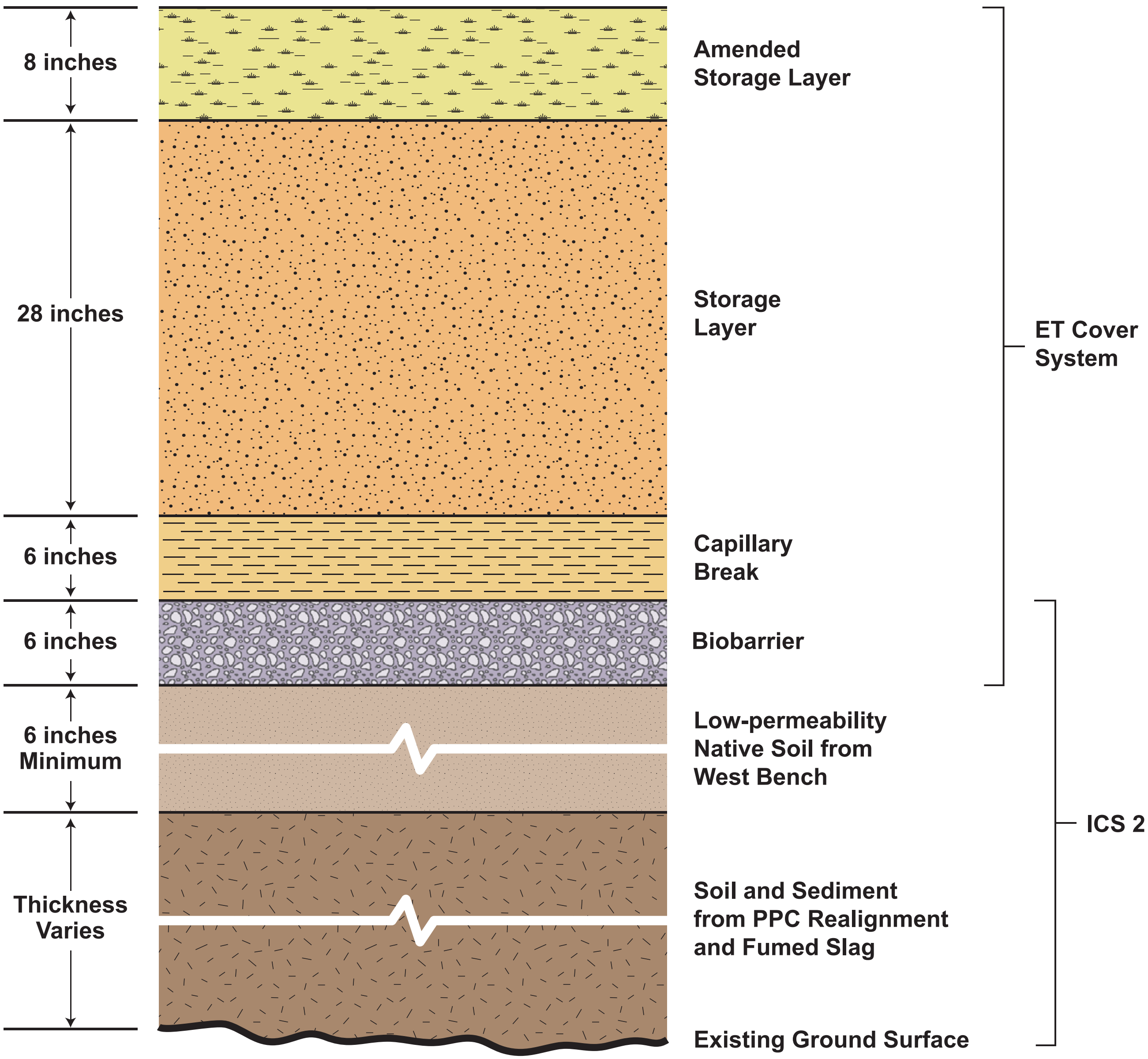


FIGURE 2-2
Channel and Floodplain Areas of Excavation Proposed in 2016
Interim Measures Work Plan–2015/2016
East Helena, Montana



Note: Wetlands Replacement Plan extracted from Pioneer Technical Services, Inc. 90% Design Drawings, Sheet 9-1, dated 10/1/14.

FIGURE 2-3
Prickly Pear Creek Wetlands Replacement Plan
Interim Measures Work Plan–2015/2016
East Helena, Montana



Notes:

1. The biobarrier is part of the ET Cover and will be installed during ICS 2 construction.
2. All the layer thicknesses for the ET Cover are estimated based on preliminary engineering and may change during final design.
3. An interim cover will not be underlain within the central corridor; therefore, the biobarrier will be installed with the ET Cover.

ET = Evapotranspiration
ICS = Interim Cover System
PPC = Prickly Pear Creek

FIGURE 2-4
ET Cover and Interim Cover System 2 Cross-Section
Interim Measures Work Plan–2015/2016
East Helena, Montana

SECTION 3

Updated Conceptual Site Model

This section provides updates to those portions of former Smelter site CSMs presented in earlier documents (e.g., the IM Work Plan 2012, IM Work Plan 2013, IM Work Plan 2014, and Phase II RFI) that are relevant to the work proposed in 2015 and 2016. This section is not intended to repeat earlier published materials but draws on those materials to provide the reader the appropriate context.

3.1 Groundwater Levels

Groundwater levels are an important component of the IM implementation at the former Smelter site for two reasons. First, groundwater elevations are a key consideration in planning and design of the PPC Realignment. Vertical alignment of the new PPC channel with the local groundwater table is critical for construction and proper long-term functioning of the realigned creek. Second, groundwater levels at the former Smelter site determine, in part, the interaction of groundwater with contaminated soil, and subsequent contaminant leaching to groundwater. The following three IM phases implemented to date have lowered groundwater elevations:

- Initiation of Upper Lake dewatering and elimination of Wilson Ditch flow as of November 1, 2011
- Diversion of the PPC through the PPC Temporary Bypass channel on October 29, 2013, effectively lowering the creek stage by up to 12 feet
- Active dewatering of Lower Lake beginning in May 2014 as part of the TPA removal action

Following is a discussion of current groundwater conditions in the ULM and main plant site areas where 2015 and 2016 IM phases are proposed.

3.1.1 Upper Lake Marsh Area Groundwater Levels

Before fall 2011, the ULM area was largely flooded year-round because of the diversion of PPC to Upper Lake. In November 2011, the Custodial Trust commenced the initial phase of the SPHC IM by dewatering Upper Lake and the associated marsh, eliminating the diversion of PPC to Upper Lake, and initiating active pumping (Hydrometrics, 2012b). Surface water level monitoring in the ULM area conducted in advance of Upper Lake dewatering consisted of monitoring the lake level itself. Once Upper Lake was sufficiently drained, a number of piezometers were installed to allow for monitoring of groundwater levels as well. **Figure 3-1** shows the ULM area groundwater-level monitoring network.

Figure 3-2 shows groundwater and surface water level trends in the ULM area since August 2011, about 3 months before the start of Upper Lake dewatering. As shown in the figure, the surface water level in Upper Lake fell about 2.5 feet immediately after Upper Lake dewatering was initiated (November 1, 2011), causing groundwater levels to subsequently decline across the main plant site (Section 3.1.2). The lake level declined a total of 4.1 feet between October 2011 and October 2013.

On October 29, 2013, PPC was diverted through the PPC Temporary Bypass channel. As a result of this diversion, groundwater levels in the ULM area declined further. From October 22, 2013, to December 2, 2013, before seasonal effects on groundwater levels would be noted, declines in groundwater levels ranged from 0.5 to 2.5 feet and averaged 1.4 feet. As expected, declines were greatest in the northeastern portion of the ULM near PPC and least in the southwestern portion, farthest from PPC.

Although a partial rebound in groundwater levels in May 2014 because of spring runoff (**Figure 3-2**), active dewatering of Lower Lake conducted as part of the TPA removal action resulted in further groundwater-level declines. Groundwater levels in the ULM area declined from 0.7 to 2.2 feet between May 1, 2014, and October 22, 2014, with an average decline of 1.5 feet.

Overall, groundwater-level declines in the ULM area range from 0.07 foot at PPCRPZ-7 to 8.58 feet at PPCRPZ-1 (**Figure 3-1**), and average 4.0 feet between October 2011 and October 2014 (**Table 3-1**). Further declines on the order of 1 to 2 feet in the north ULM area (north of the former Upper Lake inlet channel) are anticipated following completion of the PPC Realignment. The realigned PPC is expected to have minimal effect on groundwater levels south of the inlet channel.

TABLE 3-1
Upper Lake Marsh Area Groundwater-Level Response to Completed Interim Measures
Interim Measures Work Plan 2015/2016

Site	Upper Lake Dewatering 10/31/11-10/22/13	Prickly Pear Creek Diversion 10/22/13-12/13/13	Lower Lake/TPA Dewatering 5/1/14-10/14/14	Total Water Level Decline 10/31/11 – 10/14/14
PPCRPZ-1	4.46	2.52	1.41	8.58
PPCRPZ-2	3.98	1.79	1.60	7.53
PPCRPZ-3	4.00	1.37	1.17	6.58
PPCRPZ-4	3.52	1.02	1.42	5.67
PPCRPZ-5	0.46	0.84	2.19	2.51
PPCRPZ-6	-1.40	0.64	1.97	0.49
PPCRPZ-7	-2.32	1.30	1.66	0.07
ULMPZ-1	4.14	-0.08	4.87	10.71
ULMPZ-2	1.16	-0.07	0.73	1.82

Notes:

Total water level declines based on Upper Lake stage of 3,920.46 feet on October 20, 2011.

Monitoring locations are shown in **Figure 3-1**.

Negative values indicate water level rise.

TPA = Tito Park Area

3.1.2 Main Plant Site Groundwater Levels

Similar to the ULM, groundwater levels at the main plant site have been influenced by the SPHC IM and TPA removal action. **Figure 3-3** shows groundwater-level trends for select monitoring wells across the southern and western portions of the main plant site where the PPC Realignment and ET Cover System are planned. As described above for the ULM area, water levels in these areas have been closely monitored since initiation of Upper Lake dewatering in November 2011, with monitoring continuing to date. Well locations are shown in **Figure 3-1**.

As shown in **Figure 3-3**, groundwater levels throughout most of the South Plant area responded to the November 2011 dewatering of Upper Lake. Lower Lake and well DH-20 both showed an immediate decline in water levels in response to the Upper Lake dewatering, while well APSD-8, located adjacent to and influenced more by PPC, showed a delayed response. Overall, water level declines in the South Plant area resulting from dewatering of Upper Lake and before the diversion of PPC through the PPC Bypass channel averaged about 2 feet (**Table 3-2**). Water level declines during this same period averaged about 2.6 feet in the former Acid Plant area and 5 feet further downgradient in the northwestern portion of the main plant site. The larger water level declines in the northwestern portion of the main plant site are attributable primarily to the elimination of flow in nearby Wilson Ditch.

TABLE 3-2
South and West Plant Site Groundwater-Level Response to Completed Interim Measures
Interim Measures Work Plan 2015/2016

Site	Upper Lake Dewatering 10/31/11-10/22/13	Prickly Pear Creek Diversion 10/22/13-12/13/13	Lower Lake/TPA Dewatering 5/1/14-10/14/14	Total Water Level Decline 10/31/11 – 10/14/14
South Plant Area				
Lower Lake	2.56	1.64	3.71	9.18
APSD-8	2.73	0.88	2.173	6.08
DH-20	0.52	3.55	0.53	5.74
Average	**1.94**	**2.02**	**2.14**	**7.00**
Former Acid Plant Area				
DH-19R	2.40	0.91	1.13	4.97
DH-42	2.54	0.92	0.92	5.13
DH-71	2.92	0.92	0.836	5.53
Average	**2.62**	**0.92**	**0.96**	**5.21**
Northwest Plant Site				
DH-17	4.91	1.21	-0.9	5.55
DH-66	5.36	1.24	-0.96	5.95
DH-51	4.78	1.25	-0.91	5.24
DH-49	5.32	1.28	-1.03	5.63
Average	**5.09**	**1.24**	**-0.95**	**5.59**

Notes:

Total water level declines based on Upper Lake stage of 3,920.46 feet on October 20, 2011.

Monitoring locations are shown in Figure 3-1.

TPA = Tito Park Area

In response to the October 29, 2013, diversion of PPC to the PPC Temporary Bypass channel, groundwater levels declined further throughout the southern and western portions of the main plant site. South Plant area groundwater levels declined about 2 feet on average, former Acid Plant area levels declined about 0.9 foot and levels in the northwestern portion of the main plant site declined about 1.2 feet between October 15, 2013, and December 13, 2013. Water level trends in response to the dewatering of Lower Lake for the TPA removal action include 2.1- and 1.0-foot declines in the South Plant area and former Acid Plant areas, respectively, and an approximate 1-foot rise in the northwestern portion of the main plant site. The approximate 1-foot rise noted in the northwestern portion of the main plant site suggests that water levels in that area may have reached a post-SPHC IM equilibrium. Overall average water level changes since Upper Lake dewatering began in November 2011 are 7.0 feet in the South Plant area, 5.2 feet in the former Acid Plant area, and 5.6 feet in the northwestern portion of the main plant site, the latter is attributed mainly to the lack of flow in Wilson Ditch (**Table 3-2**). Further groundwater declines of 1 to 2 feet in the South Plant area and up to 1 foot in the former Acid Plant area are anticipated to occur in response to the PPC Realignment; no additional decline is anticipated in the northwestern portion of the main plant site.

3.2 Arsenic and Selenium in Groundwater

The status of the arsenic and selenium groundwater plumes has been updated using the latest comprehensive groundwater monitoring data from June 2014. Based on numerous investigations, arsenic and selenium have been identified as the primary chemicals of concern in groundwater and their plumes extend farthest beyond the former Smelter site boundary. As such, this discussion summarizes the changes in the arsenic and selenium plumes.

The current understanding of the arsenic groundwater plume is shown in **Figure 3-4**. Although arsenic concentrations in the center of plume have shown varying trends, the overall extent of the plume, as defined by a concentration of 0.010-milligram per liter (mg/L) (corresponds to the USEPA maximum contaminant level [MCL] for arsenic in groundwater), has not changed significantly in nearly 10 years. This indicates a stable plume, with no current evidence of plume advancement. However, remedial actions on the former Smelter site, including slurry wall construction and implementation of IMs, have resulted in contraction of the higher concentration portions of the arsenic plume. In 2002, arsenic concentrations in excess of 10 mg/L were common throughout the former Smelter site, extending from the South Plant area (former Acid Plant area) northward into East Helena. Recently, the greater-than-10 mg/L arsenic plume boundary has contracted in some areas, and now consists of more isolated areas within the former Smelter site, and an area extending into East Helena. In particular, decreases in arsenic are noted at some wells in the former Acid Plant area, which is located immediately downgradient of the TPA removal area and where the SPHC IM has the greatest beneficial effect. At well DH-30, arsenic concentrations have decreased from about 15 mg/L in 2011 (pre-SPHC IM implementation) to about 6 mg/L and well DH-47 shows a slight decrease in arsenic concentration.

The current configuration of the selenium groundwater plume is shown in **Figure 3-5**. Key changes noted in selenium concentrations include reductions in some wells in the south part of the former Smelter site, including the Acid Plant area. Well DH-71 reported pre-SPHC IM concentrations of selenium ranging from about 0.1 to 0.25 mg/L that have decreased to consistent concentrations near 0.05 mg/L (corresponds to the USEPA MCL for selenium in groundwater). Selenium concentrations are also decreasing in well DH-30.

A westward shift observed in both the arsenic and selenium plumes since 2011 is attributable to the SPHC IM. The selenium plume indicates an approximate 20-degree shift to the west. Previously, this plume (and the arsenic plume located just to the east) would shift slightly to the east during the fall, presumably because of leaking of water in Wilson Ditch to groundwater, then back toward the west after flow in the ditch ceased. Groundwater-level changes driven by the SPHC IM, particularly the absence of water in Wilson Ditch and the associated lack of leakage recharging groundwater during the irrigation season, have resulted in the slight shift of the plumes to the west.

As noted above, the most evident effects of the SPHC IM have been (1) ongoing contraction of higher concentration portions of the plumes in some areas of the former Smelter site, also reflecting the continued effects of previous remedial actions, and (2) a shift in selenium and (to a lesser extent) arsenic plume migration direction to the west. Because the SPHC IM has been implemented in stages over the last several years, it is likely that the groundwater flow and geochemical systems remain in a state of change, and that additional time and monitoring will be necessary to fully evaluate the water quality responses at the former Smelter site and downgradient locations.

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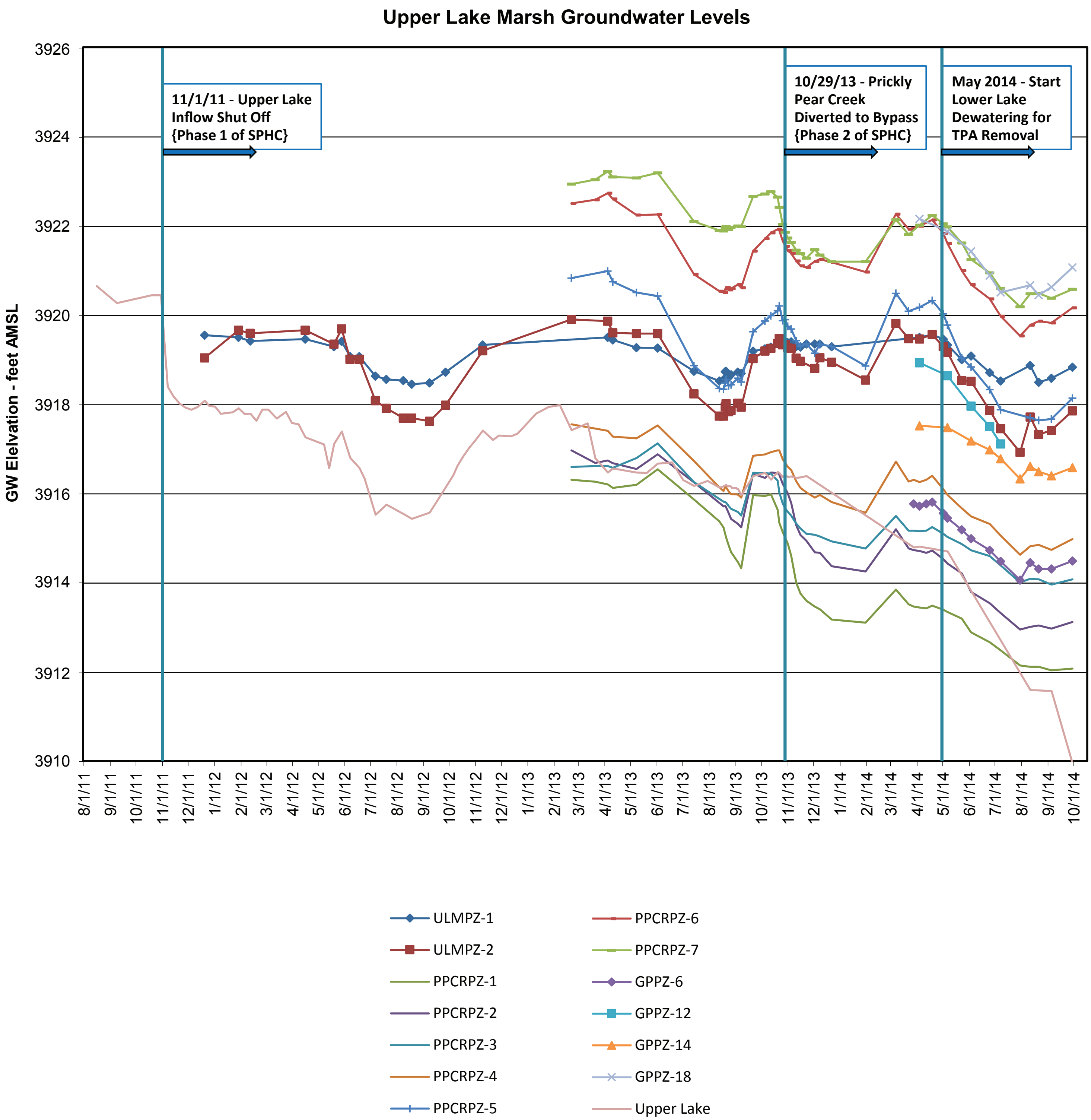
Hydrometrics, Inc.
Consulting Scientists and Engineers

LEGEND

- Groundwater Level Monitoring Well
- Existing Site Well

Note: This figure was prepared by Hydrometrics, Inc., 2014.

Figure 3-1
Plant Site Area Monitoring Wells/Piezometers
Interim Measures Work Plan–2015/2016
East Helena, Montana



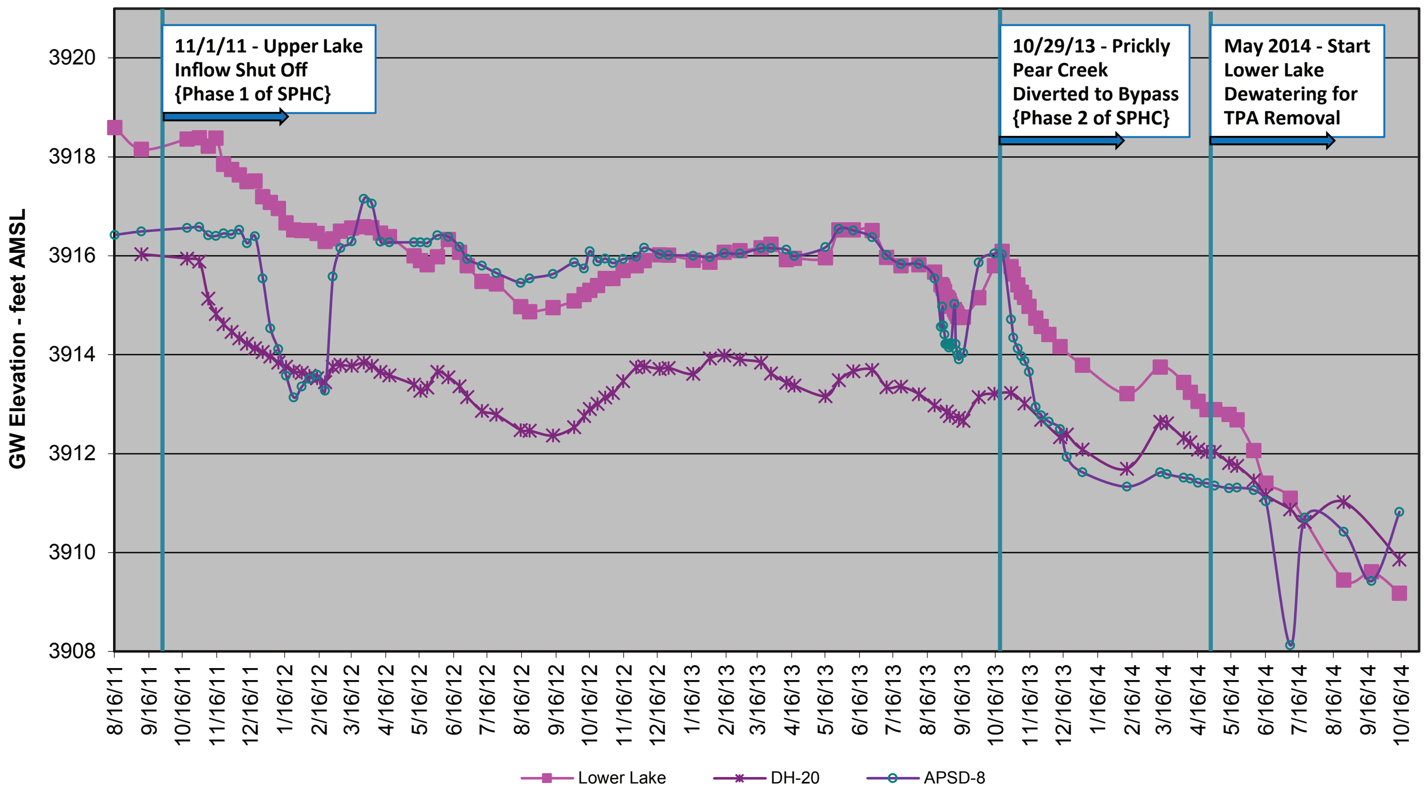
Hydrometrics, Inc.
Consulting Scientists and Engineers

Notes:
This figure was prepared by Hydrometrics, Inc., 2014.
Data locations are shown in Figure 3-1.

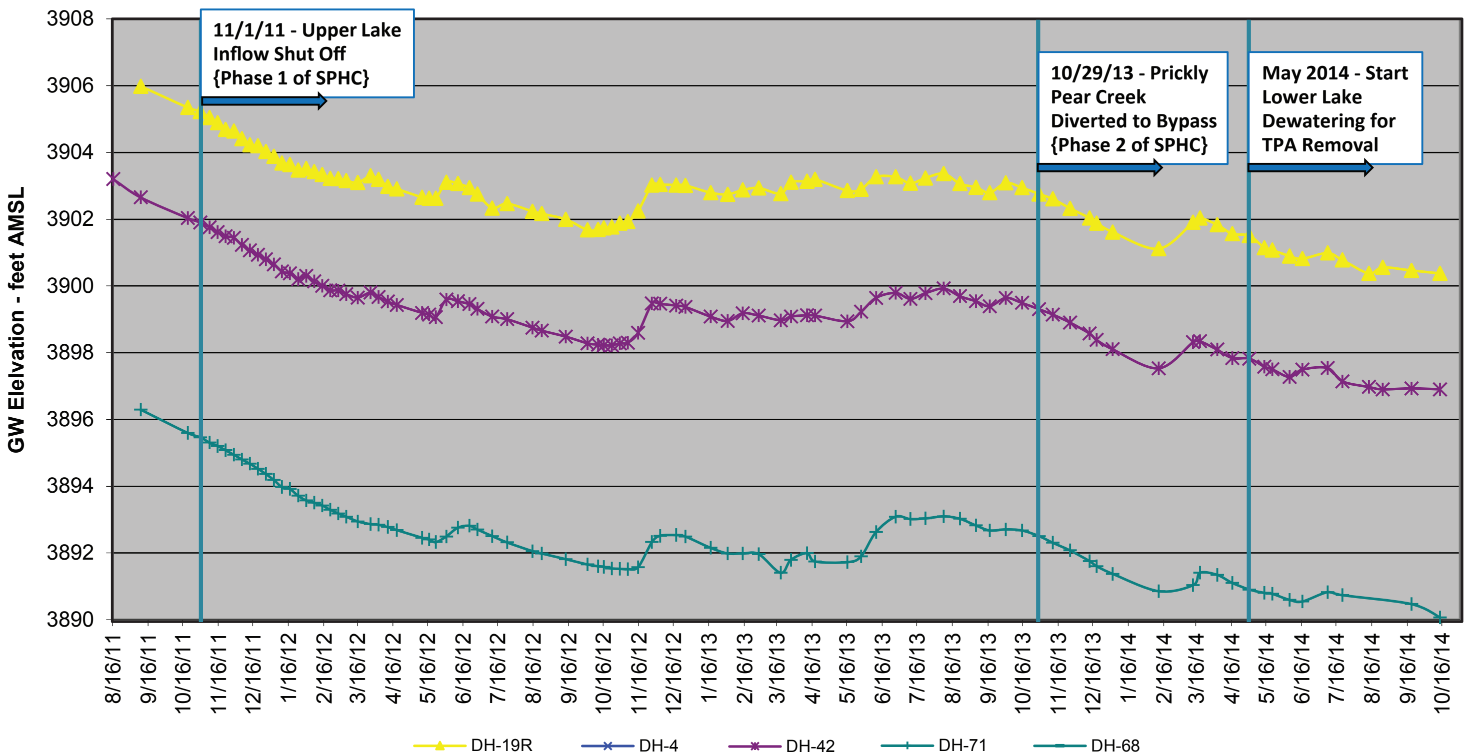
FIGURE 3-2
Groundwater Elevation Trends in Upper Lake Marsh
Interim Measures Work Plan–2015/2016
East Helena, Montana

CH2MHILL.

South Zone Groundwater Levels



Acid Plant Area Groundwater Levels



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Notes:
This figure was prepared by Hydrometrics, Inc., 2014.
Data locations are shown in Figure 3-1.

FIGURE 3-3
Groundwater Elevation Trends in Plant Site Wells
Interim Measures Work Plan–2015/2016
East Helena, Montana

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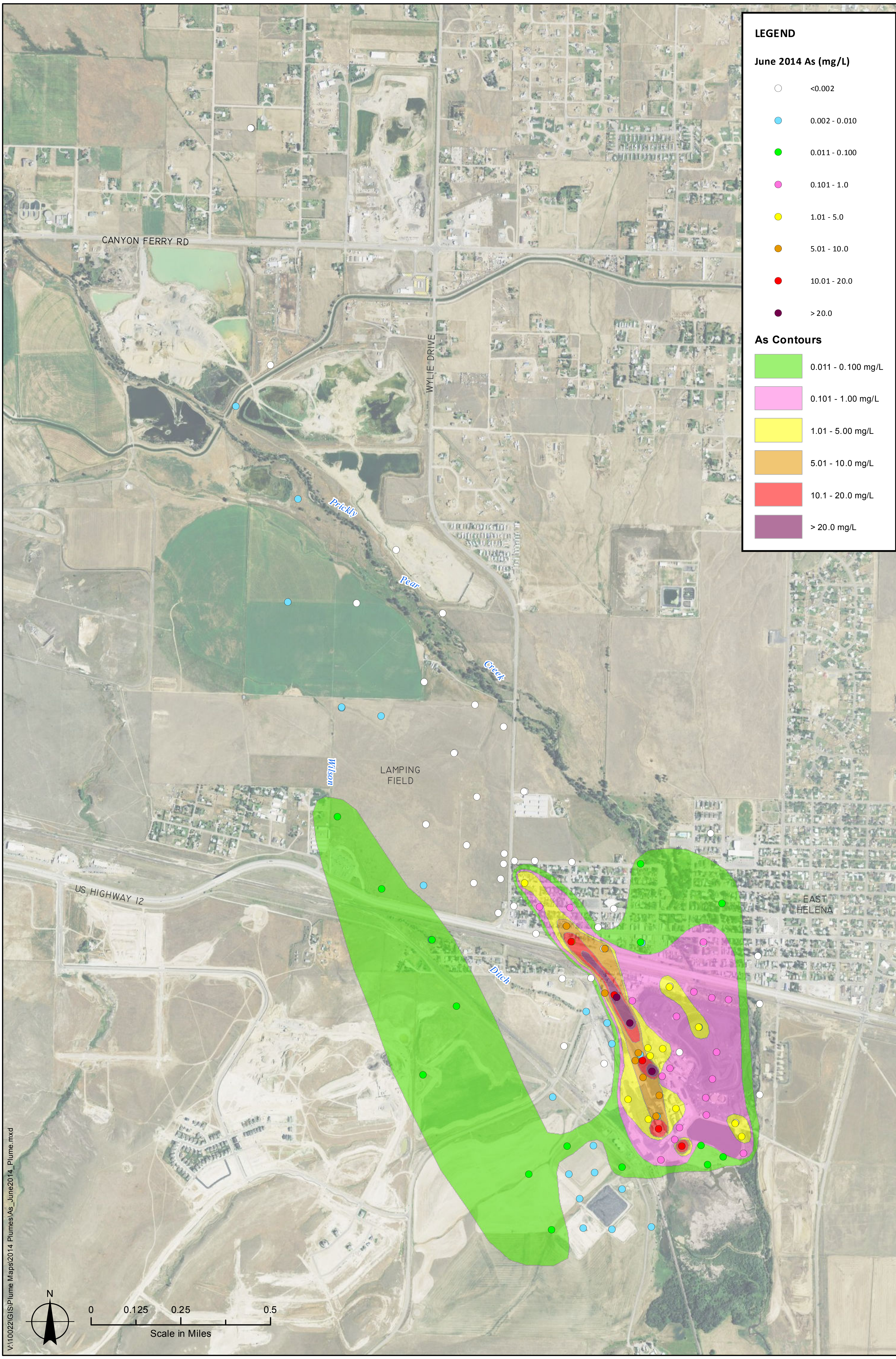

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Note:
This figure was prepared by Hydrometrics, Inc. as part of the "Former East Helena Smelter Groundwater Status Report" (December, 2014).

FIGURE 3-4
June 2014 Dissolved Arsenic Plume
Interim Measures Work Plan–2015/2016
East Helena, Montana

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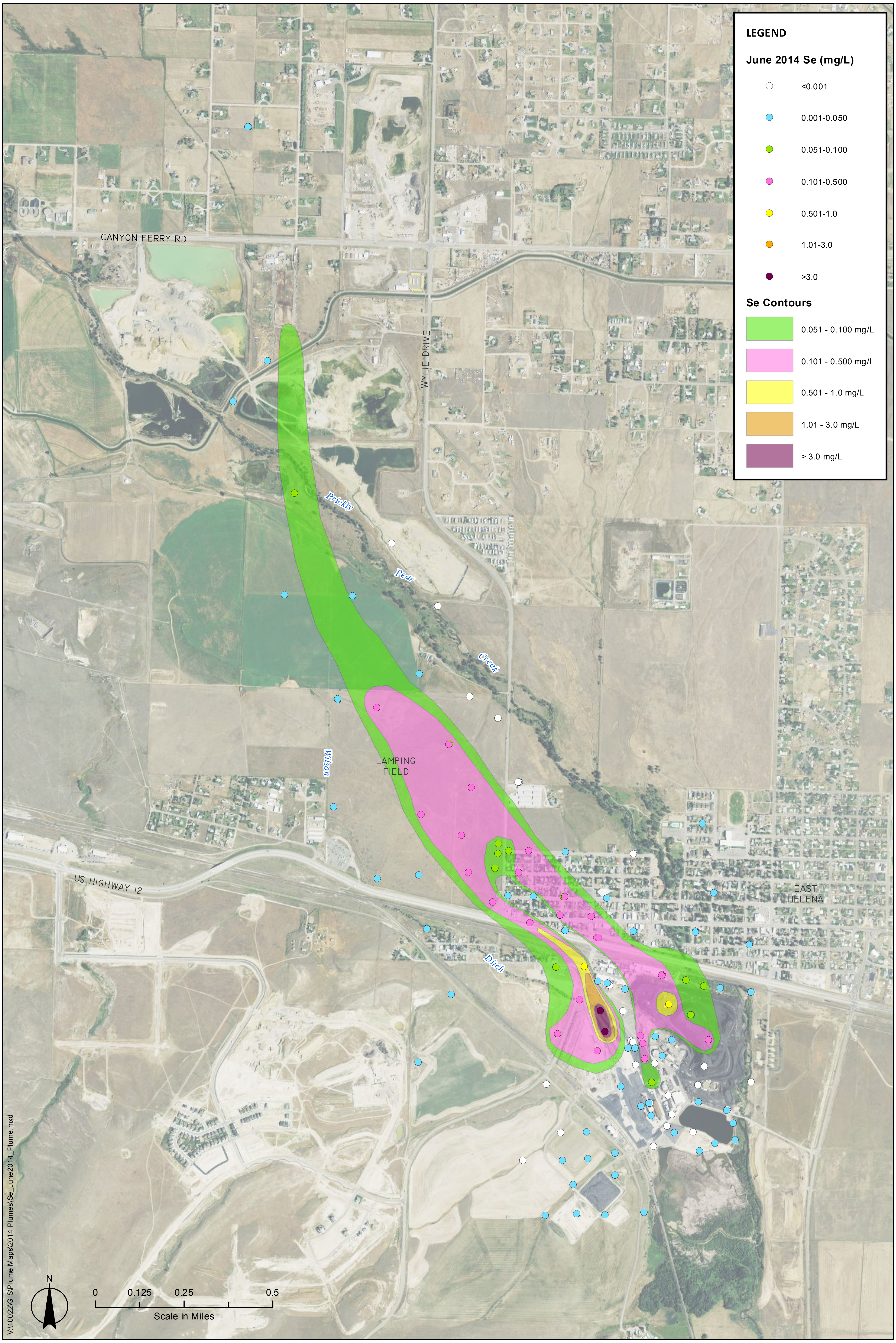

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FIGURE 3-5
June 2014 Dissolved Selenium Plume
Interim Measures Work Plan–2015/2016
East Helena, Montana

Note:
This figure was prepared by Hydrometrics, Inc. as part of the "Former East Helena Smelter Groundwater Status Report" (December, 2014).

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SECTION 4

Data Sufficiency

Data developed to date are sufficient to support the conceptual development of the IMs and design of the projects proposed for implementation in 2015 and 2016. Included in this section are a summary of existing data and potential data needs for the proposed work.

4.1 Summary of Existing Data

A variety of data have been used to evaluate, design, and construct the work described in this IM Work Plan 2015/2016. The summary data collected and incorporated into one or more IMs were originally presented in the IM Work Plan 2012 and updated in the subsequent IM Work Plans. Updates relevant to the proposed 2015 and 2016 work incorporate information collected and completed through November 2014. Updates are summarized as follows:

- Hydrogeology—Ongoing. Significant investigations over the last 20 years have contributed to a thorough understanding of groundwater conditions at the former Smelter site and offsite areas. This understanding will continue to be refined based on the results of routine (generally quarterly and semiannual) monitoring by the Custodial Trust, as summarized in the CAMP (Hydrometrics, 2014b). Available data collected during 2014 have been incorporated as appropriate into the IM designs, as will results of ongoing groundwater monitoring. Actual field results were used to continue calibrating the coupled groundwater flow and fate and transport (F&T) model. Groundwater sampling will continue on a routine basis pursuant to the CAMP.
- Groundwater Flow Model—Ongoing. The groundwater flow model initially was used to predict the performance of the SPHC IM (NewFields, 2013). The flow model simulates changes in hydrologic conditions over time to predict the efficacy of the SPHC IM at different operational stages: when the PPC Temporary Bypass was completed, when the northern segment of the PPC Realignment is completed, and when the PPC Realignment is completed in its entirety. Actual groundwater elevation data collected after the PPC Temporary Bypass was completed were used to update the predicted performance of the SPHC IM (NewFields, 2014). To further refine the flow model, additional groundwater elevation data will be collected when the northern segment of the PPC Realignment is completed and the PPC Realignment is completed in its entirety.
- Groundwater F&T Model—Ongoing. The groundwater F&T model is used to predict the performance of the IMs in terms of their effects on the arsenic and selenium plumes. The F&T model simulates the current extent of the arsenic and selenium plumes and is used to provide project planning support, design, and management. The F&T model simulations will be used to evaluate predicted effects of planned IMs on groundwater chemistry and provide ongoing source control/removal evaluations as part of the CMS process.
- Stream flow—Completed. Flow calculations were summarized in the *PPC Realignment Design Basis Documentation* and in the Conditional Letter of Map Revision (CLOMR) permit applications submitted to the Federal Emergency Management Agency (FEMA) for the PPC Temporary Bypass and PPC Realignment floodplain permits. The data are published in the *PPC Realignment Channel Stability Analysis and Engineering Design Report* (Pioneer Technical Services, 2013).
- Soil chemistry—Ongoing. Data are summarized in the Phase II RFI.
  - Additional test pits were excavated in the former Lower Ore Storage Area in the fall of 2012. Soil chemistry data from the test pits were compiled and input into the project environmental database.
  - Soil chemistry data available as of April 2014 were compiled into a soil contaminant distribution model constructed using Mining Visualization System software.

- Shallow soil samples from ULM were collected in July 2014. Additional soil samples from the ULM were collected in November 2014 and will be integrated into the designs of the PPC Realignment, the ICS 2, and the ET Cover East and West.
- Soil borings were advanced in September 2014 as part of source area investigations to augment the understanding of subsurface conditions, mostly beneath process areas and suspected source areas of the former Smelter site.
- Soil samples of the TPA removal area (includes Tito Park, UOSA, and Lower Lake) surfaces were collected between September and October 2014. The soil chemistry will be integrated into the designs of the PPC Realignment.

- Groundwater chemistry—Ongoing. The Phase II RFI summarizes work conducted through 2010. Groundwater monitoring pursuant to the annual Field Sampling and Analysis Plan (Hydrometrics, 2013b) provided updated information.
- Stormwater flows, chemistry, and discharge data—Ongoing. Data are available from former Smelter site personnel operating the HDS WTP, data collected as required under the MPDES permit, and stormwater permits.
- Utility types and locations—Completed. Existing utility drawings and underground utility information obtained by the Custodial Trust have been used to identify and locate as many underground utilities as possible.
- Structures—Completed. ASARCO engineering drawings available onsite have been compiled and reviewed as needed for demolition.
- Borrow sources and geotechnical data—Ongoing. Existing data are summarized in the Phase II RFI. Additional test pits were excavated along the East Bench in January 2012 to establish soil types and aggregate sizes to estimate quantities of construction materials. Test pits were also excavated in the Valley View Landfill stockpiles in January 2013 to define soil characteristics for ET Cover System modeling using HYDRUS-1D software (see Appendix B). ULM soil was sampled in July 2014 to assess the appropriate mixing ratio of borrow soil and ULM soil for use as the final cover soil on the ET Cover System, and more specifically, to meet the agronomic properties necessary to establish a plant community on the ET Cover System. Additional ULM samples were collected in November 2014 to further evaluate these criteria and to assess the potential for elevated metals concentrations in PPC Realignment construction dewatering water.
- Environmentally Regulated Material (ERM) Survey—Completed. An ERM Survey was performed during the summer of 2012. All remaining facilities were surveyed. Data from the ERM survey are summarized in the contract documents.

4.2 Additional Data Requirements for 2015 and 2016 Work

Additional data requirements for engineering and construction of the work identified in this IM Work Plan 2015/2016 are limited. Evaluations of source control activities currently are underway, and will be summarized in an addendum to this IM Work Plan 2015/2016. The addendum will describe changes, if any, to the IMs described herein.

The following data are being developed and factored into the final design and implementation of the activities described herein:

- Substation Soil Chemistry Data Collection—Soil samples collected in 2013 by Hydrometrics along the perimeter of the substation indicate the presence of low-level polychlorinated biphenyl (PCB) aroclors in the ground surface (Hydrometrics, 2013a). Additional surface and subsurface soil samples will be collected by NWE during the planning and engineering design phase for substation decommissioning.

Collection of these soil samples will be timed to coincide with deenergizing the facility. The results will be used to establish the extent of required soil excavation to be completed during substation demolition and the requirements for disposal of this soil. NWE will be responsible for the testing and final disposition of the soil.

SECTION 5

Engineering Design and Construction Information for Proposed 2015 and 2016 Projects

This section summarizes engineering design and construction activities planned for 2015 and 2016 associated with the PPC Realignment, Phase 3 demolition activities (including the NWE substation removal and 69-kV transmission line relocation), ICS 2 construction, ET Cover System construction (includes both the ET Cover East and ET Cover West), and cleanup standards for surface soil that will be incorporated into the final designs. A schedule for task implementation is provided in Section 8.

5.1 Prickly Pear Creek Realignment

The PPC Realignment will construct a new PPC channel and floodplain to a more natural elevation in order to lower the groundwater elevations at the former Smelter site. Approximately 800,000 cubic yards (yd^3) of contaminated material in and adjacent to PPC and proximal waterbodies will be removed. In addition, the 12-foot-high Smelter Dam will be removed. The significant components of the SPHC IM proposed in 2015 and 2016 to complete the PPC Realignment are as follows:

- Removal of the Upper Lake Diversion (2015)
- Permanent realignment of PPC (2015 and 2016)
- Floodplain and wetland reconstruction (2016)

5.1.1 Key Design Objectives

The key design objective of the PPC Realignment is to lower groundwater elevations in the southern part of the former Smelter site as part of the SPHC IM. Major objectives associated with the PPC Realignment and wetlands construction and restoration are as follows:

- Support implementation of the cleanup management strategy for the site.
- Facilitate stabilization of the slag pile.
- Provide wetland habitat restoration or replacement to comply with natural resource permitting requirements.
- Provide materials for other IM construction actions.
- Facilitate elimination of the HDS WTP discharge to PPC.
- Reconstruct PPC to a more natural functioning waterbody.
- Mitigate wetlands at an impacted to mitigated ratio of 1 to 1.
- Develop stream and wetland functions and values equal to or better than those affected.
- Provide upstream passage for adult native fish species and downstream passage for all salmonid age classes.
- In consultation with the U.S. Fish and Wildlife Service (USFWS), avoid to the extent possible the taking, killing, possession, and transportation (among other actions) of migratory birds, their eggs, parts, and nests, in adherence with the Migratory Bird Treaty Act (MBTA).

5.1.2 Design and Construction Features

The design and construction features documented in Appendix A meet the following design criteria and objectives for the PPC Realignment:

- Modify hydraulic regime to reduce mass and rate of contaminant transport away from the site.

- Realign the PPC to support modification of groundwater flow paths.
- Realign the PPC to prevent entrainment of slag materials into the creek.
- Provide a bankfull hydraulic capacity for a 2-year runoff event, slightly larger than the bankfull discharge.
- Design the channel to transport the estimated incoming sediment load without reach-scale aggradation, degradation, or large-scale instability.
- Create the channel with meandering planform and deformable banks, where geomorphically appropriate, and incorporate pool, riffle, and run sequences.
- Incorporate wetlands into the floodplain where hydrologically feasible and geomorphically stable.
- Incorporate grade controls or nondeformable bank treatments where vertical or horizontal stability is required to protect infrastructure or previously remediated areas.
- Construct deformable banks to be stable with woody vegetation allowing for some undercutting and habitat formation over time.
- Provide upstream fish passage for adult species and downstream passage for all age classes.
- Establish a total canopy that covers 80 percent within streambanks and riparian habitats; 95 percent within submergent and emergent habitat; and 60 percent in upland areas.
- Provide riparian vegetation that consists of native species of different growth forms suitable for hydrologic and climatic regimes at the project area.
- Incorporate multiple habitat types including open water, submergent, two emergent types, riparian, scrub-shrub, and upland habitats.

Construction of the PPC Realignment includes a temporary flow control structure expected to remain in place for 5 to 7 years after floodplain, wetland, and realignment construction is completed. The structure will divert only high flows through the PPC Temporary Bypass channel to maintain less than bankfull flow in the realigned PPC until vegetation along the banks has become sufficiently established to withstand unregulated flows.

5.1.3 Construction and Quality Management

Standard construction quality control and quality assurance (QA/QC) practices will be employed throughout the project to facilitate completion in accordance with the design and project objectives. Typical construction testing, surveying, and inspection and documentation measures will be employed to ensure that the materials and workmanship meet necessary project objectives. The *90% Design Basis Documentation for Stakeholder Review* (Pioneer Technical Services, 2014) provides the specific alignment, grade, and construction tolerances applicable to the PPC Realignment, as well as requirements pertaining to QA/QC activities for the entire project.

Key construction and quality management activities and issues associated with the PPC Realignment are as follows:

- Sequence operations to coordinate with the ICS 2, corridor subgrade, and ET Cover construction and availability of East Bench materials, and allow use of soil from areas north of Smelter Dam as substrate for channel/floodplain construction in the area south of the dam.
- Time seeding and plantings based on groundwater levels and season.
- Manage surface and groundwater to optimize surface water groundwater interaction, develop wetland areas, and enhance planting survival.

- Manage stormwater runoff to meet Stormwater Pollution Prevention Plan (SWPPP) criteria.
- Manage groundwater during construction to meet construction dewatering permit requirements.
- Handle materials for both the PPC Realignment and the ICS 2 to protect human health and the environment.
- Place materials (soil and riprap) to meet design objectives.
- Collect and store plant materials (cuttings and salvaged plants) to facilitate cutting and plant survival, and overall vigor.

5.1.4 Preliminary List of Drawings and Specifications

The complete list of drawings from the 90 percent design of the PPC Realignment and wetlands restoration are provided in Appendix A. Appendix A also includes the list of the technical specifications for the PPC Realignment and wetlands restoration activities.

5.2 Phase 3 Demolition

Phase 3 demolition activities include the demolition of buildings and infrastructure located within the footprint of the ET Cover East, removal of the NWE substation and transmission line relocation, and abandonment of monitoring wells.

5.2.1 Key Design Objectives

The primary purpose of the Phase 3 demolition activities is to provide a clear footprint in which to construct the ICS 2 and ET Cover East. Major objectives of the demolition design include the following:

- Demolish infrastructure in the ICS 2 footprint in 2015 to provide sufficient time to complete the ICS 2 construction in 2015.
- Protect and preserve infrastructure associated with the HDS WTP to allow continued operation as necessary to treat stormwater and other remediation waters, currently planned through early 2016.
- Demolish early in 2016 the remaining buildings, structures, utilities, and other features to support construction of the ET Cover East.
- Phase the demolition of stormwater management structures to prevent stormwater and associated sediment from running offsite.
- Perform all work in a manner that is protective of human health and the environment, efficient, and cost-effective.
- Salvage or recycle materials from the demolition activities to the extent possible, and dispose of or recycle debris appropriately.
- Manage stormwater runoff through collection, treatment, and discharge.
- Consider the impacts of weather on the project when scheduling the work and plan to mitigate impacts.
- Provide protection from groundwater infiltration during the demolition activities by limiting the amount of time bare soil is exposed at the ground surface.
- In consultation with USFWS, avoid to the extent possible the taking, killing, possession, and transportation (among other actions) of migratory birds, their eggs, parts, and nests, in adherence with the MBTA.

The demolition sequencing plan has been designed to maximize the safety, efficiency, and cost-effective management of the project. The sequencing has been established to fulfill the following objectives:

- Allow for the effective use of the existing facilities to support the demolition activities.

- Protect the existing stormwater system until construction of the ET Cover East.
- Provide emergency storage capacity for stormwater.
- Consider the other IM activities that will be conducted, as well as HDS WTP operations, and coordinate the demolition packages accordingly.

In addition to building demolition, removal of the NWE substation and relocation of the 69-kV transmission line will be conducted by NWE. Major objectives of the substation removal and line relocation include:

- Perform all work in a manner that is protective of human health and the environment, efficient, cost-effective, and in compliance with applicable regulations.
- In consultation with USFWS, avoid to the extent possible and technically feasible the disturbance of migratory bird nest areas during nesting season.
- Manage stormwater runoff during construction in accordance with applicable regulations.
- Remove electrical utilities from the former Smelter site that would prevent or interfere with construction of the ET Cover East.
- Provide NWE adequate means of accessing the relocated transmission line to complete all needed long-term maintenance activities.
- If present, remove contaminated soil from the substation as required for compliance with applicable state and federal regulations (NWE will be responsible for all activities related to removal and proper disposal of all materials and soils within the substation).
- Provide for temporary power supply to HDS WTP and other onsite buildings until they are demolished. If the HDS WTP is needed beyond 2016, an alternate power supply will be provided.

5.2.2 Design and Construction Features

Phase 3 demolition activities will remove all remaining buildings, structures, debris, utilities, and other features from the footprint of the ET Cover East. Demolition work will be sequenced with the ICS 2 and ET Cover East to provide stormwater management. As such, the work will be sequenced to maintain functionality of the HDS WTP through 2016, or longer if needed, and associated portions of the stormwater collection and storage system.

The structures that will be demolished in 2015 and 2016 are shown in **Figure 1-3**.

Technical requirements for demolition include the following:

- Recycling and salvage will be required to maximize use of sustainable remediation approaches.
- Solid, nonorganic debris that is not suitable for recycling or salvage will be placed onsite in the fill areas under the ET Cover East.
- Aboveground structures, to include walls and associated foundations, will be removed to the top of the adjacent grade. Concrete reinforcing steel and other metal protruding from concrete will be cut so that it does not extend above grade.
- Demolition excavations or below-grade areas in the Phase 3 demolition area will be backfilled and compacted in a manner that provides an incompressible, void-free fill to prevent detrimental settlement to the overlying ET Cover East.
- Concrete and concrete masonry unit debris will be reduced in size as part of the process to remove the reinforcing steel for recycling. The particles will be small enough to allow placement and compaction in an incompressible, void-free fill to prevent detrimental settlement to the ET Cover East.

- Pavements, concrete slabs, and reinforced polyethylene membrane covers will be broken or perforated so that water will not perch on the layers under the ET Cover East.
- Underground utilities will be abandoned and the ends will be cut and capped. Larger-diameter pipes and conduits will be filled to eliminate voids under the fill.
- Diesel fuel from the Pump House will be properly disposed of in advance of demolition.
- The former X-ray room in Building 10 contains lead lining that will be removed in advance of demolition.
- Iron filings associated with Warehouse Annex 4 are USEPA property and will be removed in advance of demolition.
- Decommissioning the HDS WTP will include collection and transport of residual water and water used for decommissioning, proper disposal of all remaining reagents, and removal of all sludge collected from tanks, sumps, and piping in buildings 73, 74, 75, 76, 77, 78, 79, and 83. Water collected from the decommissioning process will be collected in the Tank Farm (two 1-million-gallon tanks). Depending on water quality and volumes, the collected water will be either treated for discharge, evaporated within the tanks, or shipped offsite to an appropriate disposal facility.
- Demolition of the Rodeo Tank will include protecting the existing stormwater piping entering the tank to allow future use.

The above-grade concrete walls, slabs, foundations, and footings will be demolished using a track-mounted excavator equipped with hydraulic breakers and pulverizers. Horizontal surfaces will be fractured to reduce subsurface disturbance. Footings and foundations will be exposed by an excavator that will excavate around each below-grade structure to gain access.

To continue necessary stormwater management, stormwater runoff during final (post-construction) conditions from the northern portion of the ET Cover System will drain, via a sediment pond, to a new infiltration pond that will be constructed in the footprint of the Rodeo Tank using the following design criteria. The ponds and drainage systems were designed to accommodate peak and total runoff volumes from the northern portion (approximately 40 acres) of two different areas: ET Cover West and East Systems. To be conservative, the design scenario selected was calculated to produce the greatest flow (approximately 1,597,000 gallons) using clean cover, bare-ground condition, although the amount of stormwater is anticipated to decrease substantially due to the establishment of vegetation cover for the ET Cover System. Calculations demonstrate that vegetation will reduce the volume of water running off the northern portion of the ET Cover as a result of the 100-year, 24-hour storm event from 1,597,000 gallons (the volume used in the design) to 314,000 gallons, an 80 percent reduction. Based on hydraulic modeling, the sediment pond will be able to contain the reduced volume of stormwater without overflow to the infiltration pond. As a result, the new infiltration pond is expected to receive water only from a storm event greater than the 100-year, 24-hour storm in the long-term. During interim (construction) conditions, flows from northern runoff areas of ICS 1 and ICS 2 are routed to sedimentation ponds and only runoff from the ICS 1 area can reach the infiltration pond area.

Specific design and construction features associated with substation demolition and transmission line relocation are not currently available. Design criteria and construction features will be provided by NWE in 2015.

5.2.3 Construction and Quality Management

Key construction and quality management activities and issues associated with Phase 3 demolition are as follows:

- Sequencing mechanical demolition techniques should help ensure safe working conditions during the building demolition.

- Various excavators equipped with special attachments will be used to demolish the building in a controlled manner with minimal dusting.
- The approach used to conduct the Phase 3 demolition will be employed to reduce the work force, minimize dust and waste, and prevent potential exposure to workers and the community. Materials will be segregated and staged into universal waste and recyclable waste piles for disposal. Throughout construction, site personnel and equipment will salvage all potential ferrous and nonferrous metals to maximize recycling value.
- Buried utilities will be removed concurrent with foundation demolition; smaller utilities will be cut and capped, larger utilities will be plugged. Exposed utilities will be removed.
- Trash, carpet, insulation, glass, wall partitions, and other materials will be removed from the interior and exterior of the structures after abatement. These “soft” demolition activities will be carried out by skid steers and small tracked vehicles.
- The structures will generally be demolished using a “top-down” approach. The structures generally consist of steel and concrete framing on concrete and concrete at-grade foundations. Steps will be taken to reduce the amount of below-grade demolition and soil disturbance. Mechanical demolition equipment such as hydraulic excavators equipped with special attachments (e.g., breakers and shears) will be used to improve worker safety, facilitate sorting and recycling, and reduce the release of dust.
- Where the building structures are removed, remaining foundations and intact, below-grade slab foundations will be broken up to prevent potential subsurface ponding areas. Any pavement left intact will then be fractured (but not removed) as part of subsequent interim or remedial measure construction.
- Construction and quality management requirements associated with substation demolition and transmission line relocation will be performed by NWE in accordance with their policy and procedures.
- Monitoring wells designated for removal or abandonment will be removed or abandoned in accordance with the *Borehole Abandonment Plan for the Former Asarco East Helena Facility* (Hydrometrics, 2010). Wells will be abandoned in a manner that effectively and permanently prohibits the movement of water (vertically and horizontally) within the abandoned borehole. A borehole abandonment documentation form will be completed for each monitoring well that is decommissioned.
- Follow QA/QC guidelines outlined by the American Society for Testing and Materials.

5.2.3.1 Materials Management

ERM abatement will be conducted before demolition begins and will include the removal, management, and disposal of existing nonhazardous, hazardous, and regulated building materials. ERM identified through building surveys includes mercury in switches and gauges, lead-based paint, light bulbs (fluorescent, mercury vapor, and sodium), and asbestos-containing material. These materials will be handled, transported, and disposed in accordance with regulatory requirements.

Properly dewatered sludge and other select nonliquid demolition debris such as broken concrete, pavements, and brick, will be placed in the ICS 2. Suitable materials will be sent to recycling facilities. Remaining demolition debris will be disposed of offsite at appropriate facilities, depending on the nature of the waste. Additional information regarding management of waste is provided in Section 6.

5.2.3.2 Protective Measures during Implementation

Demolition activities will follow all applicable federal, state, and local laws and regulations as well as any specific site or permit requirements. Contractors working on the site will comply with the site-specific health and safety plan, and will be required to develop and follow plans related to asbestos-containing material (ACM) regulations, Universal Waste Management, recycling, dust control, stormwater pollution prevention, site security, and decontamination. Protection of migratory birds will be performed in accordance with an

Avian Protection Plan (APP) prepared to support construction activities. The APP covers the advanced review of construction/demolition areas, bird nesting deterrents (such as closing up or netting off potential nesting locations), and establishment of buffers for active nests.

5.2.4 Preliminary List of Drawings and Specifications

Design drawings and technical specifications of the Phase 3 demolition activities, the ICS 2, and both the ET Cover East and West are included in Appendix A.

5.3 Interim Cover System 2

5.3.1 Key Design Objectives

Key design objectives for the ICS 2 construction are summarized as follows:

- Provide a native cover soil layer that prevents direct contact with the consolidated soil, protects the soil from erosion, reduces infiltration in advance of ET Cover construction, and minimizes ET Cover System construction costs.
- Construct an interim cover that will protect consolidated soil and sediment until the ET Cover East is constructed.
- Design the ICS surface and finished grades to enable noncontact runoff to be shed to perimeter drainages.
- Manage stormwater runoff during construction in accordance with applicable regulations.
- Perform all work in a manner that is protective of human health and the environment, efficient, cost-effective, and in compliance with applicable regulations. Provide adequate engineered fill capacity to consolidate all of the excavated soil removed from the PPC Realignment.
- Incorporate soil consolidated from the PPC Realignment into a prepared subgrade on which to build the ET Cover East.
- In consultation with USFWS, avoid to the extent possible the taking, killing, possession, and transportation (among other actions) of migratory birds, their eggs, parts, and nests, in adherence with the MBTA.

5.3.2 Design and Construction Features

The ICS 2 will be constructed over the eastern portion of the former Smelter site. The area was selected to preserve and protect infrastructure scheduled for demolition in 2016 and to leave open a corridor in the center of the site to provide access for potential future source removal or Tier II remedial actions (see **Figure 1-1**). The ICS 2 will be constructed in three layers. The lowest layer in the ICS 2, the engineered fill layer, will be consolidated material from the PPC Realignment. This layer will be capped with a low-permeability native soil layer, and a biobarrier/erosion protection cover layer.

The engineered fill layer of the ICS 2 will be designed and constructed to accept the excess soil generated by the PPC Realignment, meet grading requirements to manage and control runoff, and provide a subgrade capable of supporting the ET Cover East. The engineered fill layer is expected to consist solely of material excavated from the PPC Realignment.

The ICS 2 will be capped with 12 inches of native soil. This cap will include a 6-inch-thick layer of compacted sandy clay, covered by a 6-inch-thick layer of 6-inch-minus gravel, acting as the bio-barrier/subgrade for the ET Cover East. The gravel layer of the cap will also provide erosion protection for the sandy clay layer.

5.3.3 Construction and Quality Management

Implementation considerations associated with constructing the ICS 2 include coordination of the PPC Realignment and haul operations, placement, compaction, and grading of the subgrade materials;

management of stormwater runoff collection and treatment during construction; and erosion control during and following construction.

5.3.3.1 Materials Management

Construction of the ICS 2 will involve the dewatering, excavation, transport, and placement of approximately 207,000 yd^3 of soil from the PPC Realignment. For cost effectiveness and construction efficiency, as noted in Section 5.1.3.1, PPC Realignment activities will be sequenced concurrently with the ICS 2 construction. Soil excavated from the PPC Realignment will be loaded into haul trucks and transported directly to the ICS 2 consolidation location within the AOC where it will be moisture-conditioned (if required) and compacted into place. Dewatering of the materials will occur before excavation to the maximum extent possible. Sequencing construction in this manner will facilitate protective and efficient implementation by minimizing handling and processing activities and stockpiling requirements.

5.3.3.2 Protective Measures during Implementation

Construction of the ICS 2 will fulfill specific requirements to ensure that work is conducted in a manner that is safe, protective of the environment, and in accordance with applicable permits, laws, and regulations. The design and contract specifications will require measures to safely handle and control erosion of material from the PPC Realignment during consolidation of this material within the ICS 2. Measures will be taken to prevent spillage during transport. Traffic routes, laydown and parking areas, and other temporary facilities and controls will be specified to reduce effects on nearby residences and the environment. In addition, temporary erosion and sedimentation control plans (including the SWPPP, as discussed in Section 7) will be implemented for work and material processing areas.

Construction of the cap and erosion protection layers of the ICS 2 will take place after the engineered fill has been brought to grade. Infiltration of contact runoff will be for the shortest possible timeframe needed to allow for safe and cost-efficient construction. As early in the construction sequence as possible, the top layers of the ICS 2 will be placed and noncontact runoff directed to perimeter drainages.

5.4 ET Cover System (East and West)

5.4.1 Key Design Objectives

Key design objectives associated with the ET Cover System (including ET Covers East and West) are as follows:

- Provide sufficient capacity to store infiltration, thereby reducing percolation through contaminated media and subsequent leaching to groundwater.
- Provide physical separation between consolidated material and the ground surface.
- Inhibit bioturbation and animals from contacting consolidated material.
- Resist wind and water erosion.
- Prevent inundation from flooding events.
- Meet media cleanup objectives for soil, as described in Section 5.5, and surface water, i.e., DEQ-7 standards (MDEQ, 2012), by designing a cover surface and stormwater conveyance structures that manage and control stormwater.
- Protect human health and the environment by designing a cover system footprint that incorporates existing site access controls including fencing, signs, and gates.
- In consultation with USFWS, avoid to the extent possible and technically feasible the disturbance of migratory bird nest areas during nesting season.

5.4.2 Design and Construction Features

The ET Cover System will be constructed in stages. The ET Cover West will be completed over the existing ICS 1 in 2015. In 2016, the ET Cover East will be constructed over the ICS 2. The final ET Cover will not be placed over the central corridor (Figure 1-2) until source control measures which require excavation have either been implemented or determined to be unnecessary. Because the ET Cover System will be completed in stages, the fill will be placed in four primary locations: the perimeter access road, the ICS 1, the ICS 2, and the central corridor. The footprint of the perimeter access road was selected to provide long-term access to the ET Cover System and long-term slag pile operations, maintenance, and recycling.

The ET Cover West will be placed directly over the existing ground surface, which is the armored biobarrier layer (i.e., the top layer of the ICS 1). The ET Cover East will be placed on the biobarrier surface of ICS 2 and in the central corridor over engineered fill consisting of excess soil from the PPC Realignment. In the central corridor, the entire ET Cover System (biobarrier, capillary break, storage layer, and topsoil layer) will be placed above the engineered fill and no interim cover layer will be necessary.

The thickness of the ET Cover storage and amended storage layers were designed using two hydraulic models: HYDRUS-1D and the Desert Research Institute (DRI) analytical method. Both methods used site-specific climate data and laboratory test results for soil moisture retention and gradation for soil from two potential borrow areas. Percolation rates were predicted using the HYDRUS-1D model to design appropriate cover thickness and select appropriate soil properties (Appendix B). The capillary break layer increases the water-holding capacity of the overlying storage layer by providing a gradation and permeability contrast between the two layers. The biobarrier layer inhibits animals from burrowing into contaminated soil by providing enough rock-to-rock contact to make digging difficult. In addition to providing water-holding capacity, the amended storage layer is designed to support a plant community that will remove moisture from the cover by evapotranspiration.

The finish grade surface of the ET Cover System will be steep enough to avoid ponding water on the ground surface and flat enough to avoid promoting erosion.

5.4.3 Construction and Quality Management

Construction of the ET Cover System will involve the excavation, transport, and placement of approximately 600,000 yd^3 of soil from the PPC Realignment and borrow areas. For cost effectiveness and construction efficiency, PPC Realignment activities will be sequenced concurrently with construction of both portions of the ET Cover System (East and West). Soil excavated from the PPC Realignment and borrow areas will be loaded into haul trucks and transported directly to the ET Cover East and West locations within the AOC, where it will be moisture-conditioned (if required) and compacted into place. Sequencing construction in this manner will facilitate protective and efficient implementation by minimizing handling activities, and stockpiling requirements.

Testing of ET cover materials will be performed using an independent testing laboratory. The sampling and testing proposed to meet QA/QC requirements described in the design documents will be included within the ET Cover implementation plan and submitted to MDEQ prior to construction for review.

5.5 Cleanup Standards for Surface Soil

Among the design criteria for the final exposure surfaces of the PPC Realignment and ET Cover System are the cleanup standards for arsenic and lead in surface soil. The draft CMS Work Plan proposed potential cleanup standards and their basis as presented in Table 2-2 of the CMS Work Plan. Additional evaluation of the cleanup standards has been completed based on anticipated future use. The reasonably anticipated future use for the portion of the former Smelter site covered by the ET Cover System, and the PPC Realignment and its floodplain, currently is considered to be recreational, taking into consideration market conditions, community goals and objectives, and other stakeholder interests. An arsenic cleanup standard of 794 milligrams per kilogram (mg/kg) was selected to meet the recreational land use criterion defined in the

East Helena Superfund Site Operable Unit 2 (OU-2) Record of Decision (ROD). As part of the ongoing CMS, if an ecological cleanup criterion is more conservative, then the ecological-derived value should be used; as such, a lead cleanup standard of 650 mg/kg was selected to be protective of ecological receptors (Gradient, 2010 and USEPA, 2005). The cleanup standards for arsenic and lead in surface soil are summarized in **Table 5-1**.

In order to evaluate whether these criteria would also be protective of other constituents of potential concern (COPCs) identified in the Phase II RFI, a tiered evaluation approach was used in which soil data were compared against conservative USEPA Regional Screening Levels and State of Montana background soil concentrations (Hydrometrics, 2013c). Of the 16 COPC metals, arsenic and lead were identified as presenting the highest percentage of exceedances against the screening criteria. As described in the OU-2 ROD, "… once areas are cleaned up to address lead and arsenic, low-level risks of exposure to the other, coexisting contaminants are further minimized" (USEPA, 2009).

TABLE 5-1
Cleanup Standards for Arsenic and Lead in Surface Soil
Interim Measures Work Plan 2015/2016

Constituent	Cleanup Standard (mg/kg)	Rationale
Arsenic	794	Consistent with the East Helena OU-2 ROD
Lead	650	Criterion for the Protection of Ecological Receptors

Notes:

mg/kg = milligrams per kilogram

OU = Operable Unit

ROD = Record of Decision

SECTION 6

Remediation Waste Management

This section describes the proposed approach for managing remediation waste associated with implementation of the proposed 2015 and 2016 IM components.

6.1 Use of the Area of Contamination

A RCRA AOC has been designated as part of the implementation of the Facility remediation activities. The description and rationale for the AOC was approved by USEPA in their conditional approval of the IM Work Plan 2012, dated August 28, 2012. As shown in **Figure 6-1**, the AOC covers Parcels 16 and 19 (the former Smelter site operating area); the area of Parcel 15 containing CAMUs 1 and 2, portions of Tito Park, Lower Lake, and Upper Lake; the portion of Parcel 8 west of State Highway 18; and Parcels 10, 11, 12, 17, 18, and 23. The ability to consolidate hazardous remediation waste within the designated AOC allows interim and final remedial measures to be conducted in a protective, efficient, sustainable, and cost-effective manner, and also reserved CAMU capacity for the management and treatment of other hazardous remediation waste that clearly should be segregated from site soil.

Two onsite CAMUs have been approved, constructed, and filled, and final closure was completed in November 2014. The onsite CAMUs were constructed to manage remediation waste generated during the site cleanup. CAMUs 1 and 2 were constructed by ASARCO on Parcel 15 and the southwestern corner of Parcel 19. CAMU 1 was constructed in 2001 with a final cover placed in 2008. CAMU 2 was constructed in 2008 and used to manage remediation waste and debris from cleanup operations. CAMU 2 was closed in November 2014 with a final cover.

6.2 Remediation Waste Management in 2015 and 2016

The remediation waste expected to be associated with implementation of the 2015 and 2016 IM components is summarized in **Table 6-1** and described briefly in the following paragraphs. Detailed work plans, as appropriate, for each of the components described will be prepared during final design, or will be required submittals as part of the construction contract(s).

6.2.1 Prickly Pear Creek Realignment

PPC Realignment is estimated to require the excavation of more than 800,000 yd^3 of soil. Although the majority of soil to be excavated is not contaminated and would not be considered a remediation waste, investigation work to date has indicated that a portion of the surface soil has high concentrations of COPC metals. All excavated material that will not be reused in the PPC channel or floodplain reconstruction is considered remediation waste and may be consolidated within the ET Cover System boundary. Appropriately detailed soil and remediation waste management plans will be prepared as part of final design for the IMs. The plans may include testing if necessary to develop the appropriate management of excavated material. Protocols for stockpiling, transportation, and dust suppression to minimize potential contaminant migration during construction will be specified during detailed design.

6.2.2 Phase 3 Demolition

Remediation waste management associated with the Phase 3 demolition activities is summarized as follows:

- Consistent with previous demolition work conducted, demolition will encourage the appropriate beneficial reuse of debris, and incorporate a recyclable material plan for proper handling of materials believed to have salvage or recycle value.
- Given that the majority of the demolition work will be performed within the footprint of the ET Cover System, concrete rubble and debris can be stockpiled, consolidated, and used as appropriate for fill.

TABLE 6-1
Interim Measures Remediation Waste Management
Interim Measures Work Plan 2015/2016

IM Component	Remediation Waste	Disposition
2015		
Interim Cover System 2 Construction	PPE and decontamination waste	Transport heavily soiled PPE and solid decontamination waste to appropriately permitted offsite disposal facility.
Removal of Substation and Relocation of 69-kilovolt Line	TSCA and non-TSCA PCB waste	If encountered, NWE will transport PCB materials to an appropriately permitted offsite disposal facility.
2015 through 2016		
Prickly Pear Creek Realignment	Soil	Soil with metals concentrations meeting cleanup standards will be used for reconstruction; soil exceeding applicable criteria will be consolidated within the ET Cover System footprint.
	Decontamination Water	Implement best management practices according to the approved SWPPP and comply with the MPDES General Permit for Stormwater Discharges Associated with Construction Activities.
	Stormwater and Construction Dewatering	Manage water from construction dewatering activities within the work areas, treat (if required), and discharge in accordance with MPDES General Permit for Construction Dewatering Activities.
	Debris	Evaluated for consolidation within the ET Cover System footprint
ET Cover System (East and West)	PPE and decontamination waste	Transport heavily soiled PPE and solid decontamination waste to appropriately permitted offsite disposal facility.
Phase 3 Demolition	Debris	Building debris that is not suitable for salvage or recycling will be evaluated for consolidation within the ET Cover System footprint
	Lead-based paint materials	Transport to appropriately permitted offsite disposal facility.
	Miscellaneous nonliquid and solidified chemicals	Transport to appropriately permitted offsite disposal facility.
	Asbestos from building structures	Transport to appropriately permitted offsite disposal facility
	Flushing water or stormwater	Collect and treat in the onsite HDS WTP. Discharge treated water per MPDES permit (MT0030147).
	ACM, TSCA, liquid waste not specified above, and universal waste (for example: batteries and mercury-containing equipment)	Transport to appropriately permitted offsite disposal facility.
	Process residual sludge	Transport to appropriately permitted offsite disposal facility.
Monitoring Well Decommissioning	Debris	Evaluated for consolidation as fill within the ET Cover System footprint

Notes:

ACM = asbestos-containing material
AOC = Area of Contamination
HDS WTP = high-density sludge water treatment plant
MPDES = Montana Pollutant Discharge Elimination System
NWE = NorthWestern Energy
PCB = polychlorinated biphenyl
PPE = personal protective equipment
TSCA = Toxic Substances Control Act

Excavation of soil may be necessary as part of the underground utility/infrastructure work and excavation of Speiss will be conducted as additional source removal. Because all of the utility relocation work is being done within the footprint of the AOC, soil that is excavated will be temporarily stockpiled adjacent to the work area and then placed back in the excavation as fill; however, the Speiss will be placed within the ICS 2.

Control of stormwater runoff will be a priority throughout the demolition activities. To direct and control runoff as areas are demolished, fumed slag or other fill will be placed at predetermined interim grades in the demolition areas. The grading plan will be designed to coordinate with the ET Cover System, and channel clean runoff in a controlled manner to proposed drainage discharge areas. During demolition, stormwater will be collected and managed as currently permitted under the HDS WTP MPDES permit.

6.2.2.1 Substation Removal and Transmission Line Relocation

NWE will be conducting the work associated with removing the substation and relocating the 69-kV transmission line. Any remediation waste management associated with this work will be handled by NWE.

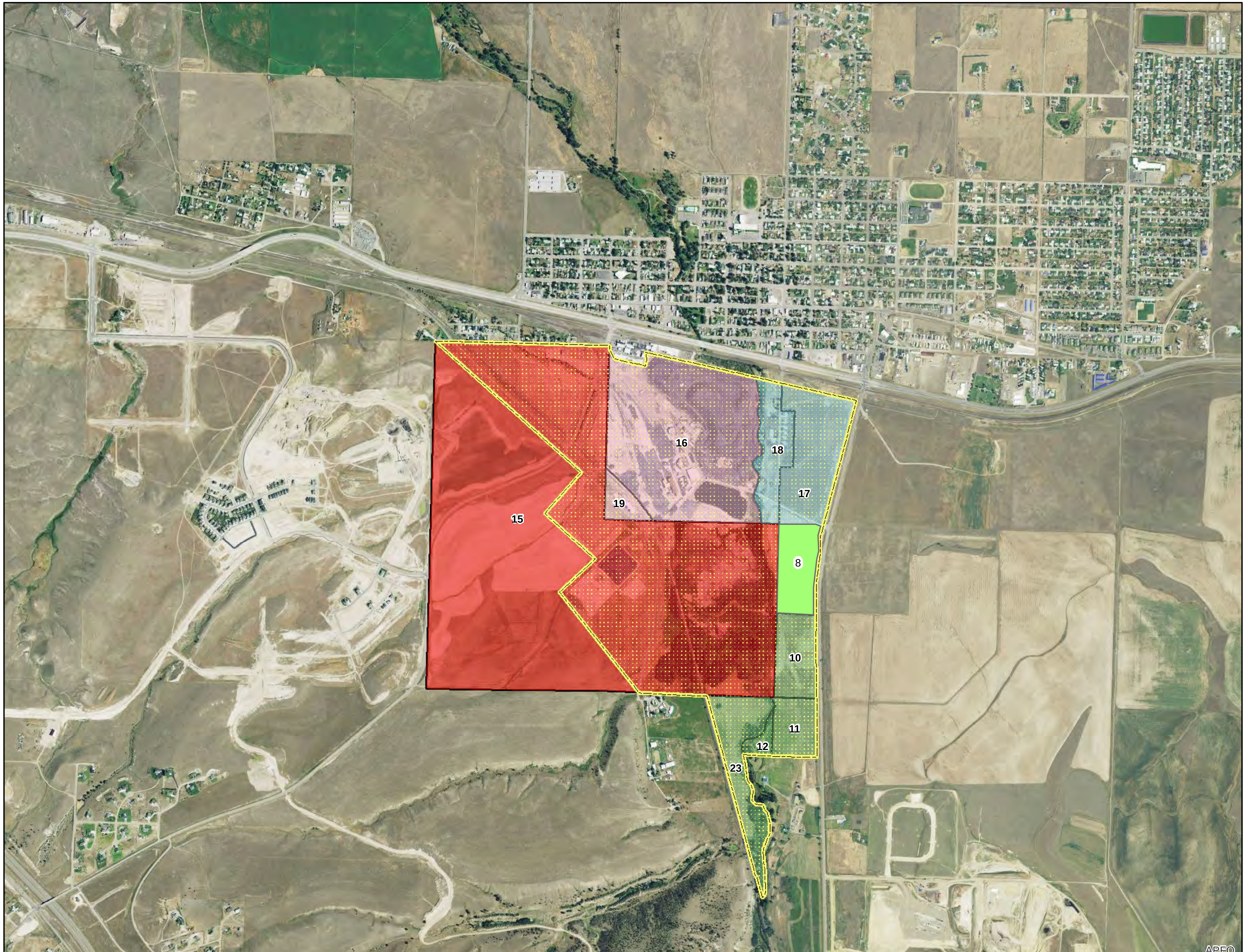
6.2.2.2 Monitoring Well Decommissioning

For monitoring wells less than 20 feet deep, well casing and screens will be pulled in accordance with ARM 36.21.810. Any decommissioning debris will be evaluated for placement as fill within the ICS 2 or subgrade for the ET Cover East.

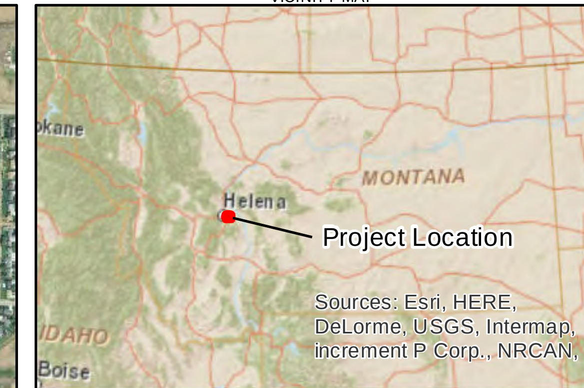
6.2.3 Interim Cover System and ET Cover System Construction

No remediation waste is expected to be generated during construction of the ICS 2 and the ET Cover System, with the exception of personal protective equipment and decontamination waste, which will be transported to a permitted offsite disposal facility.

At the completion of ICS 2 and the ET Cover System construction, the stormwater runoff will no longer be in contact with soil affected by former Smelter site operations. Stormwater runoff from the ET Cover System will report to three locations; one on the north end of the former Smelter site and two on the south end, as shown on the design drawings. Stormwater runoff from ICS 2 and the ET Cover System will be managed in accordance with the SWPPP developed in accordance with the Montana Multi-Sector Permit for Stormwater Discharges Associated with Industrial Activity.



VICINITY MAP



LEGEND

- Portion of Parcel 8 West of State Highway 518
- Parcel 15
- Parcels 16 and 19
- Parcels 17 and 18
- Parcels 10, 11, 12, and 23
- Area of Contamination Boundary

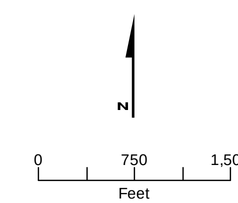


Figure 6-1
Area of Contamination Boundary
Interim Measures Work Plan–2015/2016
East Helena, Montana

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SECTION 7

Status of Permitting Activities and Approvals

This section provides an update to the federal, state, and local permit and licensing measures outlined in the IM Work Plans 2012, 2013, and 2014, and discusses the permits under evaluation for 2015 and 2016.

7.1 Past Permitting and Authorization Activities

7.1.1 Joint Application and Conditional Letter of Map Revision

The Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and Other Waterbodies (Joint Application) is used to simultaneously apply for several different water resource permits from multiple permitting agencies. In September 2012, Joint Application No. 1 for the PPC Temporary Bypass project was submitted to the City of Helena, the U.S. Army Corps of Engineers (USACE), MDEQ, and the Lewis and Clark Conservation District (LCCD). This work was conducted concurrently with the submittal of the CLOMR No. 1 for the PPC Temporary Bypass.

The CLOMR No. 1 approval was received in December 2012, and all other agency approvals under Joint Application No. 1 (including the 404, 318, 310, and City of East Helena [COEH] Floodplain Development Permit) were received by February 2013.

Joint Application No. 1 was submitted to USACE to address work necessary to install the PPC Temporary Bypass and did not include the proposed soil removal actions for the TPA. However, the proposed TPA actions did not disturb additional wetlands beyond those identified in Joint Application No. 1. Therefore, a request was made to USACE, MDEQ, and LCCD to provide an administrative authorization of the actions as an amendment to Joint Application No. 1. A technical memorandum summarizing the proposed activities, with figures illustrating the work, was submitted to these agencies as part of the authorization process.

7.1.2 Floodplain Development Permit

Because the excavation in Tito Park altered the location and elevation of the regulatory floodplain to a greater degree than was shown in CLOMR No. 1, an updated Floodplain Development Permit was obtained from the COEH. Additional Hydrologic Engineering Centers River Analysis System (HEC-RAS) modeling, reflecting the removal of Tito Park, was performed and submitted to FEMA for their PPC project file. A request was made to FEMA for a written letter of concurrence that the TPA source removal project is consistent with the CLOMR issued for the PPC Temporary Bypass (Case No. 12-08-0919R, December 4, 2012), and that it meets the minimum requirements of the National Flood Insurance Program. The concurrence letter from FEMA was the basis for subsequent TPA source removal authorization amendments to the existing PPC Temporary Bypass 404, 318, and 310 permits (by USACE, MDEQ, and LCCD) and an updated Floodplain Development Permit from the COEH. As part of the permit process, and before issuing the updated permit, the COEH solicited public comments on the application for a 15-day period. Approval of the Floodplain Development Permit by the COEH was provided on March 20, 2015.

7.1.3 Montana Dam Safety Act

In May 2013, the Dam Safety Office of the DNRC issued a determination that Smelter Dam does not impound at least 50 acre-feet of water. Therefore, a downstream hazard evaluation will not need to be performed, an operating permit will not be required, and a demolition permit will not need to be obtained for removal of the dam.

7.1.4 National Emissions Standards for Hazardous Air Pollutants (NESHAP) Compliance

In compliance with ARM Title 17, Chapter 74, Subchapters 3 and 4, NESHAP notifications were submitted for Demolition Phase 1 and 2 activities in 2013. Acknowledgements were received from MDEQ for Demolition

Phase 1 originally on April 8, 2013, and subsequently (as related to project revisions) on June 12 and July 11, 2013. Acknowledgements were received from MDEQ for Demolition Phase 2 on June 25, 2013 (with no follow-on revisions).

7.1.5 Montana Pollutant Discharge Elimination System Permits

The Custodial Trust holds the following two MPDES permits for ongoing site remedial operations: (1) an individual permit (MT0030147) that provides authorization to discharge treated effluent from the HDS WTP to an outfall in Lower Lake, and (2) authorization under the General Permit for Stormwater Discharges Associated with Industrial Activity (MTR000072). In addition, the Custodial Trust holds two additional MPDES permits for the remedial construction activity: (1) construction dewatering permit, and (2) construction stormwater permit.

7.1.5.1 HDS Plant Discharge

The Custodial Trust holds an MPDES Minor Industrial Individual Permit Number MT0030147 for authorization to discharge under the MPDES program. This permit allows for the discharge of treated effluent from the HDS WTP to an outfall located on Lower Lake. The HDS WTP will need to remain operational as long as necessary to treat contact stormwater collected from the former Smelter site, as well as other remediation waters.

7.1.5.2 Industrial Stormwater Discharges

The former Smelter site is permitted to discharge stormwater associated with industrial activities to waters of the United States pursuant to the MPDES General Permit for Stormwater Discharges (MTR000072). In accordance with permit requirements, stormwater management at the site is accomplished in accordance with an approved SWPPP. However, there have been no smelting operations at the plant site since April 2001. An updated SWPPP, representing current site conditions, was prepared for the Custodial Trust by Hydrometrics and submitted to MDEQ on November 10, 2014.

7.1.5.3 Construction Dewatering Discharges

Construction of the PPC Temporary Bypass channel required construction dewatering. Water was pumped from the work area into sediment ponds, from which the water either percolated into the ground or flowed over a weir and into PPC. Authorization to discharge under the Construction Dewatering General Permit was applied for and approved by MDEQ in August 2013. This work was completed in October 2013 and the permit was closed out with MDEQ.

7.1.5.4 Construction Stormwater Discharges

Stormwater discharge associated with construction activity, as defined in ARM 17.30.1102 (28), was addressed through the applicable requirements of the MPDES Construction Activity General Discharge Permit obtained for the former Smelter site. The IM designs include all necessary sediment controls needed to meet applicable requirements of the General Discharge Permit. A Notice of Intent (NOI) and SWPPP were submitted before construction after other permits, approvals, and authorizations were obtained. The current permit will remain in effect until a notice of termination is submitted to MDEQ due either to completion of activities covered by the existing permit or due to transfer of responsibilities.

7.1.5.5 Endangered Species Act Compliance

Endangered Species Act (ESA) compliance must be demonstrated for any federal permit approval that may be necessary during the course of IM implementation. A technical memorandum entitled *Montana Environmental Trust Group Endangered Species Act Compliance* (CH2M HILL, 2012b) was issued to USFWS on September 5, 2012. USFWS concurrence that the project complies with the ESA was received by CH2M HILL for the Custodial Trust on September 19, 2012.

7.2 Anticipated 2015 and 2016 Permitting and Authorization Activities

The following permits and authorizations are necessary for execution of the proposed 2015 and 2016 IM activities, including construction of the PPC Realignment, implementing Phase 3 demolition, removal of the NWE substation and relocation of the 69-kV line, and the placement of the ICS 2 and both ET Cover East and West.

7.2.1 Joint Application No. 2 and CLOMR No. 2

The USACE must issue a 404 Permit to any party proposing project work that will place fill material into "waters of the U.S." The purpose of the permit is to provide regulatory review of the activity and restore or maintain chemical, physical, and biological integrity of the nation's waters. A Joint Application No. 2 was submitted to USACE in October 2014 to address work necessary to install the PPC Realignment. This application was prepared concurrently with the CLOMR No. 2 for the PPC Realignment. The Joint Application No. 2 provides detailed information on the wetlands affected by all IMs and provides the mitigation plan for those impacted wetlands and subsequent monitoring.

The CLOMR No. 2 application was submitted in May 2014 and approved on November 6, 2014. The 404 Permit was approved on December 5, 2014. FEMA has completed the technical review process and the Custodial Trust has notified adjacent landowners of the proposed changes. Changes to water surface elevations resulting from the PPC Realignment are below acceptable change criteria. All other agency approvals under Joint Application No. 2 (including the 318 and COEH Floodplain Development Permit) have been approved as described below.

7.2.2 310 Permit

The Montana Natural Streambed and Land Preservation Act requires any nongovernmental entity proposing work that physically alters or modifies the bed or banks of a perennially flowing stream to obtain a 310 Permit from the County Conservation District. The purpose of the permit is to minimize sedimentation and protect streams from adverse development. The Custodial Trust submitted Joint Application No. 2 to the LCCD in October 2014. The LCCD consults with Montana Fish, Wildlife and Parks in approving the permit with recommendations and requirements. Additionally, the LCCD makes a recommendation to MDEQ on the 318 Authorization for short-term water quality standard for turbidity. The agency approved the 310 permit under Joint Application No. 2 on December 12, 2014.

7.2.3 318 Authorization

MDEQ provides 318 Authorization for short-term water quality standards for turbidity based on recommendation from the Montana Department of Fish Wildlife and Parks during the 310 Permit review process. The 318 Authorization provides a measure of protection to water quality while allowing for construction activities in or proximal to state surface waters. MDEQ received a copy of Joint Application No. 2 and is participating in the agency review process. Agency approval for the 318 Authorization under Joint Application No. 2 was received January 20, 2015.

7.2.4 Floodplain Development Permit

The Montana Floodplain and Floodway Management Act requires a Floodplain Development Permit be obtained by any entity planning construction within a designated 100-year floodplain. The purpose of the permit is to restrict development and uses that present hazards, thereby limiting the expenditure of public revenues for emergency operations. The Custodial Trust submitted Joint Application No. 2 to the administering body, the COEH, in October 2014. A CLOMR is required, as well, for the review process and FEMA provided approval on November 6, 2014. Approval of the Floodplain Development Permit by the COEH was provided on March 20, 2015.

7.2.5 MPDES Permits

For the proposed 2015 and 2016 IM activities, the associated MPDES permitting incorporates HDS WTP discharges, industrial stormwater discharges, construction dewatering discharges, and construction stormwater discharges as described in the following subsections.

7.2.5.1 HDS WTP Discharges

As previously noted in Section 7.1.5.1, the Custodial Trust holds an MPDES Minor Industrial Individual Permit Number MT0030147 for authorization to discharge under the MPDES program. This permit allows for the discharge of treated effluent from the HDS WTP to an outfall located on Lower Lake. The MPDES permit is valid until July 31, 2015, and the current IM schedule indicates that the HDS WTP will continue to operate into at least 2016 and possibly longer in the event that the IM schedule needs to be modified. Therefore, the Custodial Trust submitted a permit renewal application to MDEQ in early 2015 for the MPDES program, as stated in 40 C*ode of Federal Regulations* 122 and adopted by reference in ARM Title 17, Chapter 30 – Water Quality.

The Custodial Trust has also requested (in a letter dated April 21, 2014) that MDEQ issue an administrative order on consent to extend the interim numerical effluent discharge limits for 4 of the 12 constituents currently regulated by the MPDES permit. This is necessary to obviate the need for expensive mechanical system upgrades to the HDS WTP, which are not cost-effective given the relatively short operational life that currently is anticipated.

7.2.5.2 Industrial Stormwater Discharges

The Custodial Trust holds an MPDES General Permit for Stormwater Discharges from Industrial Activity. The current SWPPP (submitted to MDEQ in November 2014) is kept up-to-date to reflect current conditions on the site. A SWPPP update is expected to be prepared and submitted to MDEQ in the summer of 2015 to incorporate the addition of a stormwater discharge outfall to Lower Lake (Outfall 3B).

7.2.5.3 Construction Dewatering Discharges

The PPC Realignment may require a construction dewatering permit. The IM designs will include all necessary controls needed to meet applicable requirements of the MPDES Authorization to discharge under the Construction Dewatering General Permit. An application package for the General Permit will be submitted before construction after other permits, approvals, and authorizations have been obtained.

7.2.5.4 Construction Stormwater Discharges

The permit for stormwater discharge associated with construction activity will be required for ongoing IM activities such as the ICS 2 and both ET Cover East and West. The IM designs include all necessary sediment controls needed to meet applicable requirements of the MPDES Construction Activity General Discharge Permit. The NOI and SWPPP will be submitted to MDEQ before construction after other permits, approvals, and authorizations have been obtained.

7.2.6 Montana Department of Transportation Permits

Any work done within the Montana Department of Transportation (MDT) right-of-way will require the appropriate permit. MDT will be contacted to secure all required permits in advance of starting construction activities. It is not anticipated at this time that work will be completed in any MDT right-of-ways, except delivery of materials to the site by on-highway vehicles in road-legal loads.

7.2.7 Montana Water Use Act (Water Right Permit and Change Authorization)

As noted in the IM Work Plan 2013, the PPC Realignment will require two changes to the Point of Diversion. One change will be required to support the PPC Temporary Bypass, and another will be required to cover the change associated with the PPC Realignment. Existing water rights for the owners legally tied to the Wilson Ditch headgate will be affected. Work continues to appropriately address those effects.

7.2.8 City of East Helena — Partial Abandonment of South Montana Avenue

As part of the PPC Realignment, the Custodial Trust will work with the COEH in preparing a petition for road abandonment for COEH review and comment that seeks approval to abandon (vacate) a portion of the roads within the area of South Montana Avenue. Communications to date with the COEH indicate the City would like to preserve the existing railroad crossing and the northernmost section of the South Montana Avenue.

The Custodial Trust will work with the COEH to evaluate the additional property needs for providing a new connection to the remaining portion of South Montana Avenue, and new right-of-way for access from Highway 518.

7.2.9 Migratory Bird Treaty Act

The Custodial Trust will continue to coordinate and consult with USFWS and USEPA regarding deterrence activities aimed at minimizing noncompliance with the MBTA associated with all IMs. The MBTA was enacted to protect migratory birds in the U.S. All but a few of the bird species naturally occurring in the U.S. are protected from take under the MBTA, and, therefore warrant consideration to avoid and minimize potential impacts.

In coordination with USFWS, an approach was developed to provide migratory bird protection within the primary nesting areas involved in upcoming construction within the PPC Realignment construction areas. Early clearing outside of the nesting season (before April 15) was performed as part of a plant salvage and clearing plan implemented in March 2015. In addition, an APP was prepared to provide a framework for avoiding impacts to nesting birds and outline response actions in the event that an active nest is found within the project impact area or buffer, either before construction starts or during the course of the PPC Realignment. The APP satisfies the requirements of the MBTA and identifies the types of birds that may nest in the project area and the proposed buffers, monitoring requirements, and reporting standards that will be implemented to demonstrate compliance with MBTA.

SECTION 8

Project Management and Schedule

This section provides an overview of project management activities and the proposed schedule for 2015 and 2016 IM implementation. Organization and lines of communication, public participation, documentation and reporting, and the preliminary schedule are described.

The Custodial Trust will manage all IM activities as part of the responsibilities and obligations set forth in the Settlement Agreement and First Modification to the 1998 Consent Decree. The Custodial Trust will communicate relevant information about the IM task plans, results, and progress to USEPA, as Lead Agency, as well as to the federal and state beneficiaries of the Custodial Trust. Communication will occur on a frequent and timely basis, to review progress on the IMs, to solicit input from the beneficiaries, and to ensure that the beneficiaries are kept well informed of activities onsite.

8.1 Organization and Lines of Communication

The Custodial Trust will procure the services of consultants and contractors to implement the IMs as efficiently and cost-effectively as possible. **Figure 8-1** shows the current overall Project Organization Chart and the lines of communication. **Table 8-1** identifies the consultant leads for IM design and construction.

TABLE 8-1
Interim Measures Consultant Leads
Interim Measures Work Plan 2015/2016

Name	Lead Contact	Description of Role
CH2M HILL	Jay Dehner: 509-979-5733	Project management and overall engineering design and construction lead for former Smelter site IMs
Pioneer Technical Services	Joel Gerhart: 406-490-2530	Overall lead for PPC Realignment design, permitting, and construction
Hydrometrics	Bob Anderson: 406-443-4150	Hydrogeology and engineering design
	Mark Rhodes: 406-443-4150	Construction Management/Oversight
NewFields	Cam Stringer: 406-549-8270	Groundwater flow and F&T modeling
Morrison Maierle Inc.	Mark Brooke: 406-495-3469	Engineering design support and floodplain modeling
Applied Geomorphology	Karin Boyd: 406-587-6352	Stream geomorphology
Confluence	Jim Lovell: 406-585-9500	Stream geomorphology

8.2 Public Participation

Public involvement is a critical part of the overall cleanup process for the former Smelter site. General communication with the public will continue to follow the *Draft Community Relations Plan, Former ASARCO Smelter Facility, East Helena, Montana* prepared by the Custodial Trust (2010), as well as the requirements of the First Modification to the 1998 Consent Decree. In 2014, the Custodial Trust held the following meetings and workshops:

- A series of meetings were held to discuss the CGWA, including a public/stakeholder meeting held in August 2014.
- A meeting of the East Helena Entire Cleanup Team in Coordination (EHECTIC) was held in March 2014 to provide project stakeholders and the community information on the PPC Realignment design.

- Two Town Hall meetings were held in 2014. In March 2014, a meeting was held to update the community on the PPC Realignment design. An additional Town Hall meeting was held on December 17, 2014, to provide the community another update on the PPC Realignment design. In August 2014, a public/stakeholder meeting was held to update the community on the impacts observed in groundwater as a result of the implementation of several components of the SPHC IM, and the progress of 2014 IM construction activities.

An informational meeting was held in February 2015 to provide the community with an overview of the 2015 and 2016 IM work described herein. In addition, the Custodial Trust holds meetings with the EHECTIC group to provide information to key local stakeholders and attends the East Helena City Council meetings. The Custodial Trust's Web site contains links to news on cleanup progress, design documents, meeting materials, and future meeting dates. As described in the IM Work Plan 2014, a video of the PPC Realignment project is available for viewing. The Web site address is: http://www.mtenvironmentaltrust.org/east-helena.

Written public comments on this document or ongoing activities may be submitted to:

Attn: Betsy Burns
USEPA Region 8 Montana Office
10 West 15th Street, Suite 3200
Helena, MT 59626

Submit electronic comments by e-mail to: burns.betsy@epa.gov.

8.3 Documentation and Reporting

The following IM documentation is under development:

- Contract scopes of work and schedules
- Engineering technical reports and memorandums
- Modeling results
- Permit application packages
- Detailed engineering designs (plans and specifications)
- Construction contract packages (drawings and specifications)
- Operation and maintenance plans
- Record drawings and contract close-out documents

Core plans that have been developed for the Facility will be incorporated by reference, or amended as appropriate, to ensure that IM activities follow relevant protocols and methods. Core plans include the following:

- Health and safety plan for the East Helena former Smelter site
- QA/QC plan
- Sampling and analysis plans

IM progress will be summarized in the monthly progress reports.

8.4 Preliminary Interim Measure Implementation Schedule

Table 8-2 summarizes key dates for the proposed 2015 and 2016 IM implementation and provides schedule updates for the work proposed and approved in the IM Work Plans 2012, 2013, and 2014. The schedule is considered a living document and will be revised on a regular basis as needed to reflect planned implementation requirements for each IM. The preliminary schedule was developed in coordination with other ongoing work being conducted by the Custodial Trust pursuant to the First Modification. The schedule for these activities is subject to refinement as input is received from the Custodial Trust, beneficiaries, and other stakeholders.

TABLE 8-2
Summary of Proposed 2015 and 2016 Implementation Schedule
Interim Measures Work Plan 2015/2016

East Helena Facility Planning and Construction Activities	Start	End
2015/2016 Interim Measures Work Plan		
Public Comment Period	February 2015	March 2015
U.S. Environmental Protection Agency Approval		April 2015
2015—PPC Realignment		
Bidding and Award	March 2015	May 2015
Construction	May 2015	November 2015
2015—ET Cover West/ICS 2/Phase 3 Demolition Construction		
Bidding and Award	February 2015	May 2015
Construction	May 2015	November 2015
2016—PPC Realignment (including Smelter Dam Demolition)		
Bidding and Award	March 2015	May 2015
Construction	April 2016	October 2016
2016—ET Cover East/Phase 3 Demolition Construction		
Bidding and Award	February 2015	May 2015
Construction	May 2016	October 2016*

*Demolition of the high-density sludge water treatment plant and construction of portions of the Evapotranspiration (ET) Cover over the central corridor may be performed in 2017 or beyond if necessary to accommodate source control measures.

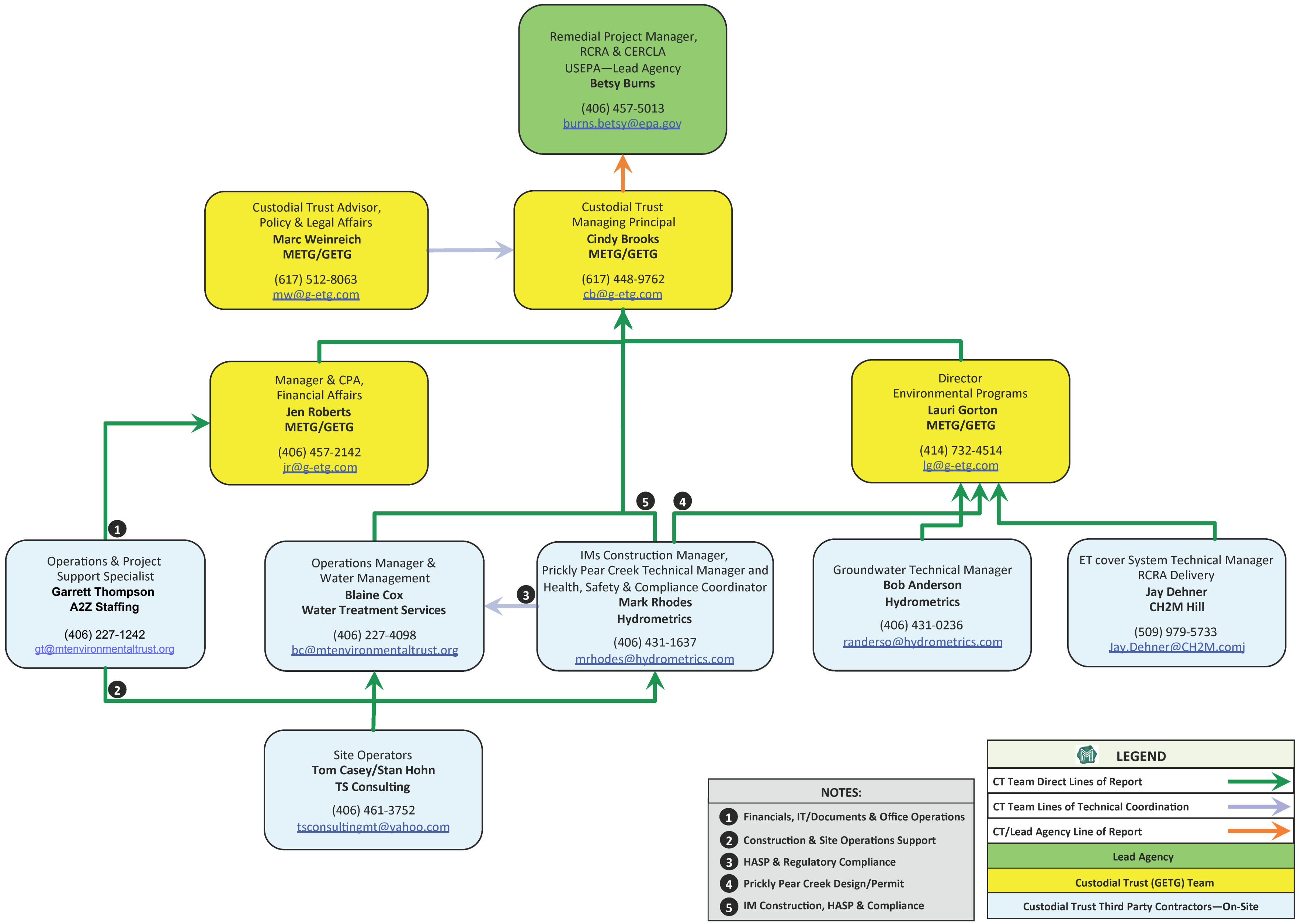

FIGURE 8-1
Project Organization and Lines of Communication
Interim Measures Work Plan–2015/2016
East Helena, Montana

CH2MHILL.

SECTION 9
References

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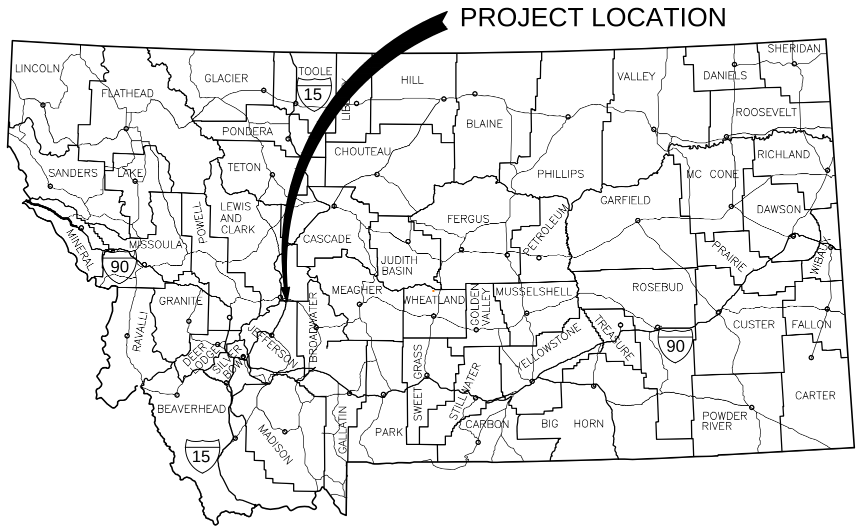
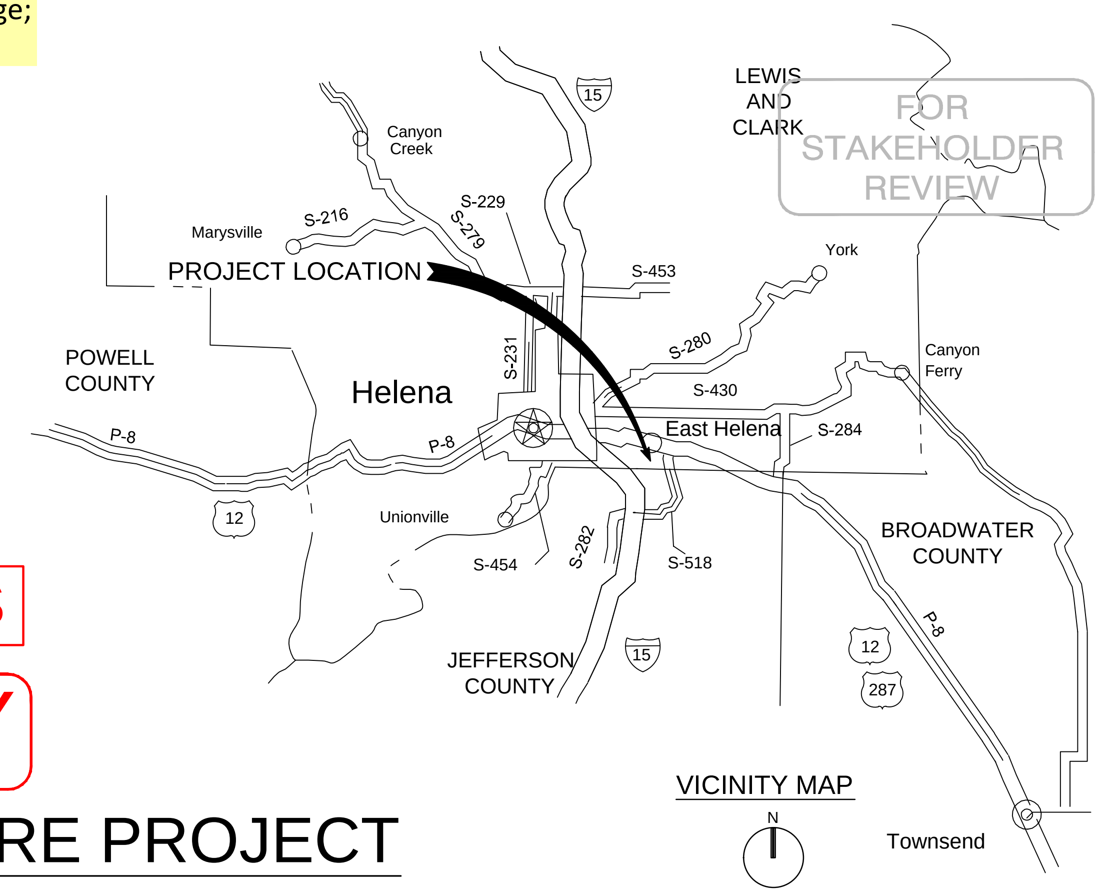
Appendix A
Design Details and Supporting Documentation

Select Prickly Pear Creek Realignment Design Drawings

Note: The index of drawings summarized below lists the design drawings that will be included in the final design and bid package; however, only a portion of those are included in this appendix for review. The attached drawings are highlighted in yellow.



LOCATION MAP



VICINITY MAP

FOR STAKEHOLDER REVIEW

90% DOCUMENTS

PRELIMINARY

NOT FOR CONSTRUCTION

EAST HELENA SMELTER CLOSURE PROJECT
PRICKLY PEAR CREEK REALIGNMENT

GENERAL

SHEET NO.	DRAWING NO.	DRAWING TITLE
1	1-1	TITLE, LOCATION AND VICINITY MAP, INDEX TO DRAWINGS
2	1-2	CIVIL LEGENDS, ABBREVIATIONS AND GENERAL NOTES (1 OF 2)
3	1-3	CIVIL LEGENDS, ABBREVIATIONS AND GENERAL NOTES (2 OF 2)
4	1-4	CIVIL SITE LAYOUT/EXISTING CONDITIONS
5	1-5	EXISTING WELL PROTECTION/ABANDONMENT PLAN

CONSTRUCTION STAGING

SHEET NO.	DRAWING NO.	DRAWING TITLE
6	2-1	CONSTRUCTION STAGING STAGE 1 PLAN
7	2-2	CONSTRUCTION STAGING STAGE 2 PLAN
8	2-3	CONSTRUCTION STAGING STAGE 3 PLAN
9	2-4	CONSTRUCTION STAGING STAGE 4 PLAN
10	2-5	CONSTRUCTION STAGING STAGE 5 PLAN
11	2-6	CONSTRUCTION STAGING STAGE 6 PLAN

GROUNDWATER DEWATERING

SHEET NO.	DRAWING NO.	DRAWING TITLE
*12	3-1	SOUTH FLOODPLAIN DEWATERING PLAN
*13	3-2	NORTH FLOODPLAIN DEWATERING PLAN
*14	3-3	SEDIMENT POND PLAN AND DETAILS
*15	3-4	DEWATERING DETAILS

EROSION CONTROL PLAN

SHEET NO.	DRAWING NO.	DRAWING TITLE
16	4-1	STAGE 1B EXCAVATION STORMWATER BMP'S PLAN
17	4-2	STAGE 4 EXCAVATION STORMWATER BMP'S PLAN
18	4-3	STORMWATER BMP DETAILS

EXCAVATION

SHEET NO.	DRAWING NO.	DRAWING TITLE
19	5-1	FLOODPLAIN EXCAVATION PLAN AND PROFILE
20	5-2	STAGE 1A/3 FLOODPLAIN EXCAVATION PLAN AND PROFILE
21	5-3	STAGE 1B FLOODPLAIN EXCAVATION PLAN AND PROFILE (1 OF 2)
22	5-4	STAGE 1B FLOODPLAIN EXCAVATION PLAN AND PROFILE (2 OF 2)
23	5-5	TITO PARK FLOODPLAIN EXCAVATION PLAN AND PROFILE
24	5-6	STAGE 4 FLOODPLAIN EXCAVATION PLAN AND PROFILE (1 OF 2)

EXCAVATION(CONT.)

SHEET NO.	DRAWING NO.	DRAWING TITLE
25	5-7	STAGE 4 FLOODPLAIN EXCAVATION PLAN AND PROFILE (2 OF 2)
26	5-8	SLAG PILE GRADING
27	5-9	STAGE 5 FLOODPLAIN EXCAVATION PLAN AND PROFILE
28	5-10	STAGE 5 FLOODPLAIN EXCAVATION PLAN AND PROFILE
29	5-11	FLOODPLAIN EXCAVATION DETAILS
30	5-12	FLOODPLAIN EXCAVATION DETAILS

FLOODPLAIN

SHEET NO.	DRAWING NO.	DRAWING TITLE
31	6-1	FLOODPLAIN CONSTRUCTION PLAN AND PROFILE
32	6-2	STAGE 1A/3 FLOODPLAIN CONSTRUCTION PLAN AND PROFILE
33	6-3	STAGE 1B FLOODPLAIN CONSTRUCTION PLAN AND PROFILE (1 OF 2)
34	6-4	STAGE 1B FLOODPLAIN CONSTRUCTION PLAN AND PROFILE (1 OF 2)
35	6-5	TITO PARK FLOODPLAIN CONSTRUCTION PLAN AND PROFILE
36	6-6	STAGE 4 FLOODPLAIN CONSTRUCTION PLAN AND PROFILE (1 OF 2)
37	6-7	STAGE 4 FLOODPLAIN CONSTRUCTION PLAN AND PROFILE (2 OF 2)
38	6-8	BUTTRESS AND VEGETATED RIPRAP DETAIL
39	6-9	FLOODPLAIN CONSTRUCTION DETAILS
40	6-10	BURIED SILL DETAIL
41	6-11	SLAG PILE EMBANKMENT PLAN AND PROFILE (1 OF2)
42	6-12	SLAG PILE EMBANKMENT PLAN AND PROFILE (2 OF 2)

CHANNEL RECONSTRUCTION

SHEET NO.	DRAWING NO.	DRAWING TITLE
43	7-1	CHANNEL RECONSTRUCTION PLAN AND PROFILE
44	7-2	STAGE 2A CHANNEL RECONSTRUCTION PLAN AND PROFILE
45	7-3	STAGE 2B CHANNEL RECONSTRUCTION PLAN AND PROFILE (1 OF 2)
46	7-4	STAGE 2B CHANNEL RECONSTRUCTION PLAN AND PROFILE (2 OF 2)
47	7-5	STAGE 4 CHANNEL RECONSTRUCTION PLAN AND PROFILE
48	7-6	STAGE 5 CHANNEL RECONSTRUCTION PLAN AND PROFILE
49	7-7	STAGE 6 CHANNEL RECONSTRUCTION PLAN AND PROFILE
50	7-8	DEFORMABLE RUN, RIFFLE AND POOL SECTIONS
51	7-9	RUN-RIFFLE, RIFFLE-POOL TRANSITION TYPICAL SECTIONS
52	7-10	CHANNEL SECTION TABLES
53	7-11	NON-DEFORMABLE CHANNEL AND STREAM BANK DETAILS
54	7-12	CHANNEL RECONSTRUCTION ROCK RAMP DETAILS
55	7-13	PPC INLET STAGE 1 PLAN AND PROFILE
56	7-14	PPC INLET STAGE 2 PLAN AND PROFILE AND DETAILS
57	7-15	FABRIC ENCAPSULATED SOIL LIFT INSTALLATION DETAILS
58	7-16	TBC OUTLET TIE IN
59	7-17	SMELTER DAM BRIDGE PLACEMENT
60	7-18	STREAMBANK CONSTRUCTION FORM DETAILS
61	7-19	FABRIC ENCAPSULATED SOIL LIFT CONSTRUCTION SEQUENCING

FINAL GRADING

SHEET NO.	DRAWING NO.	DRAWING TITLE
62	8-1	FINAL GRADING OVERALL PLAN VIEW
63	8-2	FINAL PLAN VIEW(1 OF 6)
64	8-3	FINAL PLAN VIEW(2 OF 6)
65	8-4	FINAL PLAN VIEW(3 OF 6)
66	8-5	FINAL PLAN VIEW(4 OF 6)
67	8-6	FINAL PLAN VIEW(5 OF 6)
68	8-7	FINAL PLAN VIEW(6 OF 6)

VEGETATION

SHEET NO.	DRAWING NO.	DRAWING TITLE
69	9-1	VEGETATION OVERALL PLAN
70	9-2	VEGETATION PLAN(1 OF 6)
71	9-3	VEGETATION PLAN (2 OF 6)
72	9-4	VEGETATION PLAN (3 OF 6)
73	9-5	VEGETATION PLAN (4 OF 6)
74	9-6	VEGETATION PLAN (5 OF 6)
75	9-7	VEGETATION PLAN (6 OF 6)
76	9-8	MEANDER BEND PLANTING DETAILS
77	9-9	RUN-RIFFLE PLANTING DETAILS
78	9-10	HARVESTING AND PLANTING DETAILS
79	9-11	EROSION CONTROL BLANKET SLOPE PROTECTION DETAIL
80	9-12	EROSION CONTROL BLANKET SWALE PROTECTION DETAIL

PROJECT SECTIONS

SHEET NO.	DRAWING NO.	DRAWING TITLE
81	10-1	PPC REALIGNMENT CROSS-SECTIONS OVERVIEW
82	10-2	PPC REALIGNMENT CROSS-SECTIONS STA 1+00 TO 8+00
83	10-3	PPC REALIGNMENT CROSS-SECTIONS STA 9+00 TO 16+00
84	10-4	PPC REALIGNMENT CROSS-SECTIONS STA 17+00 TO 29+00
85	10-5	PPC REALIGNMENT CROSS-SECTIONS STA 30+00 TO 47+00
86	10-6	PPC REALIGNMENT CROSS-SECTIONS STA 48+00 TO 53+00

PROJECT COMPLETION GRADING

SHEET NO.	DRAWING NO.	DRAWING TITLE
87	11-1	PROJECT COMPLETION GRADING OVERVIEW PLAN AND PROFILE
88	11-2	PROJECT COMPLETION GRADING NORTH PLAN AND PROFILE
89	11-3	PROJECT COMPLETION GRADING SOUTH PLAN AND PROFILE
90	11-4	PROJECT COMPLETION GRADING CROSS SECTIONS STA 1+06 TO 34+54
91	11-5	PROJECT COMPLETION GRADING CROSS SECTIONS STA 37+33 TO 52+38

REVISION: DATE: BY: DESC:

DRAWN BY: JJJ
DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER

SCALE IN FEET
0
NTS

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
TITLE, LOCATION AND VICINITY MAP INDEX OF DRAWINGS

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, STE. C
HELENA, MONTANA 59601
(406) 457-8252

SHEET 1-1

ABBREVIATIONS

AB	ANCHOR BOLT, ABOVE
ABDN	ABANDON
AC	ASPHALTIC CONCRETE
AD	AREA DRAIN
ADDL	ADDITIONAL
ADJ	ADJACENT
AGGR	AGGREGATE
AHR	ANCHOR
AJ	ADJUSTABLE
APPROX	APPROXIMATE
APVD	APPROVED
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
@	AT
BETW	BETWEEN
BF	BLIND FLANGE, BOTTOM FACE
BG	BELOW GRADE
BLDG	BUILDING
BLK	BLOCK
BM	BEAM, BENCHMARK
BOT	BOTTOM
BRG	BEARING
BRKR	BREAKER
BVC	BEGINNING OF VERTICAL CURVE
C	CONDUIT, CASEMENT
C TO C	CENTER TO CENTER
CAB	CABINET
CB	CATCH BASIN, CIRCUIT BREAKER
CC	CONTROL CABLE
CCL	COMPACTED CLAY LAYER
CCP	CENTRAL CONTROL PANEL
CCS	CENTRAL CONTROL SYSTEM
CDN	COMPOSITE DRAINAGE NET
CIP	CAST IN PLACE
CIP	CULVERT INLET PROTECTION
CJ	CONSTRUCTION JOINT
CL	CENTERLINE
CLSF	CONTROLLED LOW STRENGTH FILL
CLR	CLEAR, CLEARANCE
CMP	CORRUGATED METAL PIPE
CO	CLEANOUT, CARBON MONOXIDE
CONC	CONCRETE
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUED, CONTINUATION
COORD	COORDINATE
CRS	COLD ROLLED STEEL
CRS	CONSTRUCTION ROAD STABILIZATION
CTR	CENTER
CTRD	CENTERED
CU	CUBIC
CU FT	CUBIC FOOT
CU IN	CUBIC INCH
CY, CU YD	CUBIC YARD
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIR	DIRECTION
DISCH	DISCHARGE
DWG	DRAWING
△	DELTA
E	EAST, EMPTY
EA	EACH
EF	EACH FACE
EL	ELEVATION
ELB	ELBOW
ELC	ELECTRICAL LOAD CENTER
ELEC	ELECTRIC, ELECTRICAL
ENGR	ENGINEER
EQL SP	EQUALLY SPACED
EQPT	EQUIPMENT
ESC	EROSION AND SEDIMENT CONTROL
EVC	END OF VERTICAL CURVE
EW	EACH WAY
EXP	EXPANSION, EXPOSED
EXP AB	EXPANSION ANCHOR BOLT
EXP JT	EXPANSION JOINT
EXST, EXIST	EXISTING
EXT	EXTERIOR
FC	FLEXIBLE CONDUIT/ CONNECTOR
FCA	FLANGED COUPLING ADAPTER
FDN	FOUNDATION
FG	FINISH GRADE
FHY	FIRE HYDRANT
FIG	FIGURE
FL	FLOW LINE
FLG	FLANGE
FL	FLOOR
FLEX	FLEXIBLE
FNSH	FINISH
FOB	FLAT ON BOTTOM
FP	FIELD PANEL
FPL	FROST PROTECTION LAYER
FPM	FEET PER MINUTE
FT	FOOT OR FEET
FWD	FORWARD
G, GND	GROUND
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GC	GROOVED COUPLING
GCL	GEOSYNTHETIC CLAY LINER
GVL	GRAVEL
HDPE	HIGH DENSITY POLYETHYLENE
HH	HANDHOLE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPT	HIGH POINT
HWL	HIGH WATER LEVEL
IE	INVERT ELEVATION
I.F.	INSIDE FACE
IN	INCH(ES)
INVT	INVERT
IP	INLET PROTECTION
IRRIG	IRRIGATION
JB	JUNCTION BOX
JCT	JUNCTION
JT	JOINT
L	ANGLE, LENGTH
LB(S)	POUND(S)
LCRS	LEACHATE COLLECTION AND RECOVERY SYSTEM
LDS	LEAK DETECTION SYSTEM
LF	LINEAR FEET
LG	LONG
LONG	LONGITUDINAL
LP	LIGHT POLE
LPT	LOW POINT
LR	LONG RADIUS
LT	LEFT
LTG, LTS	LIGHTS OR LIGHTING
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MFD	MANUFACTURED
MFR	MANUFACTURER
MH	MANHOLE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MS	MANUFACTURER'S STANDARD
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MU	MULCHING
MWS	MAXIMUM WATER SURFACE
N	NORTH
NA	NOT APPLICABLE
NEUT	NEUTRAL
NG	NATURAL GAS
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
N.O.	NORMALLY OPEN
NO., #	NUMBER
NOM	NOMINAL
N-S	NORTH - SOUTH
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OVERFLOW
O.F.	OUTSIDE FACE
OPNG	OPENING
OPP	OPPOSITE
OZ	OUNCE
PC	POINT OF CURVE
PCF	POUNDS PER CUBIC FOOT
PI	POINT OF INTERSECTION
PJF	PREMOULDED JOINT FILLER
PL	PROPERTY LINE
PLYWD	PLYWOOD
PMP	PUMP
PNL	PANEL
POE	POINT OF ENDING
PP	POWER POLE
PPC	PRICKLY PEAR CREEK
PR	PAIR
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PRES	PRESSURE
PRI	PRIMARY
PROP	PROPERTY
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PT	POINT OF TANGENCY
PT	PRESSURE TREATED
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
R OR RAD	RADIUS
RC	REINFORCED CONCRETE
RDCR	REDUCER
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RH	RIGHT HAND
RHR	RIGHT HAND REVERSE
RPE	REINFORCED POLYETHYLENE
RST	REINFORCING STEEL
RT	RIGHT
RTN	RETURN
R/W	RIGHT OF WAY
S	SWITCH
SB	SEDIMENT BASIN
SCHED	SCHEDULE
SEC	SECONDARY
SED	SEDIMENTATION
SH	SHEET
SIM	SIMILAR
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
ST	STRAIGHT
STA	STATION
STD	STANDARD
STL	STEEL
STRUCT	STRUCTURE
T&B	TOP AND BOTTOM
TAN	TANGENT
TBC	TEMPORARY BYPASS CHANNEL
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY, TEMPERATURE
THK	THICKNESS
THRU	THROUGH
TOC	TOP OF CONCRETE
TOS	TOP OF SLAB
TP	TURNING POINT
TRANSV	TRANSVERSE
TX	TRANSFORMER
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
VC	VERTICAL CURVE
VERT	VERTICAL
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
W	WEST
W/	WITH

NOTES:

1. CONTACT ENGINEER FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING.

GENERAL SITE

1. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS ARE BASE MAPS PROVIDED BY DJ&A, P.C. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
2. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED.
3. HORIZONTAL DATUM: NAD 83, MONTANA STATE PLANE COORDINATE SYSTEM, INTERNATIONAL FEET.
4. VERTICAL DATUM: N.A.V.D. 88, U.S. SURVEY FEET.
5. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
6. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS.
7. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
8. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE NOTED.
9. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
10. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED AND INSPECTED AS STATED IN THE APPROVED EROSION AND SEDIMENTATION PLAN APPROVED IN THE STORMWATER DISCHARGE PERMIT.
11. ALL CONTRACTORS AND SUBCONTRACTORS SHALL COMPLY WITH THE FIELD SAFETY INSTRUCTIONS APPROVED (FSI)FOR THIS SITE AT ALL TIMES.
12. EXISTING SITE DRAINAGE FLOW PATTERNS/DIRECTIONS SHALL BE MAINTAINED UNLESS OTHERWISE INDICATED ON THE PLANS.
13. CONSTRUCTION ACTIVITY BY OTHERS MAY IMPACT THE WORK CONTEMPLATED WITHIN THIS PACKAGE. THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY IF A CONFLICT ARISES RELATING TO THE PROGRESS OF THE WORK. FINAL COORDINATION/RESOLUTION OF SUCH CONFLICTS SHALL BE THE RESPONSIBILITY OF THE CONTRACTORS INVOLVED.
14. EXISTING FEATURES AND UTILITIES ARE SHOWN ON THE PLANS BASED UPON INFORMATION AVAILABLE AT THE TIME THE PLANS WERE PREPARED. SHOULD UNIDENTIFIED UTILITY OR SERVICE ELEMENTS BE ENCOUNTERED, NOTIFY THE ENGINEER AND THE APPROPRIATE UTILITY OWNER IMMEDIATELY.
15. ACCESS TO THE GENERAL SITE, AND TO SPECIFIC WORK AREAS SHALL BE LIMITED TO THE LOCATIONS SHOWN ON THE PLANS.
16. WATER FOR CONSTRUCTION ACTIVITIES SHALL BE OBTAINED BY THE CONTRACTOR AT THEIR SOLE EXPENSE. ANY AND ALL PERMITS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

90% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

REVISION: DATE: BY: DESC:

DRAWN BY: JJJ
DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER

SCALE IN FEET
0
NTS

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
CIVIL LEGENDS ABBREVIATIONS AND GENERAL NOTES
(1 OF 2)

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, STE. C
HELENA, MONTANA 59601
(406) 457-8252

SHEET
1-2

CIVIL LEGEND

EXISTING	THIS CONTRACT	
× 157.7	⊗ 158.5	SPOT ELEVATION
155	155	CONTOUR LINE
	3:1	EMBANKMENT AND SLOPE
		DRAINAGEWAY OR DITCH
		COMPLETED CONSTRUCTION
		CURRENT FLOW AREA
○	Ⓓ OR Ⓟ	MANHOLE D = STORM DRAIN P = PROCESS
□E	■E	ELECTRICAL MANHOLE
□H	■H	ELECTRIC HANDHOLE
		POST OR GUARD POST
		GUY ANCHOR
		FIRE HYDRANT
		UTILITY POLE
		LIGHT POLE
	° BM	BENCH MARK
		SURVEY CONTROL POINT OR POINT OF INTERSECTION
		BRUSH/TREE LINE
		TREE
		PROPERTY LINE
		CENTER LINE, BUILDING, ROAD, ETC.
		STAGING OR WORK AREA LIMITS
	N 1000.00 E 1000.00	STRUCTURE, BUILDING OR FACILITY LOCATION POINT - COORDINATES
	B-1	BORING LOCATION AND NUMBER
OR	OR	STRUCTURE, BUILDING OR FACILITY
		SINGLE SWING GATE
		DOUBLE SWING GATE
		SLIDING GATE
		GUARD RAIL
		CHAIN LINK FENCE
		WIRE FENCE
		CULVERT
		TEMPORARY CONSTRUCTION FENCE
W	W	WATER LINE
A	A	AIR LIQUID LINE
FO	FO	FIBER OPTIC BURIED
OHP	OHP	POWER OVERHEAD
G	G	NATURAL GAS
BT	BT	TELEPHONE LINE BURIED
OIL	OIL	HIGH PRESSURE OIL LINE
PW	PW	PRESSURIZED WATER LINE
		TRACK LINE
	Ⓦ	GROUND MONITORING WELL

SECTION OR DETAIL DESIGNATION

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET)

A / -   3 / 5-9

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

SHEET/DRAWING NUMBER WHERE SHOWN

B / C7-2 SECTION SCALE

ON DRAWING WHERE SECTION IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN ADDITIONAL SHEETS SHOWN BY SCALE

2 / C7-2 DETAIL SCALE

ON DRAWING WHERE DETAIL IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN ADDITIONAL SHEETS SHOWN BY SCALE

DRAWING TITLE
SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)

A / -

SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

A / 4-7   A / 4-7

SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

1 KEYED NOTES

1 REVISION NUMBER

FOR STAKEHOLDER REVIEW

90% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

REVISION:
DATE: BY: DESC:

DRAWN BY: JJJ
DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: NA
SOURCE: PIONEER

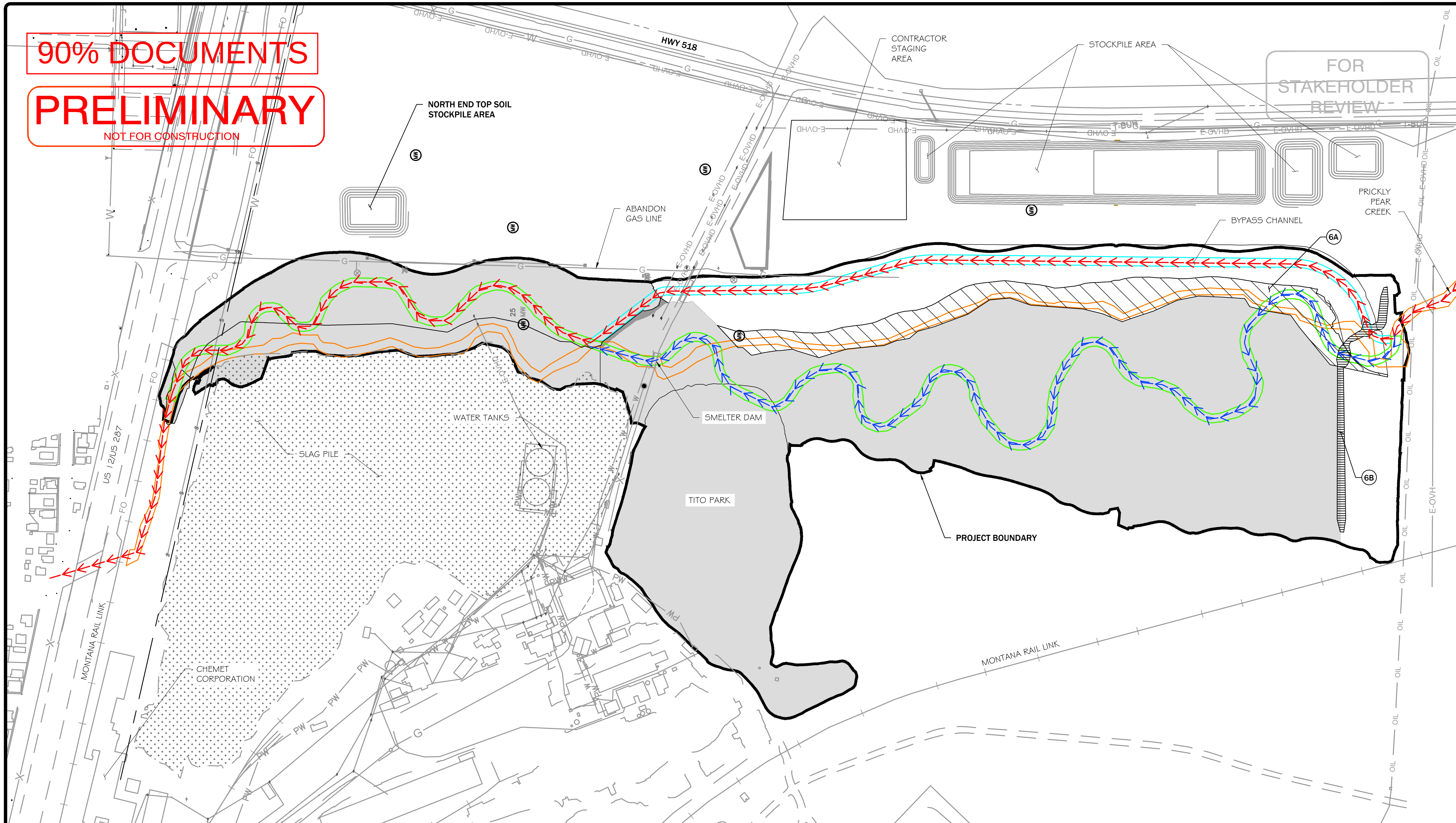
SCALE IN FEET
0 NTS

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
CIVIL LEGENDS ABBREVIATIONS AND GENERAL NOTES (2 OF 2)

PIONEER TECHNICAL SERVICES, INC.
201 E. BROADWAY, STE. C
HELENA, MONTANA 59601
(406) 457-8252

SHEET 1-3



CONSTRUCTION SEQUENCE:

STAGE 6A: EXCAVATE AND BACKFILL CHANNEL AND FLOODPLAIN FEATURES IN DESIGNATED AREA PER EXCAVATION PLANS, FLOODPLAIN PLANS, CHANNEL RECONSTRUCTION, FINAL GRADING PLANS AND TECHNICAL SPECIFICATIONS. INSTALL VEGETATION PER VEGETATION PLANS AND SPECIFICATIONS.

STAGE 6B: CONSTRUCT SHEETPILE AND PPC INLET STRUCTURE. DIVERT FLOW INTO RE-CONSTRUCTED PPC, BUILD TBC INLET SILL AND ONCE TBC MODIFICATIONS ARE COMPLETE RETURN FLOW TO TBC AS DIRECTED BY ENGINEER.

LEGEND:

- (1A) CONSTRUCTION SEQUENCE
- TEMPORARY PPC FLOW DIVERSION 6A
- TEMPORARY PPC FLOW DIVERSION 6B
- ACTIVE EXCAVATION AREA
- ACTIVE EXCAVATION AREA (6B)
- COMPLETED EXCAVATION AND BACKFILL AREA

REVISION: DATE:	BY:	DESC:

DRAWN BY: JJJ
DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

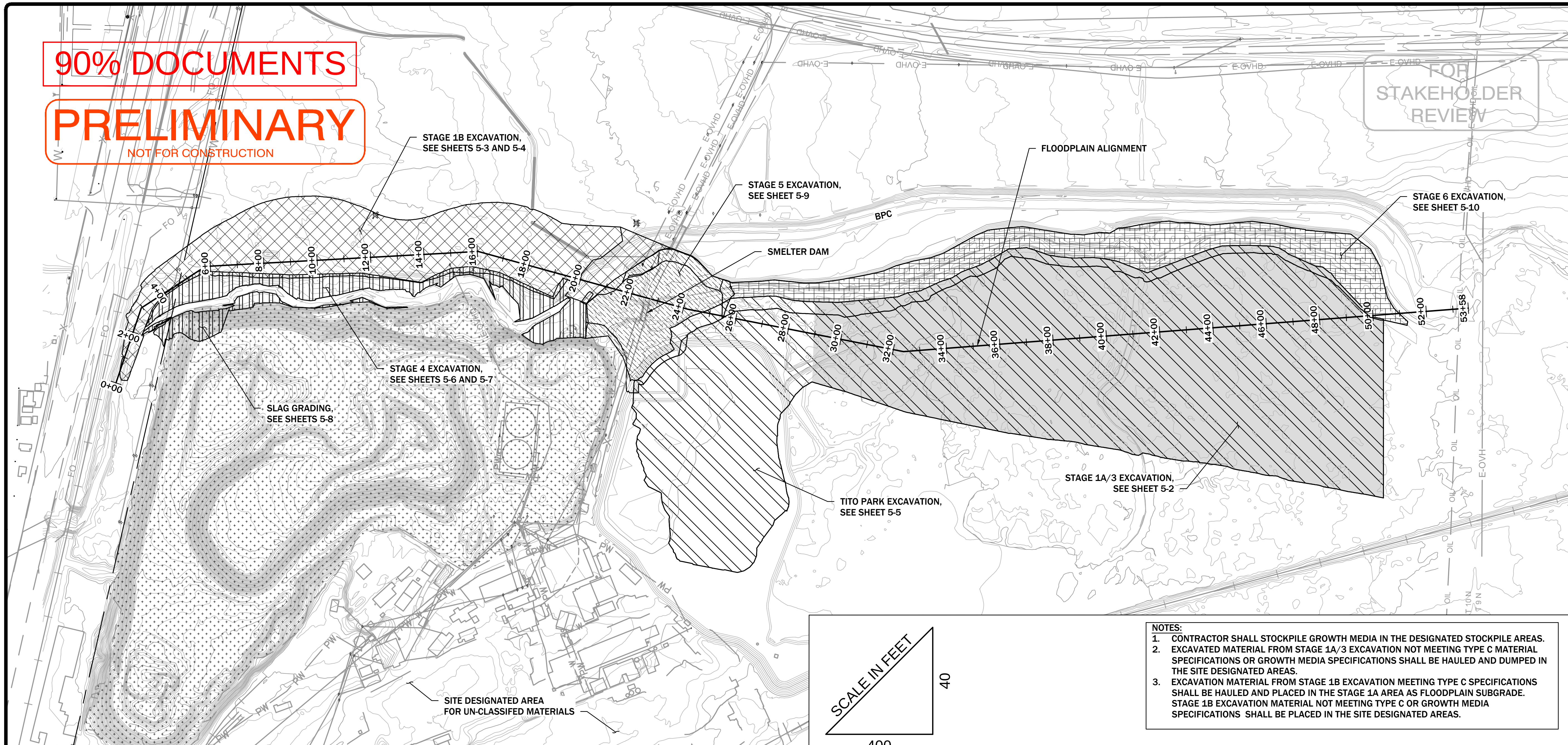
DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
CONSTRUCTION SEQUENCING STAGE 6 PLAN

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
2-6

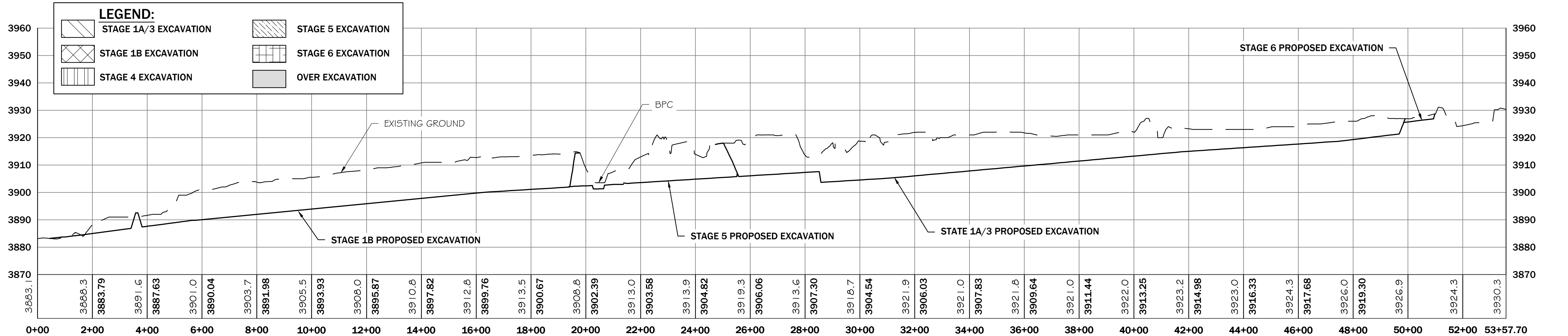


NOTES:

1. CONTRACTOR SHALL STOCKPILE GROWTH MEDIA IN THE DESIGNATED STOCKPILE AREAS.
2. EXCAVATED MATERIAL FROM STAGE 1A/3 EXCAVATION NOT MEETING TYPE C MATERIAL SPECIFICATIONS OR GROWTH MEDIA SPECIFICATIONS SHALL BE HAULED AND DUMPED IN THE SITE DESIGNATED AREAS.
3. EXCAVATION MATERIAL FROM STAGE 1B EXCAVATION MEETING TYPE C SPECIFICATIONS SHALL BE HAULED AND PLACED IN THE STAGE 1A AREA AS FLOODPLAIN SUBGRADE. STAGE 1B EXCAVATION MATERIAL NOT MEETING TYPE C OR GROWTH MEDIA SPECIFICATIONS SHALL BE PLACED IN THE SITE DESIGNATED AREAS.

LEGEND:

- STAGE 1A/3 EXCAVATION
- STAGE 1B EXCAVATION
- STAGE 4 EXCAVATION
- STAGE 5 EXCAVATION
- STAGE 6 EXCAVATION
- OVER EXCAVATION



REVISION: DATE:	BY:	DESC:

DRAWN BY: JJJ
DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

SCALE IN FEET
0 200 400

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT

FLOODPLAIN EXCAVATION PLAN AND PROFILE

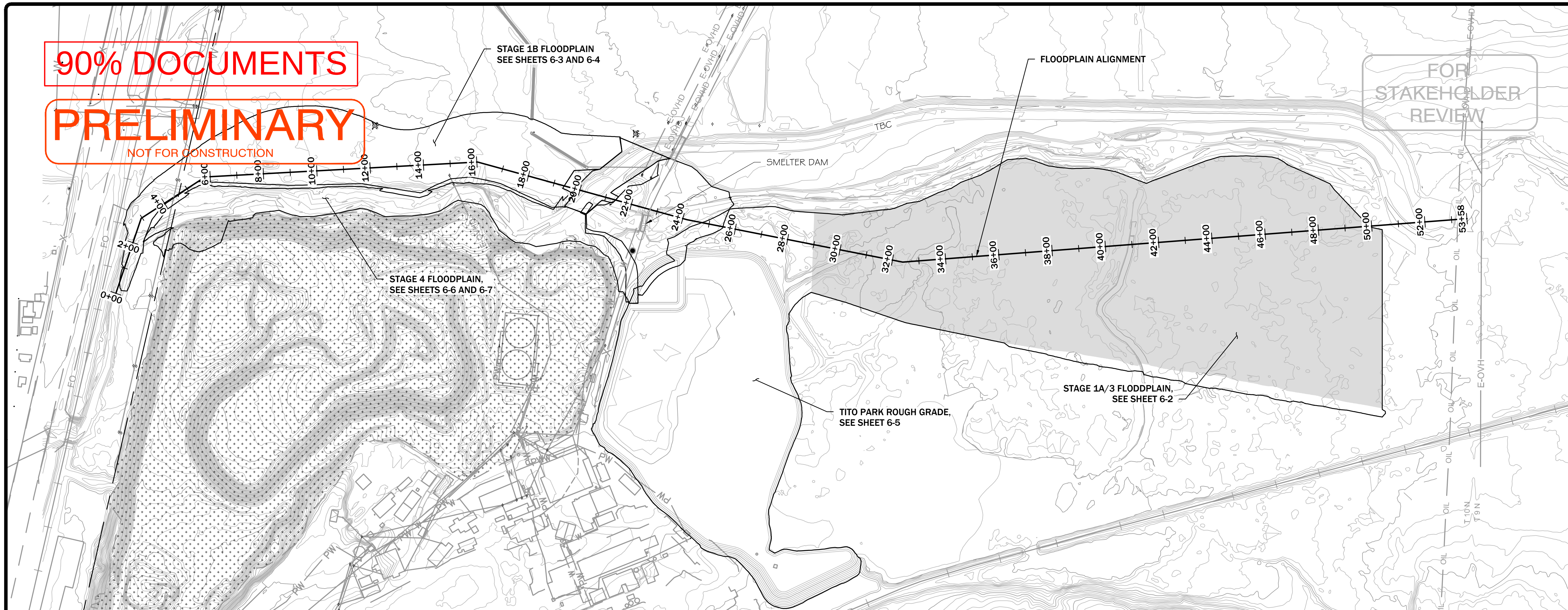
PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

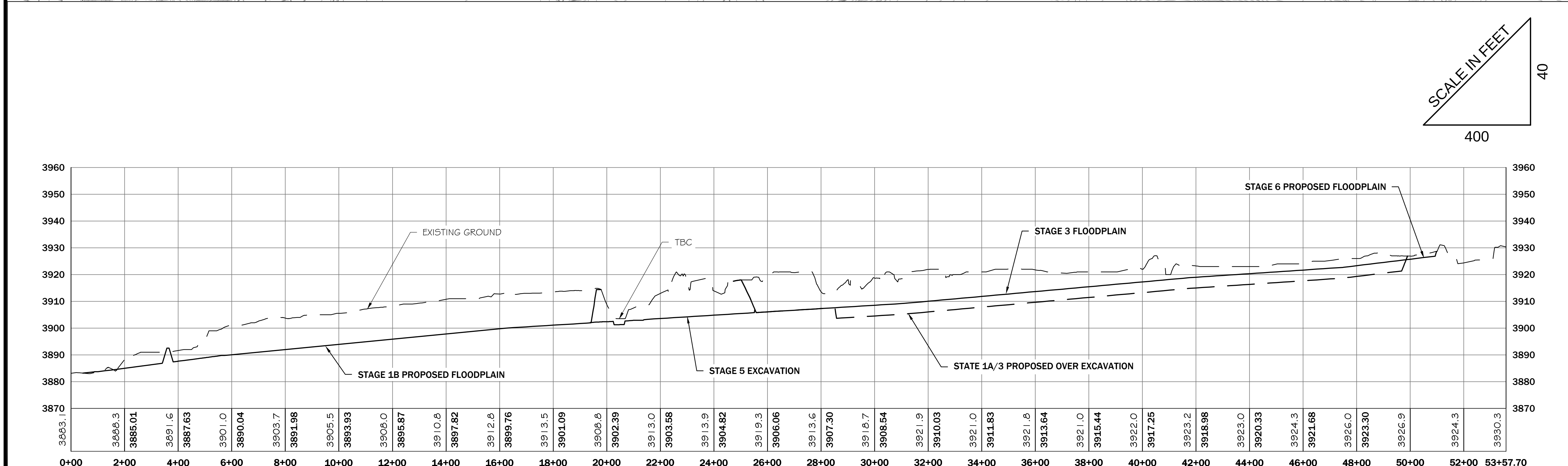
SHEET 5-1

90% DOCUMENTS

PRELIMINARY
NOT FOR CONSTRUCTION

FOR STAKEHOLDER REVIEW





REVISION:
DATE: BY: DESC:

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DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

SCALE IN FEET
0 200 400

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
FLOODPLAIN CONSTRUCTION PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
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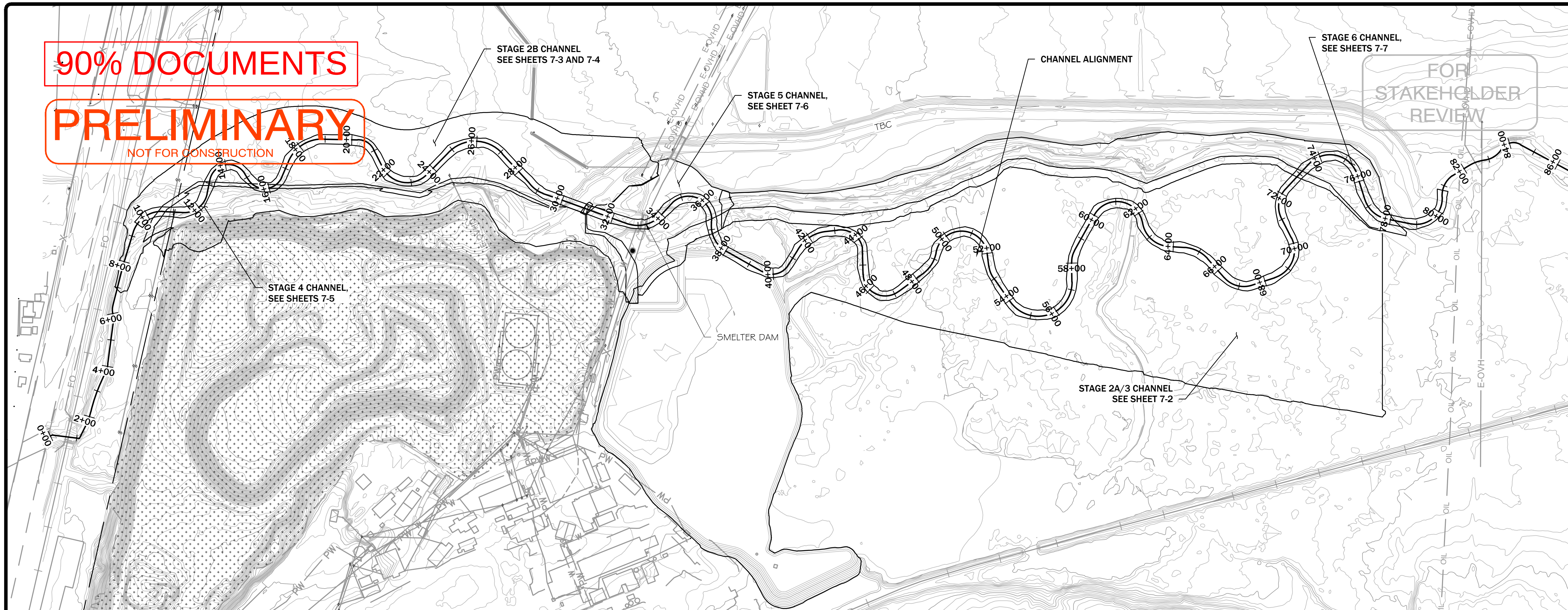
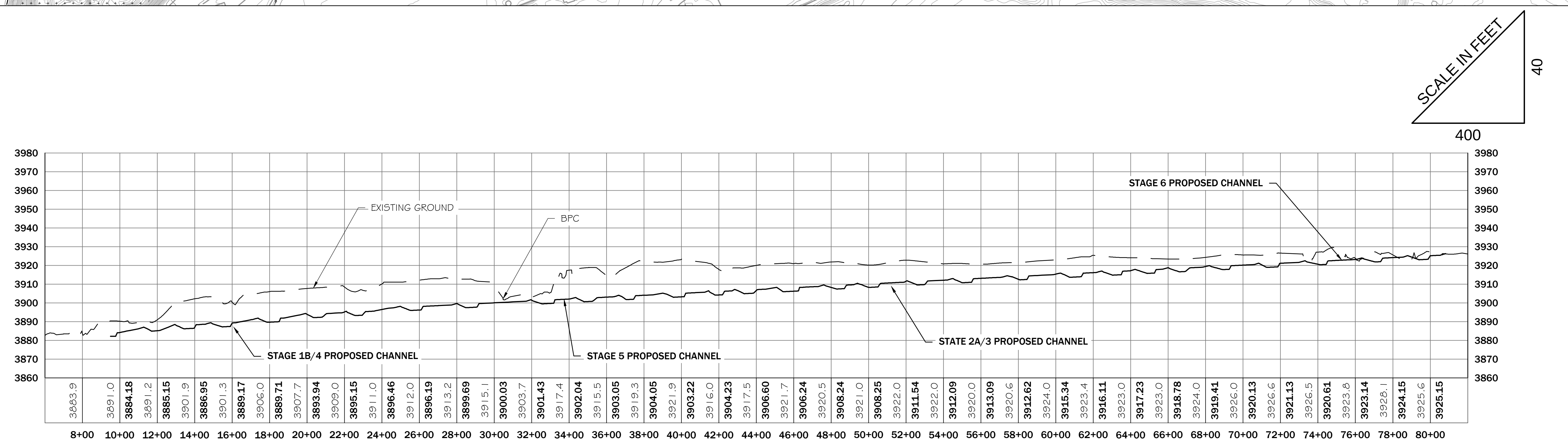
(406) 457-8252

SHEET
6-1





REVISION:
DATE: BY: DESC:

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DESIGNED BY: GEA
CHECKED BY: CEB
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

N
SCALE IN FEET
0 200 400

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
CHANNEL RECONSTRUCTION PLAN AND PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
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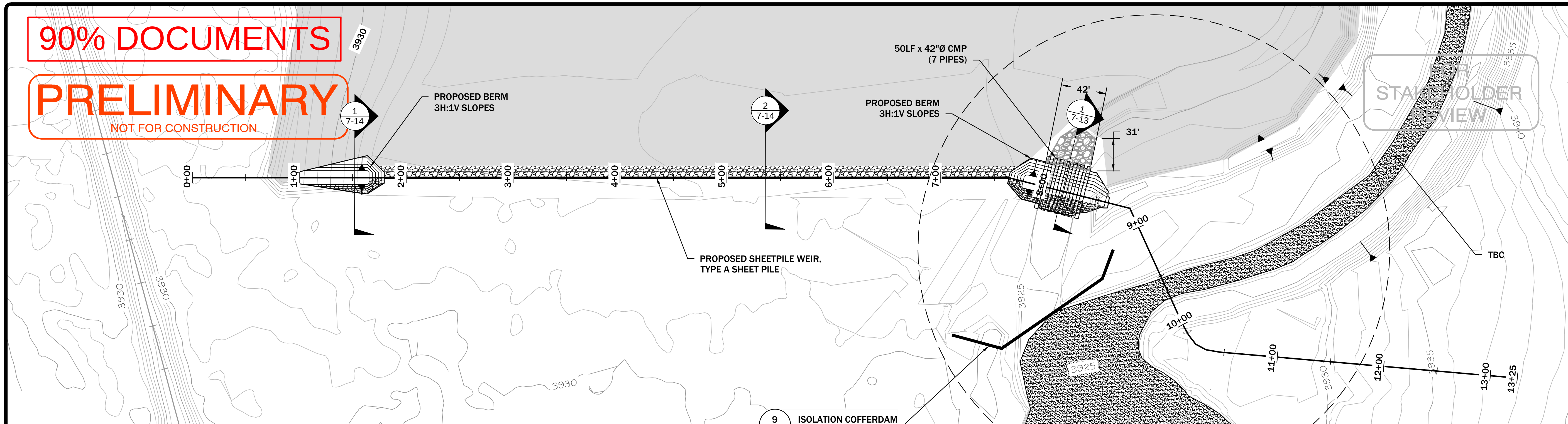
(406) 457-8252

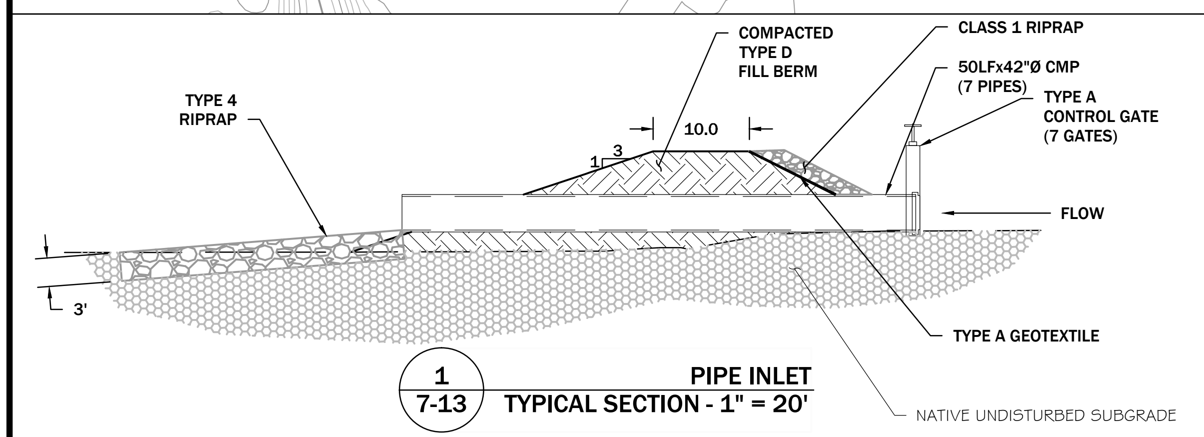
SHEET
7-1

90% DOCUMENTS

PRELIMINARY

NOT FOR CONSTRUCTION

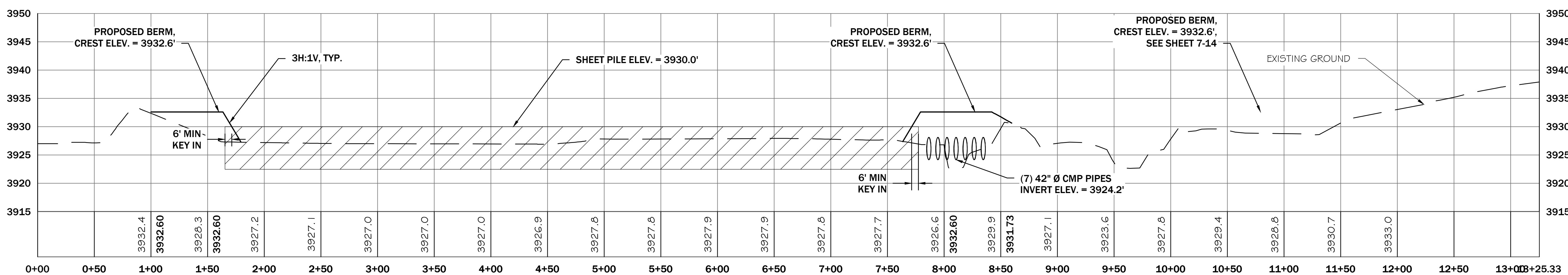




1
7-13
PIPE INLET
TYPICAL SECTION - 1" = 20'

NOTES:

1. CONSTRUCT SHEETPILE WEIR, PROPOSED BERM ON WEST SIDE OF FLOODPLAIN.
2. CONSTRUCT TEMPORARY COFFERDAM TO DIRECT ALL FLOW INTO TBC AWAY FROM ACTIVE WORK AREA DURING LOW FLOW CONDITIONS.
3. INSTALL BASEFLOW PIPES AND COMPACTED FILL BERM WITH GATES CLOSED.
4. REMOVE TEMPORARY COFFERDAM



SCALE IN FEET

20

100

REVISION:

DATE: BY: DESC:

DRAWN BY: JJJ

DESIGNED BY: CEB

CHECKED BY: GEA

APPROVED BY: JG

PROJECT NO:

DATE: 10/1/14

DISPLAYED AS:

COORD SYS/ZONE: MSP

DATUM: NAD83

UNITS: INT. FEET

SOURCE: PIONEER

SCALE IN FEET

0 50 100

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT

PPC INLET
STAGE 1
PLAN AND PROFILE

PIONEER
TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
7-13

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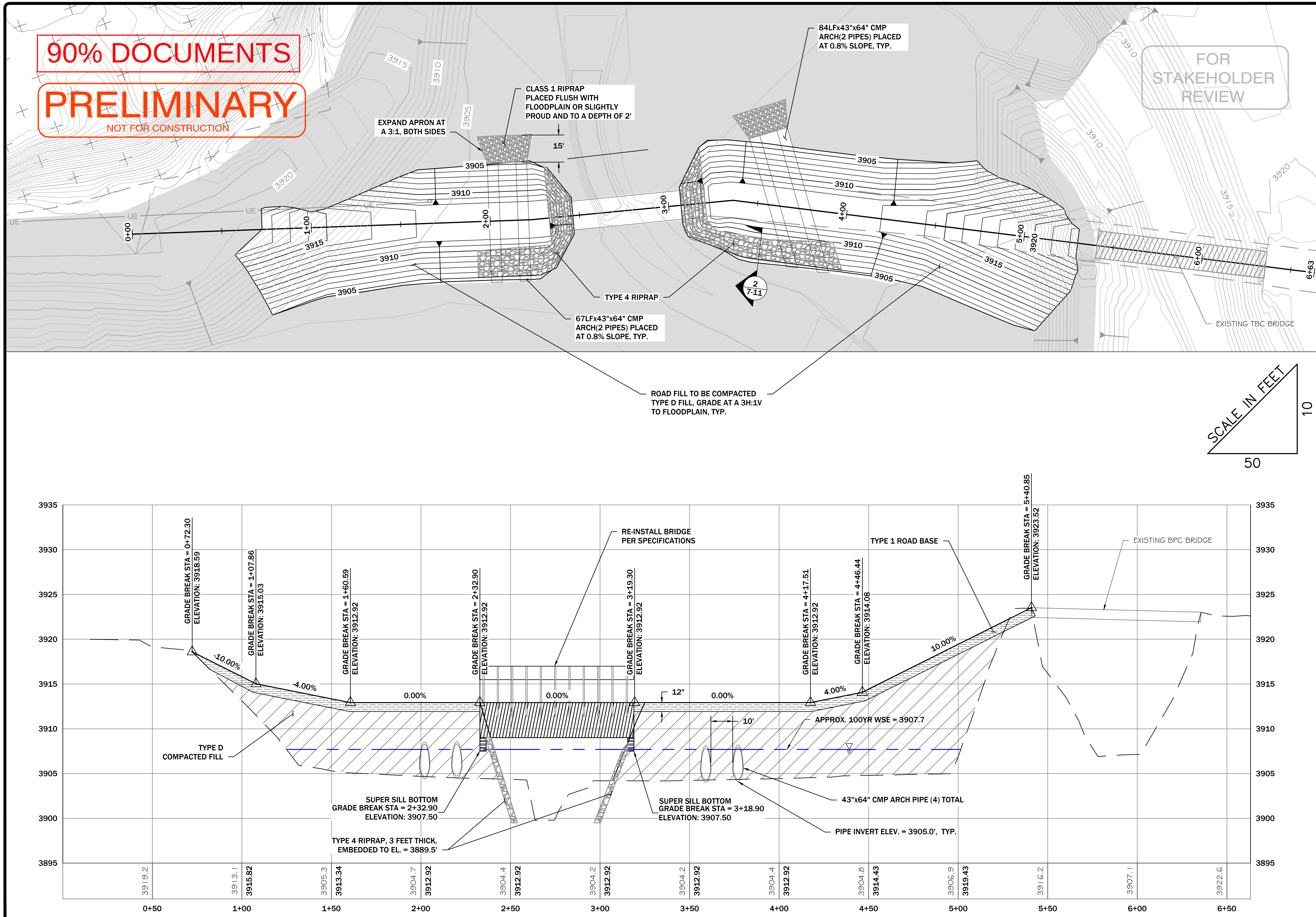

REVISION:
DATE: BY: DESC:

DRAWN BY: JJJ
DESIGNED BY: CEB
CHECKED BY: GEA
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

SCALE IN FEET
0 50 100

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
SMELTER DAM BRIDGE PLACEMENT

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
7-17

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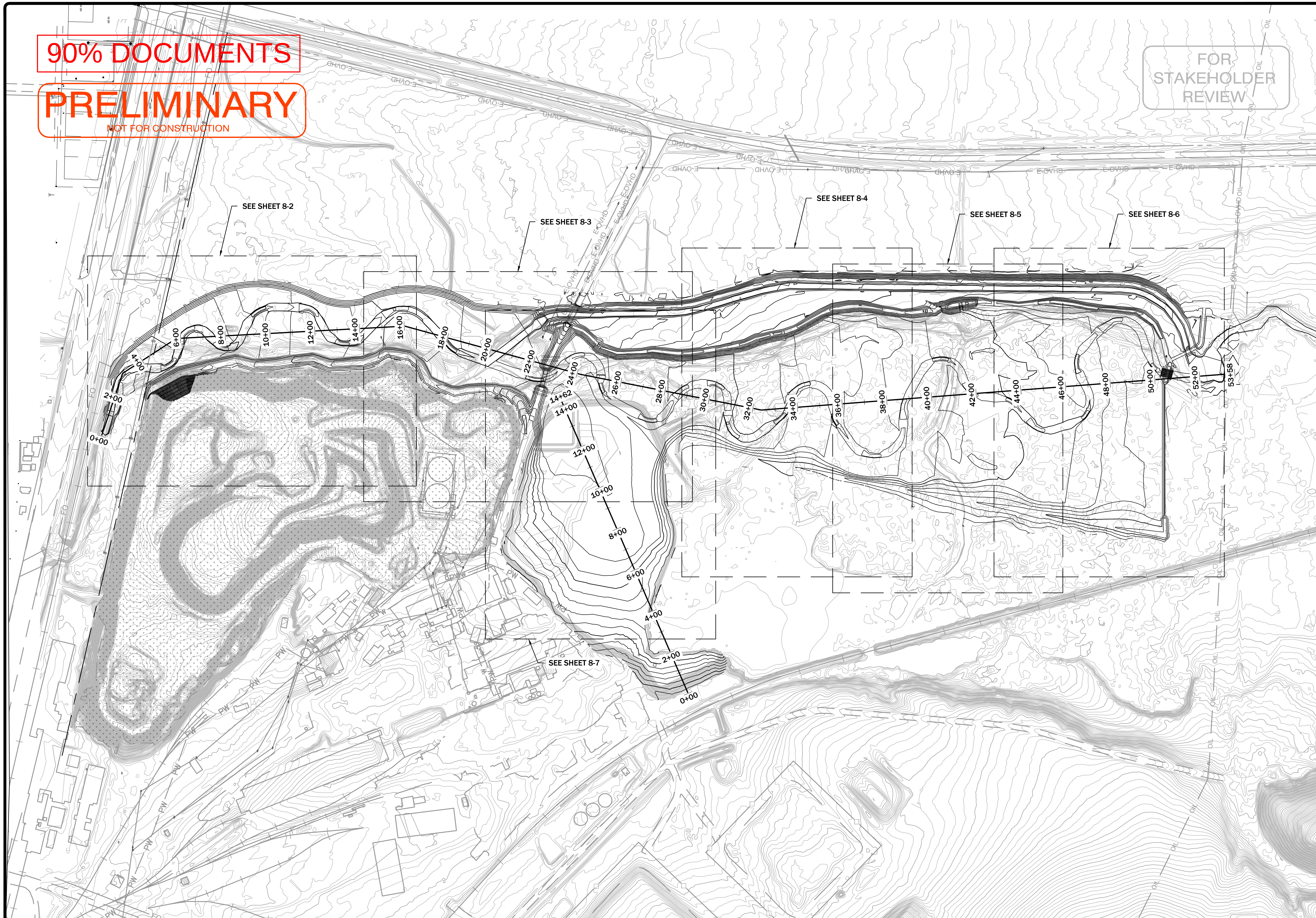

REVISION:
DATE: BY: DESC:

DRAWN BY:	JJJ
DESIGNED BY:	GEA
CHECKED BY:	CEB
APPROVED BY:	JG
PROJECT NO:	
DATE:	10/1/14

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DATUM:	NAD83
UNITS:	INT. FEET
SOURCE:	PIONEER

SCALE IN FEET
0 200 400

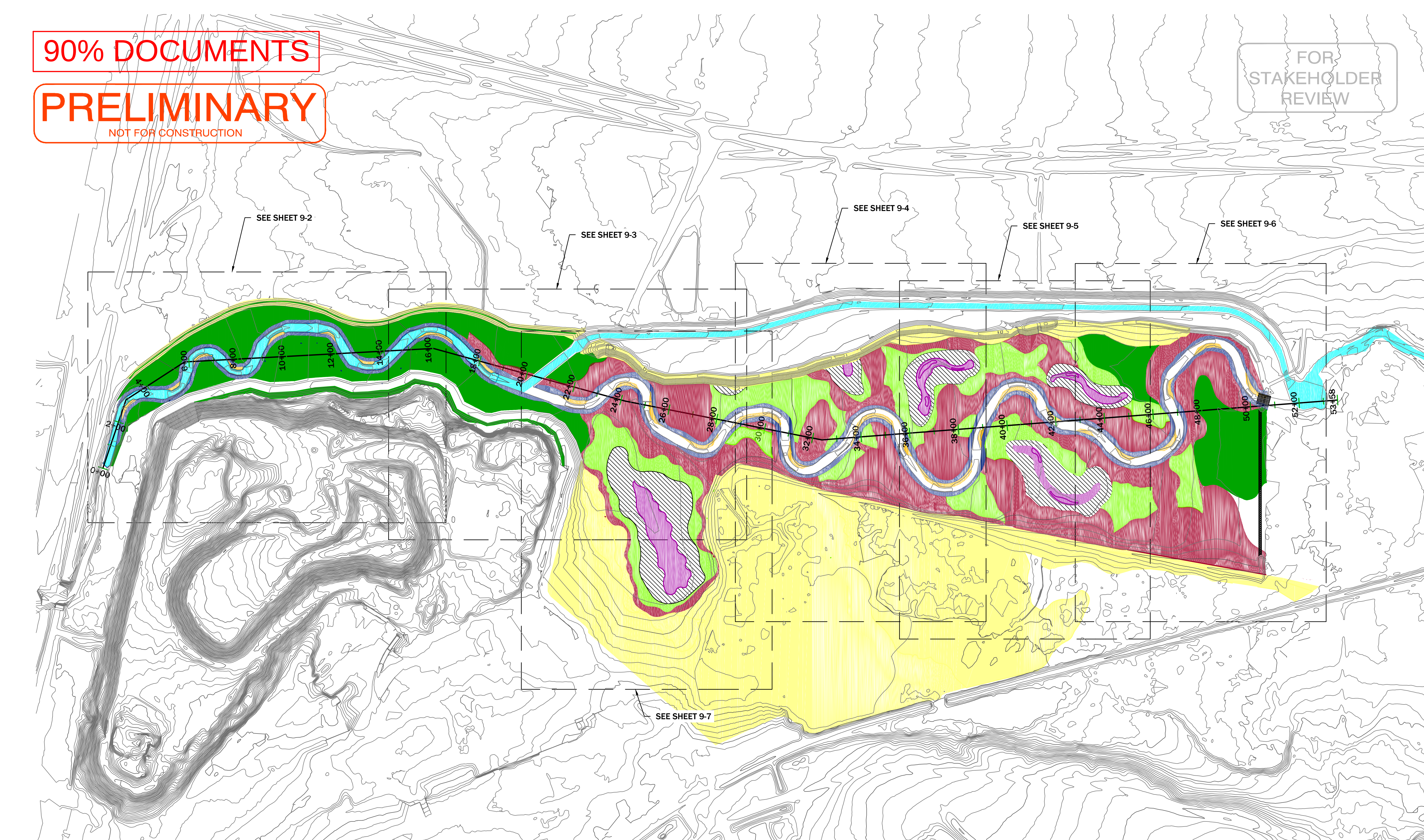
MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT

FINAL GRADING OVERALL PLAN VIEW

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
8-1



Legend

SUBMERGENT AREAS -1' TO -2' BELOW 2YR FLOW (1.90 ACRES)	SCRUB/SHRUB AREAS 0' TO 1' ABOVE 2YR FLOW (19.40 ACRES)
EMERGENT 1 AREAS 0' TO -1' BELOW 2YR FLOW (5.42 ACRES)	UPLAND HABITAT AREAS (40.52 ACRES)
EMERGENT 2 AREAS 0' TO 0.5' ABOVE 2YR FLOW (9.39 ACRES)	COLONIZING DEPOSITIONAL
RIPARIAN AREAS (11.77 ACRES)	RIPARIAN BUFFER (5.01 ACRES)

NOTE:
1. GROUNDWATER ELEVATION BASED ON 2-28-13 POST SPHC ESTIMATE EQUAL TO APPROXIMATELY 2' BELOW Q2.
2. PROPOSED RE-ALIGNED PPC SHOWN AT A FLOW OF 50 CFS.

NOTES:
1. SEED AND PLANT INDIVIDUAL HABITATS ACCORDING TO SPECIAL PROVISIONS AND TECHNICAL SPECIFICATIONS.
2. ALL FLOODPLAIN HABITAT AREAS SHALL BE BOTH DRILL SEEDED AND BROADCAST SEEDED.
3. STAGING AREA AND ALL ANCILLARY DISTURBANCE AREAS SHALL BE SEEDED WITH UPLAND SEED MIXTURE UNLESS OTHERWISE DIRECTED BY ENGINEER.
4. SLOPES STEEPER THAN 3:1 SHALL BE HYDRAULIC SEEDED ACCORDING TO SPECIAL PROVISIONS AND TECHNICAL SPECIFICATIONS.
5. WOODY DEBRIS SHALL BE PLACED UNIFORMLY ACROSS THE FLOODPLAIN FOLLOWING SEEDING AND ACCORDING TO SPECIAL PROVISIONS.

REVISION:

DATE:	BY:	DESC:

DRAWN BY: JJJ
DESIGNED BY: MES
CHECKED BY: GEA
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

SCALE IN FEET
0 200 400

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
VEGETATION OVERALL PLAN VIEW

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
9-1

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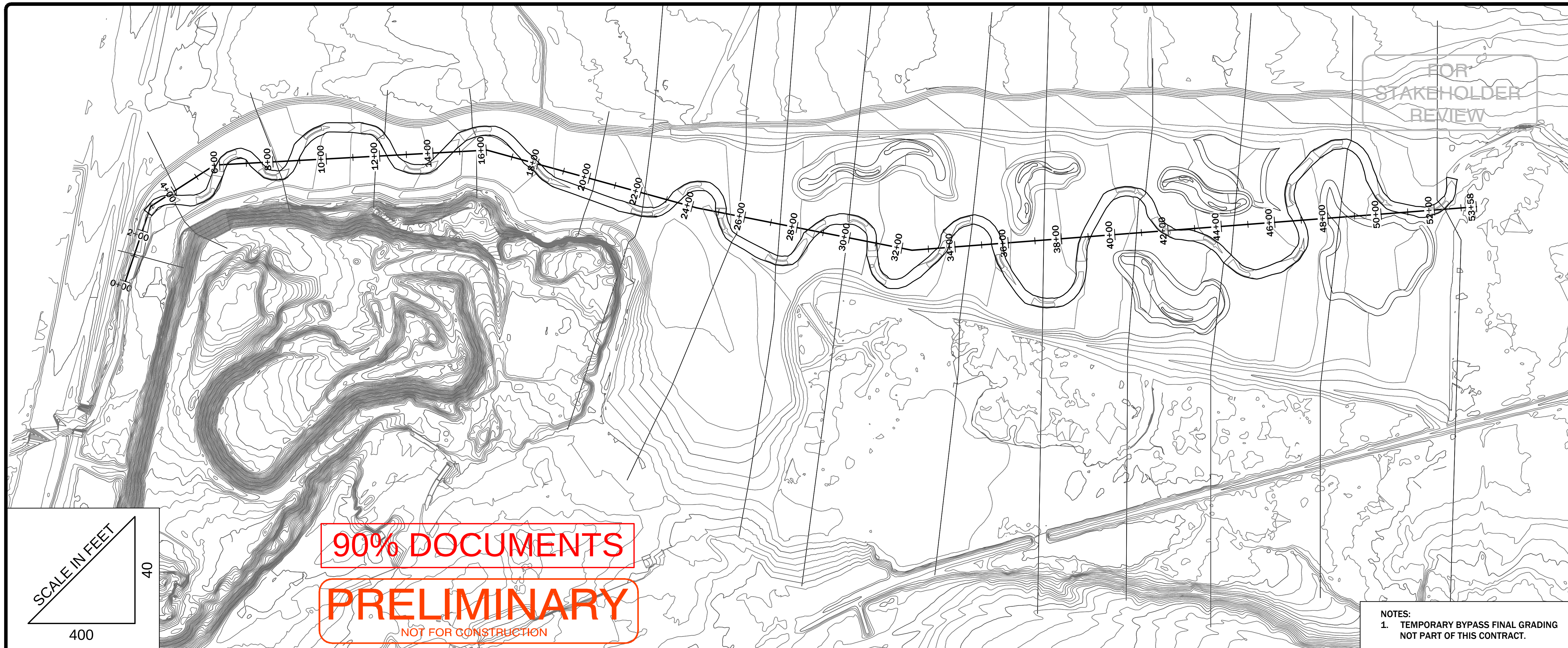
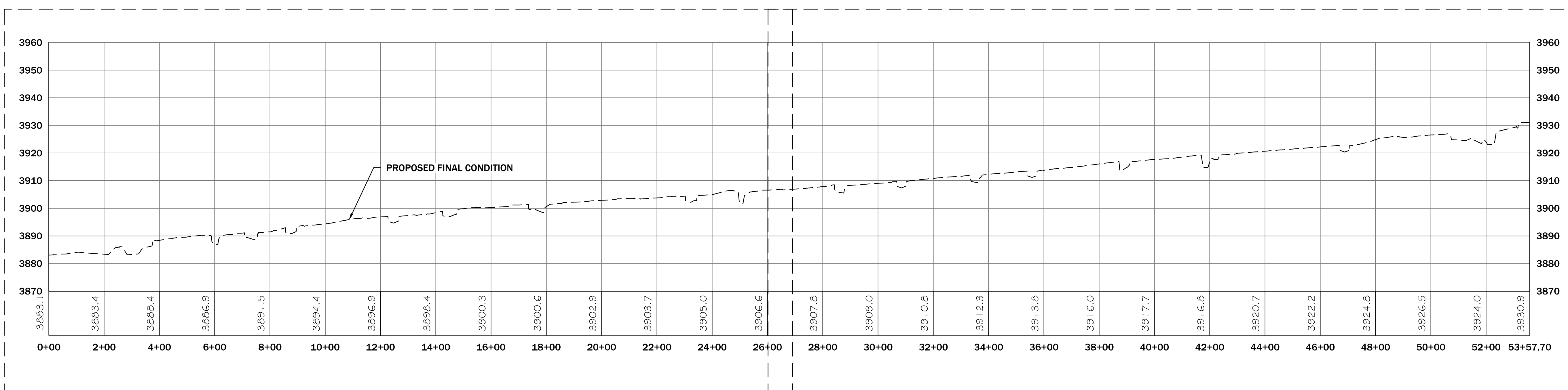


NOTES:
1. TEMPORARY BYPASS FINAL GRADING NOT PART OF THIS CONTRACT.



NORTH PLAN AND PROFILE, SEE SHEET 11-2

SOUTH PLAN AND PROFILE, SEE SHEET 11-3

REVISION:

DATE:	BY:	DESC:

DRAWN BY: JJJ
DESIGNED BY: CEB
CHECKED BY: GEA
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

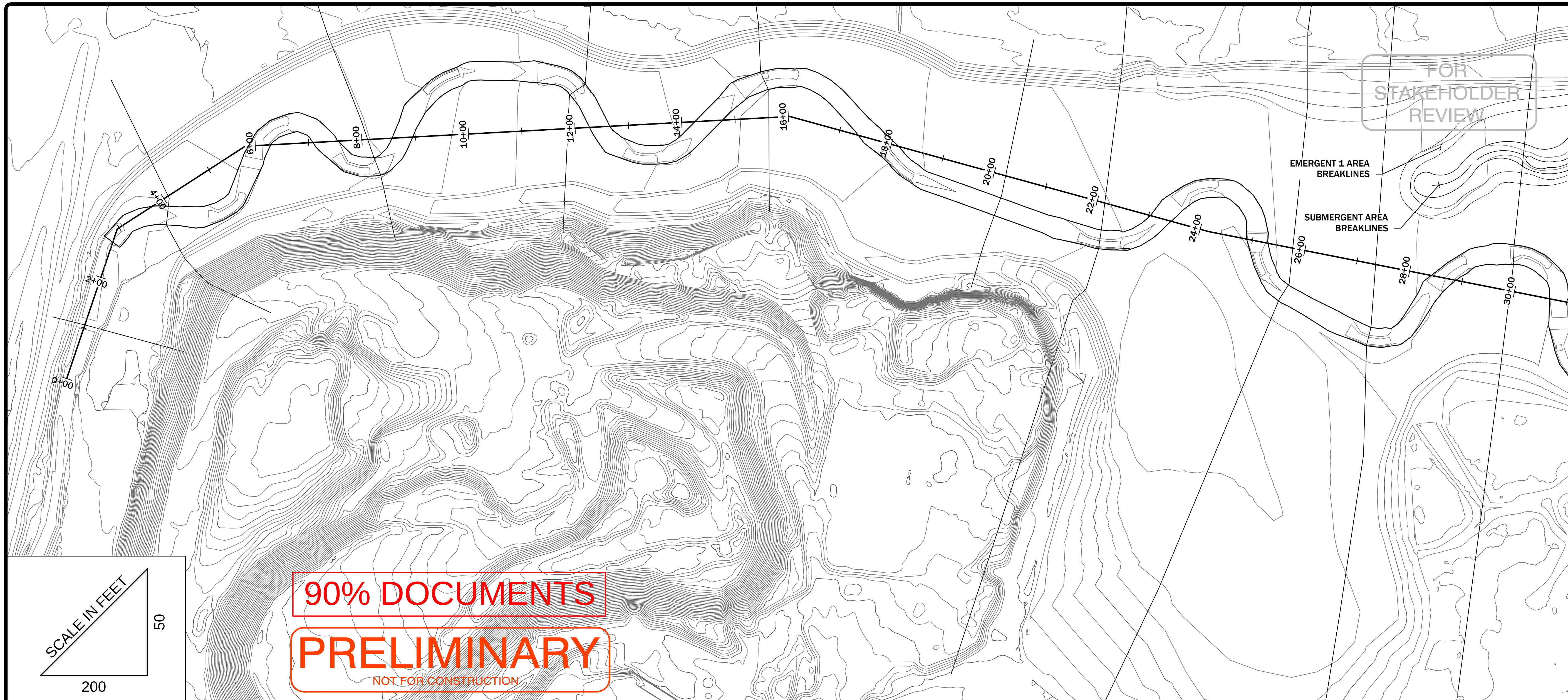
SCALE IN FEET
0 200 400

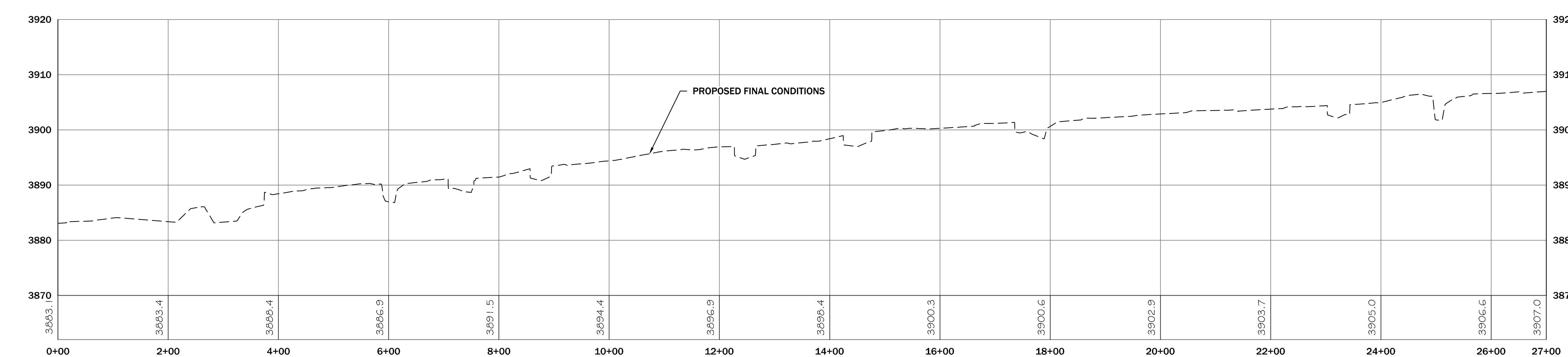
MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
PROJECT COMPLETION GRADING OVERVIEW PLAN & PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET 11-1





REVISION:

DATE:	BY:	DESC:

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DESIGNED BY: CEB
CHECKED BY: GEA
APPROVED BY: JG
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

N

SCALE IN FEET
0 100 200

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
PROJECT COMPLETION GRADING NORTH PLAN & PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
11-2

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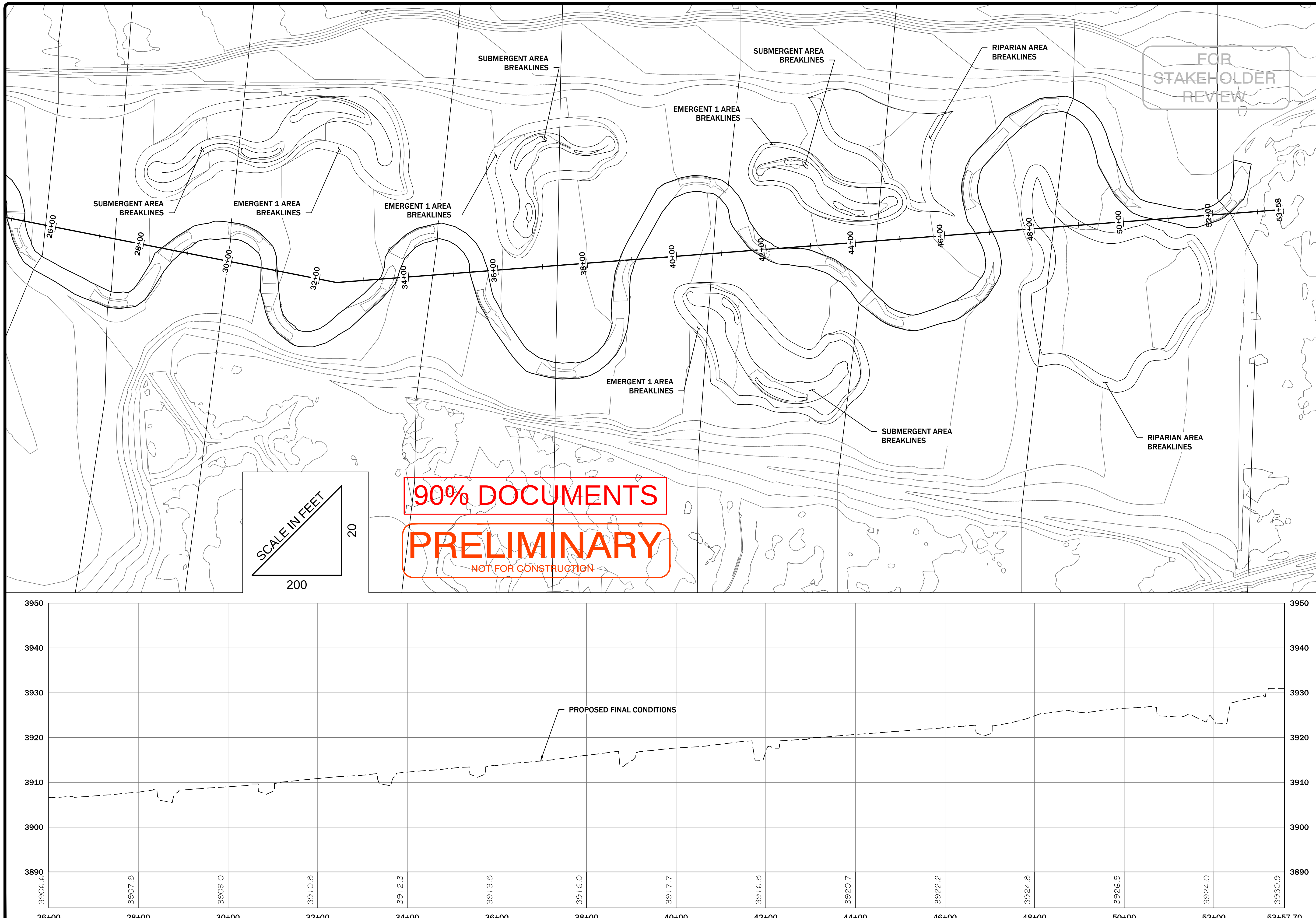

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REVISION: DATE:	BY:	DESC:

DRAWN BY: JJJ
DESIGNED BY: CEB
CHECKED BY: GEA
APPROVED BY: JL
PROJECT NO:
DATE: 10/1/14

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD83
UNITS: INT. FEET
SOURCE: PIONEER

SCALE IN FEET
0 100 200

MONTANA ENVIRONMENTAL TRUST GROUP
FORMER ASARCO SMELTER SITE
EAST HELENA, MONTANA

PRICKLY PEAR CREEK REALIGNMENT
PROJECT COMPLETION GRADING SOUTH
PLAN & PROFILE

PIONEER TECHNICAL SERVICES, INC.
201 E BROADWAY
HELENA, MONTANA 59601
(406) 457-8252

SHEET
11-3

Prickly Pear Creek Technical Specifications List

STANDARD TECHNICAL SPECIFICATIONS FOR PRICKLY PEAR CREEK REALIGNMENT

DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 2 – SITE WORK

SECTIONS 02100 – SITE PREPARATION

SECTIONS 02200 – EARTHWORK

SECTIONS 02300 – RIPRAP AND GABIONS

SECTIONS 02400 – CONSTRUCTION FABRICS

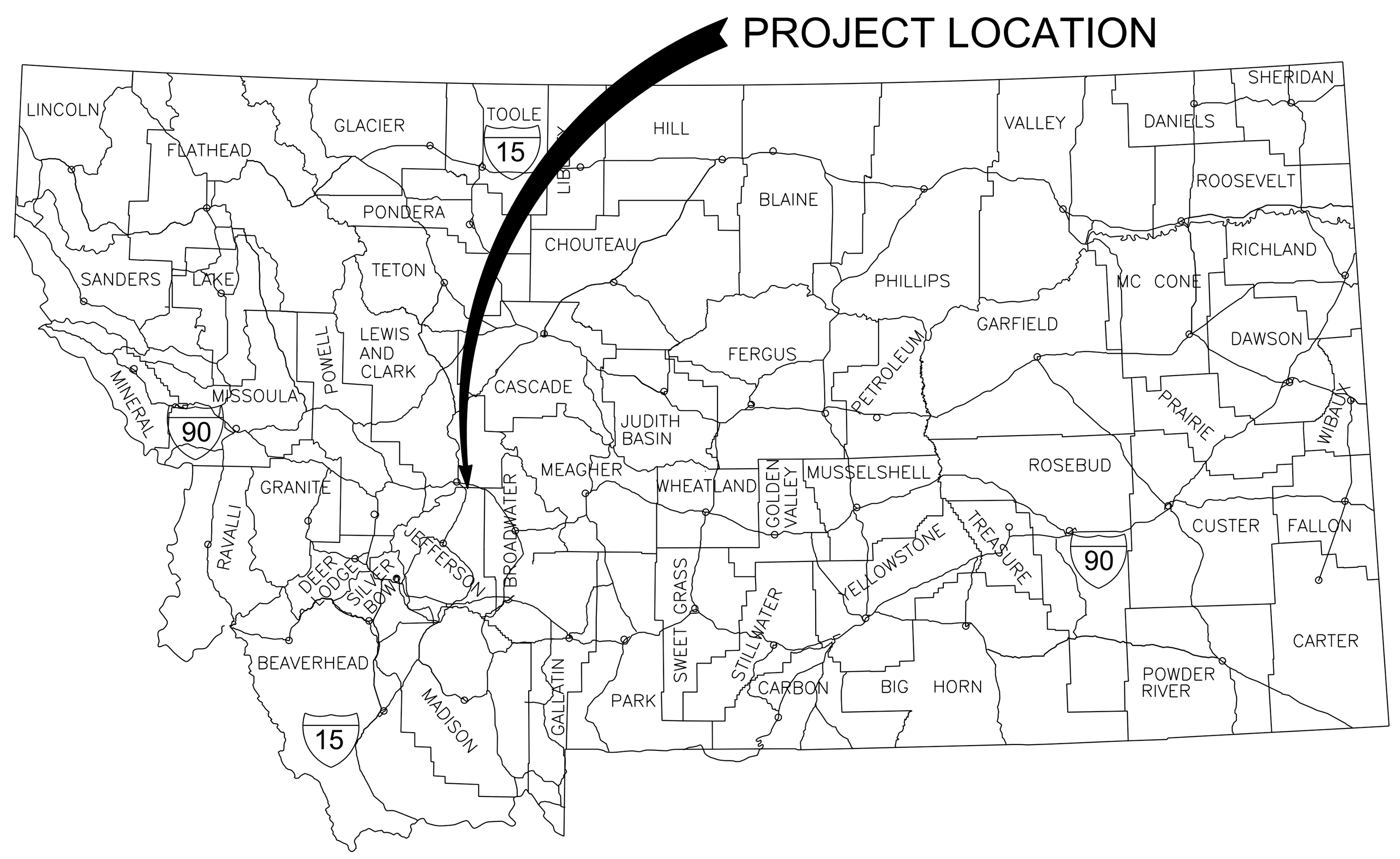
Notes:
*Refer to the Montana Public Works Standard Specification, most recent edition.

Prickly Pear Creek List of Available Documents

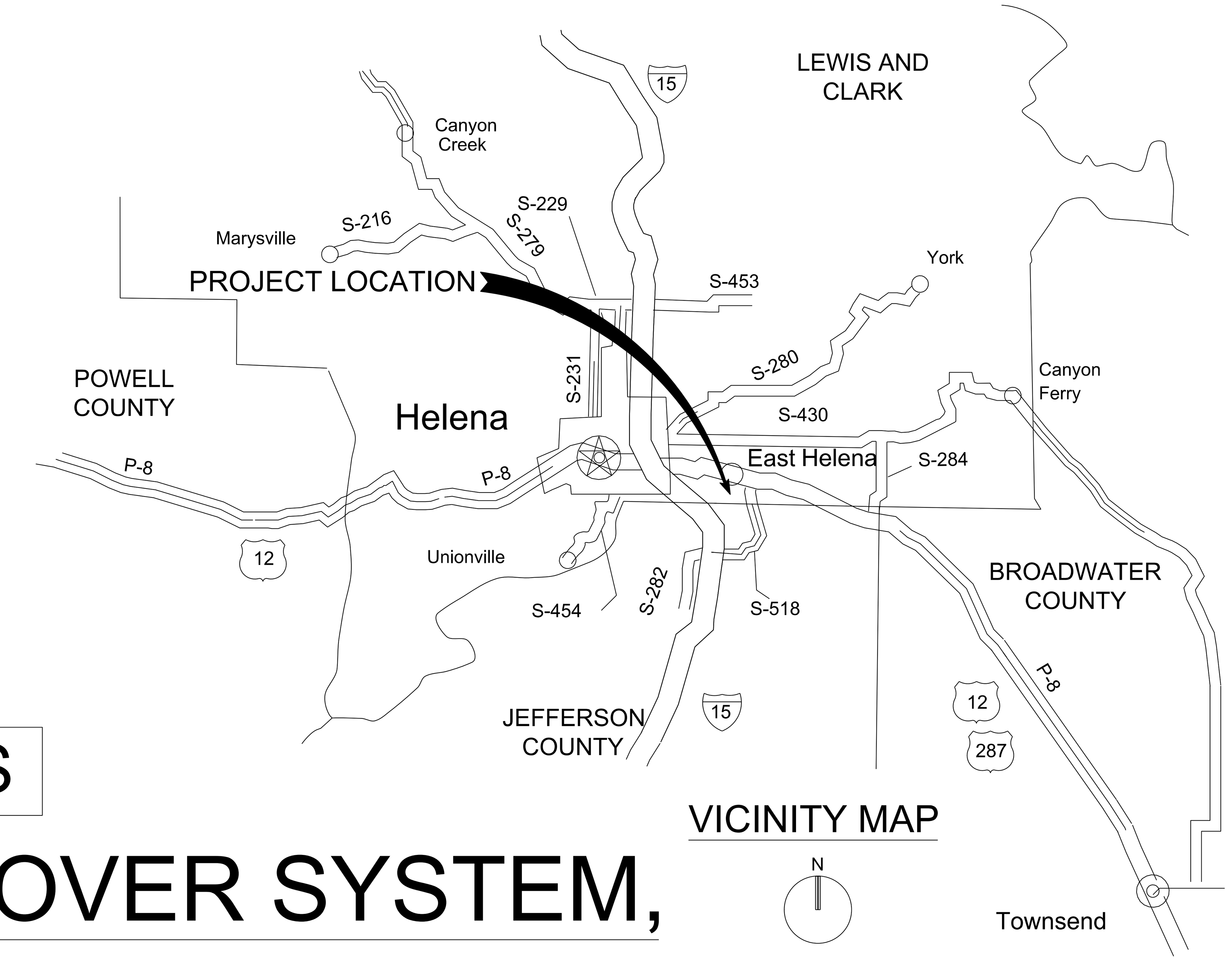
List of Available Documents used in Prickly Pear Creek Realignment and Wetland Design

- Joint Application No. 2 Binder
  - Application Form
  - Compensatory Mitigation Report
  - Design Documents (see List Below)
  - Design Basis Documents on CD (see List Below)
- Design Documents (Included in Joint Application No. 2, Provided in Hard Copy to Stakeholders)
  - Special Provisions
  - Technical Specifications
  - Drawings
- Design Basis Documents (Provided on CD with Joint Application No. 2 and to all Stakeholders with Design Documents)
  - Baseline Reports
    - Initial Wetlands Delineation Report
    - Baseline Stream Assessment Report
    - Photos, Forms, and Assessments
    - Wildlife Species/T&E Documentation
  - Conceptual Design Report
    - Goals and Objectives
    - Basic Design Criteria
    - Sediment Continuity Analysis
    - Baseline Calculation Summaries (hydrology, hydraulics, sediment transport, etc.)
  - Additional Technical Memos
    - East Helena Geomorphic Assessment and Sediment Transport Analysis
    - Construction Sequencing Options
    - Temporary Bypass Use
    - Slag Pile Regrading Options
    - Plant Salvage
    - Materials Balance
    - Geotechnical/Soils Investigations
  - Even More Calculation Summaries
    - Basic Design Calculations – Scour, Riprap Sizing, Filter, Fish Passage, etc.
    - Temporary Bypass Inlet Design Calculations
    - Updated Sediment Continuity Analysis
    - Conditional Letter of Map Revision No. 2 Floodplain Modeling Technical Memorandum
  - Comments and Responses to Comments on 60 percent Design

Select Evapotranspiration Cover System, Interim Cover System 2, and Demolition Phase 3 Design Drawings



LOCATION MAP



VICINITY MAP

60% DRAWINGS

EVAPOTRANSPIRATION (ET) COVER SYSTEM, INTERIM COVER SYSTEM 2 (ICS 2) AND DEMOLITION PHASE 3 FORMER ASARCO EAST HELENA FACILITY

INDEX OF DRAWINGS

GENERAL

SHEET NO.	DRAWING NO.	DRAWING TITLE
1	G-1	TITLE, LOCATION AND VICINITY MAP, INDEX OF DRAWINGS
2	G-2	LEGENDS, ABBREVIATIONS, SYMBOLS AND GENERAL NOTES
3	G-3	OVERALL SITE PLAN

CIVIL AND DEMOLITION

SHEET NO.	DRAWING NO.	DRAWING TITLE
4	C-1	OVERALL INTERIM COVER GRADING AND SEQUENCING PLAN 2015
5	C-2	OVERALL ET COVER GRADING AND SEQUENCING PLAN PHASE 2015
6	C-3	OVERALL INTERIM COVER GRADING AND SEQUENCING PLAN 2016
7	C-4	OVERALL ET COVER GRADING AND SEQUENCING PLAN PHASE 2016
8	C-5	PERIMETER ROAD PLAN AND PROFILE 1
9	C-6	PERIMETER ROAD PLAN AND PROFILE 2
10	C-7	PERIMETER ROAD PLAN AND PROFILE 3
11	C8	GRADING PLAN 1 OF 4
12	C-9	GRADING PLAN 2 OF 4
13	C-10	GRADING PLAN 3 OF 4
14	C-11	GRADING PLAN 4 OF 4
15	C-12	SECTIONS
16	C-13	CIVIL DETAILS 1 OF 2
17	C-14	CIVIL DETAILS 2 OF 2
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21	C-18	DRAINAGE PLAN - FINAL ET COVER
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25	EC-1	TEMPORARY EROSION AND STORMWATER PLAN
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38	D-10	MONITORING WELL LOCATIONS

Note: The index of drawings summarized below lists the design drawings that will be included in the final design and bid package; however, only a portion of those are included in this appendix for review. The attached drawings are highlighted in yellow.

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NO.	DATE	REVISION	BY	APVD
B	11/07/14	60 PERCENT DESIGN	NB	JD
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ET COVER SYSTEM, ICS 2, AND DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

TITLE, LOCATION AND VICINITY MAP, INDEX OF DRAWINGS

NTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	G-1
SHEET	1 OF 38

FILENAME: P043G001D_467300.dgn PLOT DATE: 2014\11\07 PLOT TIME: 1:59:24 PM

ABBREVIATIONS

ADDL	ADDITIONAL
ADJ	ADJACENT
APPROX	APPROXIMATE
APSD	ACID PLANT SEDIMENT DRYING
AS	ACTION SUBMITTAL
BG	BELOW GRADE
BM	BEAM, BENCHMARK
BOT	BOTTOM
BRG	BEARING
CAMU	CORRECTIVE ACTION MANAGEMENT UNIT
CDN	COMPOSITE DRAINAGE NET
CIP	CAST IN PLACE
CL	CENTERLINE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CONC	CONCRETE
CONT	CONTINUED, CONTINUATION
COORD	COORDINATE
CTR	CENTER
CTRD	CENTERED
CU	CUBIC
CY, CU YD	CUBIC YARD
DET	DETAIL
DIA	DIAMETER
DWG	DRAWING
E	EAST
EA	EACH
EL	ELEVATION
ELC	ELECTRICAL LOAD CENTER
ESC	EROSION AND SEDIMENT CONTROL
EW	EACH WAY
EXC	EXCAVATION
EXST, EXIST	EXISTING
EXT	EXTERIOR
FG	FINISH GRADE
FL	FLOW LINE
FLEX	FLEXIBLE
FT	FOOT OR FEET
FWD	FORWARD
G, GND	GROUND
GALV	GALVANIZED
GM	GEOMEMBRANE
GPM	GALLONS PER MINUTE
GVL	GRAVEL
HDS	HIGH DENSITY SLUDGE
HORIZ	HORIZONTAL
IAW	IN ACCORDANCE WITH
ICS	INTERIM COVER SYSTEM
IE	INVERT ELEVATION
IN	INCH(ES)
INVT	INVERT
IS	INFORMATION SUBMITTAL
L	ANGLE, LENGTH
LF	LINEAR FEET
LG	LONG
LGP	LOW GROUND PRESSURE
LL	LOWER LAKE
LOC	LOCATION
LONG	LONGITUDINAL
LPT	LOW POINT
MATL	MATERIAL
MAX	MAXIMUM
MDT	MONTANA DEPARTMENT OF TRANSPORTATION
MFR	MANUFACTURER
MIL	$\frac{1}{1000}$ OF 1 INCH
MIN	MINIMUM
MISC	MISCELLANEOUS
N	NORTH
NA	NOT APPLICABLE
NEUT	NEUTRAL
NO.,#	NUMBER
NOM	NOMINAL
N-S	NORTH - SOUTH
NTS	NOT TO SCALE
OD	OUTSIDE DIAMETER
OZ	OUNCE
PCF	POUNDS PER CUBIC FOOT
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
PLS	PROFESSIONAL LAND SURVEYOR
PNL	PANEL
POC	POINT OF CONTACT
PPC	PRICKLY PEAR CREEK
PRI	PRIMARY
PROP	PROPERTY
RDCR	REDUCER
REF	REFER OR REFERENCE
PSI	POUNDS PER SQUARE INCH
PT	POINT
PVC	POLYVINYL CHLORIDE
REQD	REQUIRED
RPE	REINFORCED POLYETHYLENE
R/W	RIGHT OF WAY
SCHED	SCHEDULE
SEC	SECONDARY
SF	SQUARE FEET
SH	SHEET
SIM	SIMILAR
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
STD	STANDARD
SY	SQUARE YARDS
TECH	TECHNICAL
TEMP	TEMPORARY, TEMPERATURE
THK	THICKNESS
THRU	THROUGH
TPA	TITO PARK AREA
TYP	TYPICAL
UL	UPPER LAKE
UON	UNLESS OTHERWISE NOTED
UOSA	UPPER ORE STORAGE AREA
UV	ULTRAVIOLET
VERT	VERTICAL
VVL	VALLEY VIEW LANDFILL
W	WEST
WTP	WATER TREATMENT PLANT
W/	WITH

NOTES:

1. CONTACT CONTRACTOR FOR ABBREVIATIONS USED BUT NOT SHOWN ON THIS DRAWING

GENERAL NOTES:

1. SOURCE OF TOPOGRAPHY FOR EXISTING GROUND IN ICS 1, THE FORMER TITO PARK AREA, THE FORMER LOWER LAKE AREA, AND THE WEST FIELDS BORROW AREA ARE BASED ON A GROUND SURVEY CONDUCTED BY HELENA SAND AND GRAVEL DATED NOVEMBER XX, 2014. SOURCE OF TOPOGRAPHY FOR OTHER AREAS, IS AN AERIAL SURVEY CONDUCTED DJ&A, P.C. BETWEEN AUGUST AND OCTOBER 2011. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS. VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION.
2. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED.
3. HORIZONTAL DATUM: NAD 83, MONTANA STATE PLANE COORDINATE SYSTEM, INTERNATIONAL FEET.
4. VERTICAL DATUM: N.A.V.D. 88, U.S. SURVEY FEET.
5. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE SUBCONTRACTOR'S EXPENSE.
6. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
7. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE NOTED.
8. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
9. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE MAINTAINED AND INSPECTED AS STATED IN THE APPROVED EROSION AND SEDIMENTATION PLAN APPROVED IN THE STORMWATER DISCHARGE PERMIT.
10. COMPLY WITH THE FIELD SAFETY INSTRUCTIONS (FSI) APPROVED FOR THIS SITE AT ALL TIMES.
11. EXISTING SITE DRAINAGE FLOW PATTERNS/DIRECTIONS SHALL BE MAINTAINED UNLESS OTHERWISE INDICATED ON THE PLANS.
12. CONSTRUCTION ACTIVITY BY OTHERS MAY IMPACT THE WORK IN THIS PACKAGE. COORDINATE WITH OTHERS AS SPECIFIED. NOTIFY THE CONTRACTOR IMMEDIATELY IF A CONFLICT ARISES RELATING TO THE PROGRESS OF THE WORK. FINAL COORDINATION/RESOLUTION OF SUCH CONFLICTS SHALL BE THE RESPONSIBILITY OF THE SUBCONTRACTOR.
13. EXISTING FEATURES AND UTILITIES ARE SHOWN ON THE PLANS BASED UPON INFORMATION AVAILABLE AT THE TIME THE PLANS WERE PREPARED. SHOULD UNIDENTIFIED UTILITY OR SERVICE ELEMENTS BE ENCOUNTERED, NOTIFY THE CONTRACTOR AND THE APPROPRIATE UTILITY OWNER IMMEDIATELY.
14. ACCESS TO THE GENERAL SITE, AND TO SPECIFIC WORK AREAS SHALL BE LIMITED TO THE LOCATIONS SHOWN ON THE PLANS.
15. WATER FOR CONSTRUCTION ACTIVITIES SHALL BE OBTAINED BY THE SUBCONTRACTOR AT THEIR SOLE EXPENSE. ANY AND ALL PERMITS REQUIRED SHALL BE THE RESPONSIBILITY OF THE SUBCONTRACTOR.

REFERENCE SYMBOLS

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET)

A

3 C-9

ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

SHEET/DRAWING NUMBER WHERE SHOWN

B C-1 SECTION SCALE

ON DRAWING WHERE SECTION IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN

2 C-3 DETAIL SCALE

ON DRAWING WHERE DETAIL IS SHOWN:

DRAWING NUMBER(S) WHERE TAKEN

DRAWING TITLE SCALE

ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (eg: ELEVATIONS)

A — SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

A C-7 — SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

1 — KEYED NOTES

A1 — ALIGNMENT CURVE NUMBER

1 — REVISION NUMBER

N — NORTH ARROW

CIVIL LEGEND

EXISTING	THIS CONTRACT	
× 157.7	⊗ 158.5	SPOT ELEVATION
155	155	CONTOUR LINE
	3:1	EMBANKMENT AND SLOPE
		DRAINAGEWAY OR DITCH
	CB OR CB	CATCH BASIN OR INLET
		TRENCH DRAIN
	OR	SIGN
	D OR P	MANHOLE D = STORM DRAIN P = PLANT
	° BM	BENCH MARK
	△	SURVEY CONTROL POINT OR POINT OF INTERSECTION
		BRUSH/TREE LINE
		TREE
		PROPERTY LINE
		CENTER LINE, BUILDING, ROAD, ETC.
		STAGING OR WORK AREA LIMITS
	N 1000.00 E 1000.00	STRUCTURE, BUILDING OR FACILITY LOCATION POINT - COORDINATES
OR	OR	STRUCTURE, BUILDING OR FACILITY
		DOUBLE SWING GATE
		CHAIN LINK FENCE
		SILT FENCE
W	W	WATER LINE
PW	PW	PLANT WATER (DRAINAGE)
	CU	BURIED INSTRUMENT CABLE
		TRACK LINE
		JERSEY BARRIER
W	W	GROUNDWATER MONITORING WELL
G	G	STAFF GAUGE
	⊗	SPOT ELEVATION
		DEMOLISHED STRUCTURES

GENERAL NOTE:

1. THIS IS A STANDARD LEGEND SHEET. THEREFORE, NOT ALL OF THE INFORMATION SHOWN MAY BE USED ON THIS PROJECT.

SURVEY CONTROL POINTS

POINT #	NORTHING, IN FEET	EASTING, IN FEET	ELEVATION, IN FEET	MONUMENT DESCRIPTION
2	859807.77	1358978.72	3931.69	SET - AC
101	858847.195	1359848.197	3935.396	ASARCO - BM1
103	859423.257	1361402.417	3919.772	BRIDGE - STAFFNUT
106	861564.695	1359088.903	3899.418	E-459 USGS
125	859721.970	1360039.615	3913.60	FND - MAGNAIL
250	861078.79	1359099.59	3911.8	SET - REBAR CAP
251	861179.74	1359415.57	3907.15	SET - MAGNAIL
354	858981.56	1362515.45	3923.47	FND 3/4 REBAR

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East Helena, Montana

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ET COVER SYSTEM, ICS 2 AND, DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

LEGENDS, ABBREVIATIONS, SYMBOLS AND GENERAL NOTES

NTS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	G-2
SHEET	2 OF 38

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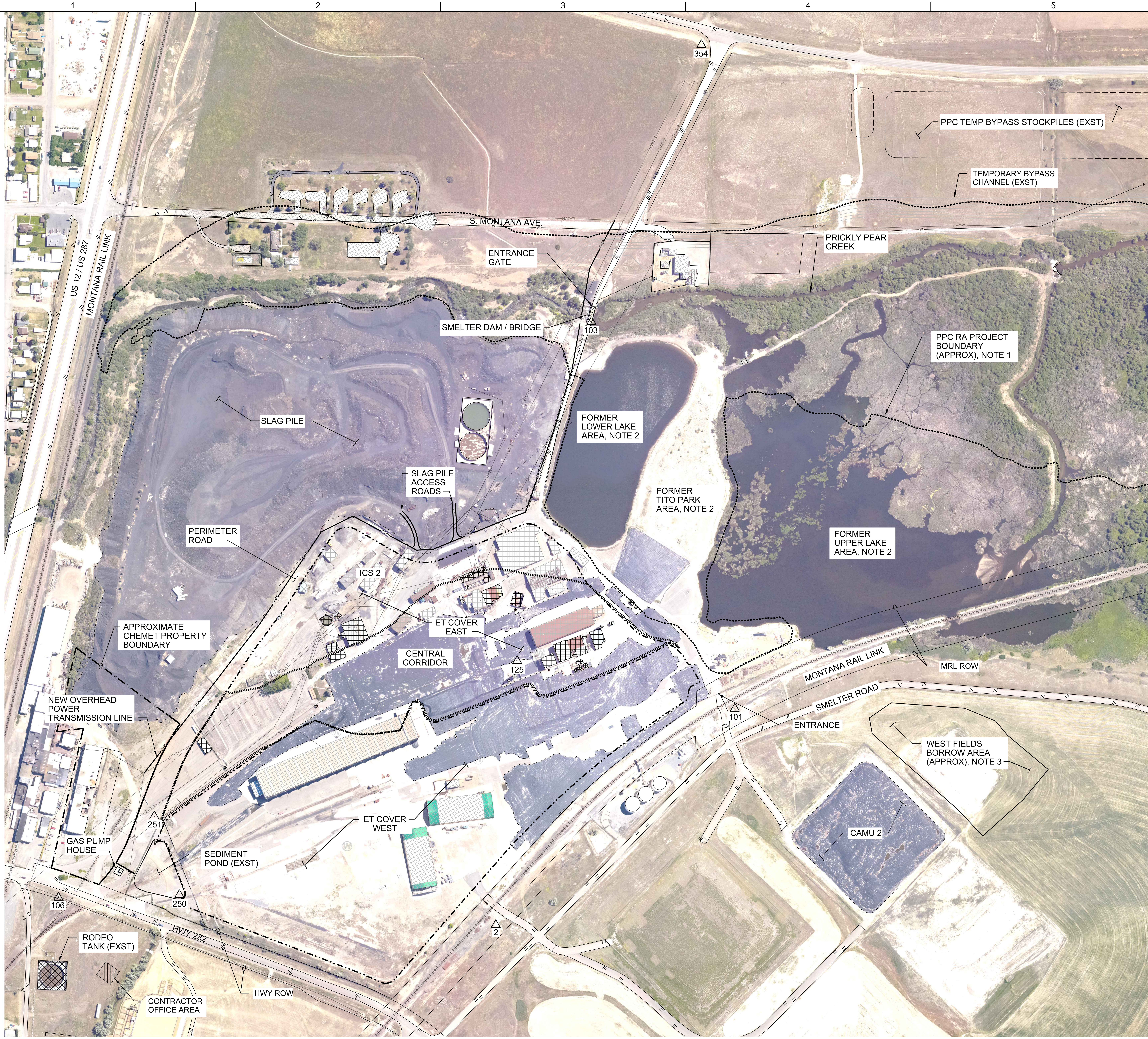

NOTES:

1. THE PPC REALIGNMENT (RA) PROJECT IS NOT INCLUDED IN THIS CONTRACT. COORDINATE WORK WITH THE PPC RA CONTRACTOR AS SPECIFIED.
2. LOWER LAKE, TITO PARK, AND UPPER LAKE WERE REMOVED IN 2014.
3. REFER TO BORROW DRAWINGS FOR MORE DETAIL.

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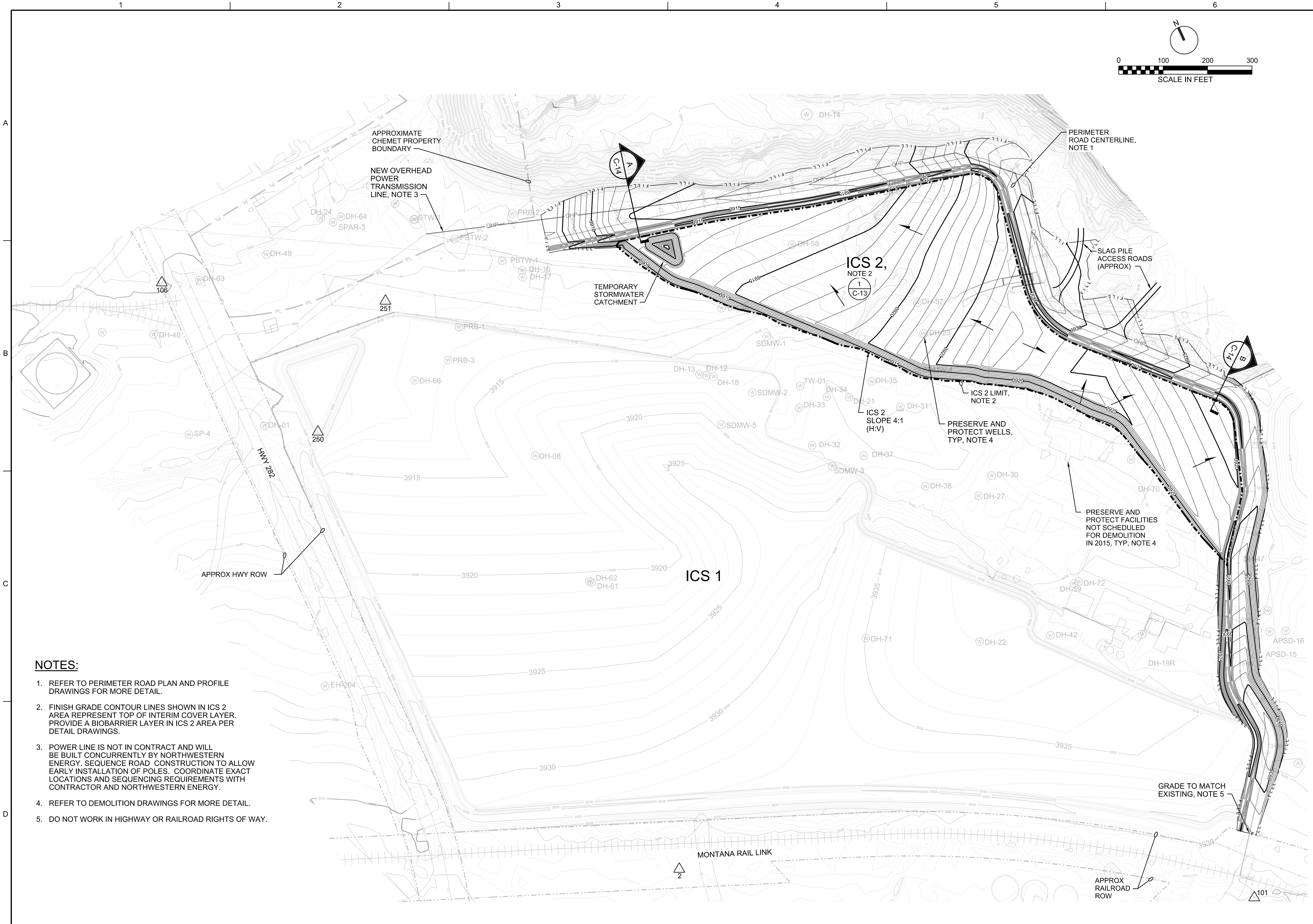
ET COVER SYSTEM, ICS2 AND, DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

OVERALL SITE PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	G-3
SHEET	3 OF 38



NOTES:

1. REFER TO PERIMETER ROAD PLAN AND PROFILE DRAWINGS FOR MORE DETAIL.
2. FINISH GRADE CONTOUR LINES SHOWN IN ICS 2 AREA REPRESENT TOP OF INTERIM COVER LAYER. PROVIDE A BIOBARRIER LAYER IN ICS 2 AREA PER DETAIL DRAWINGS.
3. POWER LINE IS NOT IN CONTRACT AND WILL BE BUILT CONCURRENTLY BY NORTHWESTERN ENERGY. SEQUENCE ROAD CONSTRUCTION TO ALLOW EARLY INSTALLATION OF POLES. COORDINATE EXACT LOCATIONS AND SEQUENCING REQUIREMENTS WITH CONTRACTOR AND NORTHWESTERN ENERGY.
4. REFER TO DEMOLITION DRAWINGS FOR MORE DETAIL.
5. DO NOT WORK IN HIGHWAY OR RAILROAD RIGHTS OF WAY.

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
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A	09/30/14	30 PERCENT DESIGN	NB	JD

DSGN	DR	CHK	APVD
N. BETTS	R. VILORIA	J. SMESRUD	J. DEHNER

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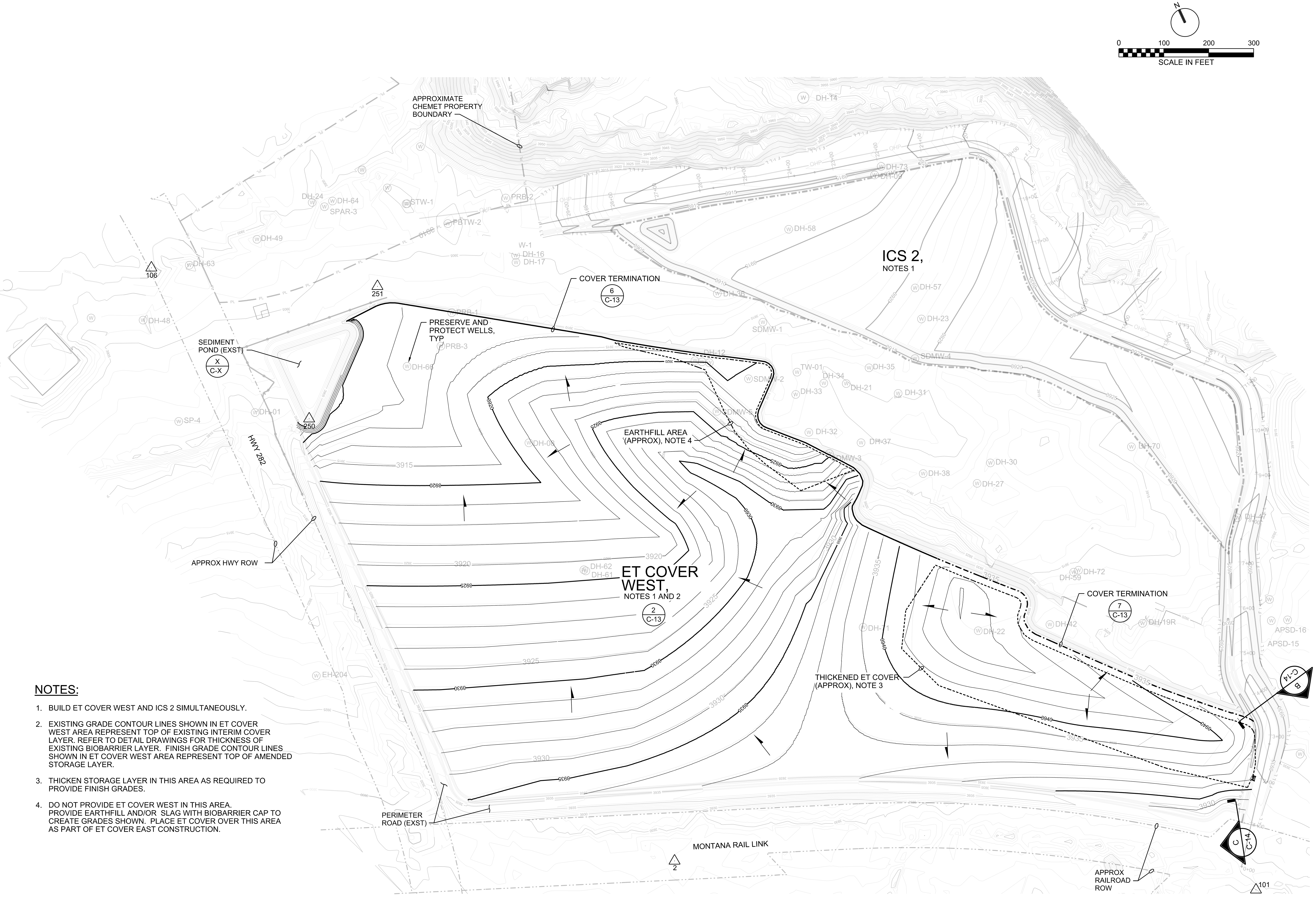
ET COVER SYSTEM, ICS 2 AND, DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

OVERALL INTERIM COVER GRADING AND SEQUENCING PLAN 2015

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	C-1
SHEET	4 OF 38

FILENAME: P043C001D_467300.dgn PLOT DATE: 2014\11\07 PLOT TIME: 8:02:52 AM



NOTES:

1. BUILD ET COVER WEST AND ICS 2 SIMULTANEOUSLY.
2. EXISTING GRADE CONTOUR LINES SHOWN IN ET COVER WEST AREA REPRESENT TOP OF EXISTING INTERIM COVER LAYER. REFER TO DETAIL DRAWINGS FOR THICKNESS OF EXISTING BIOBARRIER LAYER. FINISH GRADE CONTOUR LINES SHOWN IN ET COVER WEST AREA REPRESENT TOP OF AMENDED STORAGE LAYER.
3. THICKEN STORAGE LAYER IN THIS AREA AS REQUIRED TO PROVIDE FINISH GRADES.
4. DO NOT PROVIDE ET COVER WEST IN THIS AREA. PROVIDE EARTHFILL AND/OR SLAG WITH BIOBARRIER CAP TO CREATE GRADES SHOWN. PLACE ET COVER OVER THIS AREA AS PART OF ET COVER EAST CONSTRUCTION.

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A	09/30/14	30 PERCENT DESIGN	NB	JD

DSGN	DR	CHK	APVD
P. KRYCH	R. VILORIA	J. SMESRUD	J. DEHNER

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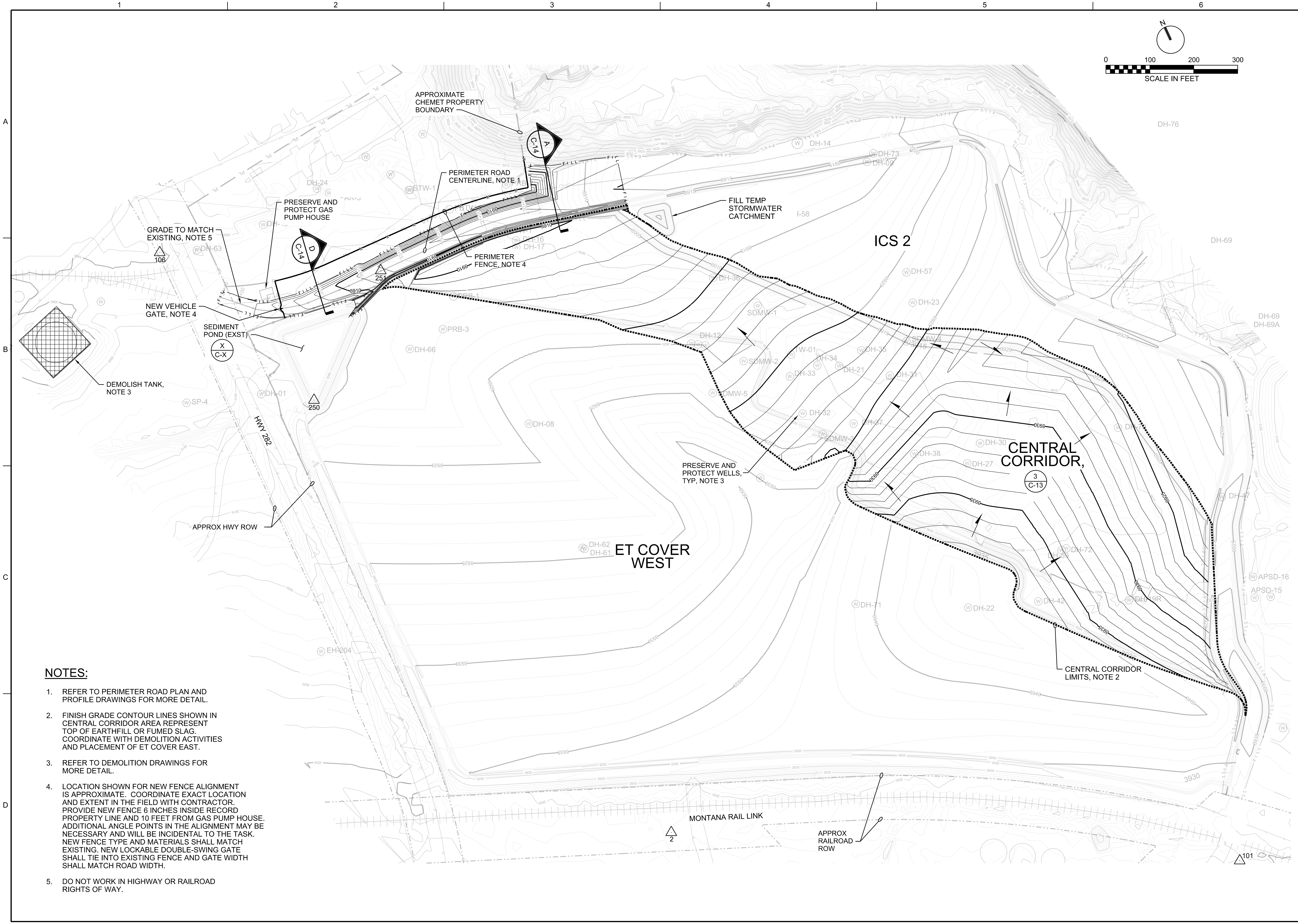
ET COVER SYSTEM, ICS 2, AND DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

OVERALL ET COVER GRADING AND SEQUENCING PLAN 2015

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	C-2
SHEET	5 OF 38



NOTES:

1. REFER TO PERIMETER ROAD PLAN AND PROFILE DRAWINGS FOR MORE DETAIL.
2. FINISH GRADE CONTOUR LINES SHOWN IN CENTRAL CORRIDOR AREA REPRESENT TOP OF EARTHFILL OR FUMED SLAG. COORDINATE WITH DEMOLITION ACTIVITIES AND PLACEMENT OF ET COVER EAST.
3. REFER TO DEMOLITION DRAWINGS FOR MORE DETAIL.
4. LOCATION SHOWN FOR NEW FENCE ALIGNMENT IS APPROXIMATE. COORDINATE EXACT LOCATION AND EXTENT IN THE FIELD WITH CONTRACTOR. PROVIDE NEW FENCE 6 INCHES INSIDE RECORD PROPERTY LINE AND 10 FEET FROM GAS PUMP HOUSE. ADDITIONAL ANGLE POINTS IN THE ALIGNMENT MAY BE NECESSARY AND WILL BE INCIDENTAL TO THE TASK. NEW FENCE TYPE AND MATERIALS SHALL MATCH EXISTING. NEW LOCKABLE DOUBLE-SWING GATE SHALL TIE INTO EXISTING FENCE AND GATE WIDTH SHALL MATCH ROAD WIDTH.
5. DO NOT WORK IN HIGHWAY OR RAILROAD RIGHTS OF WAY.

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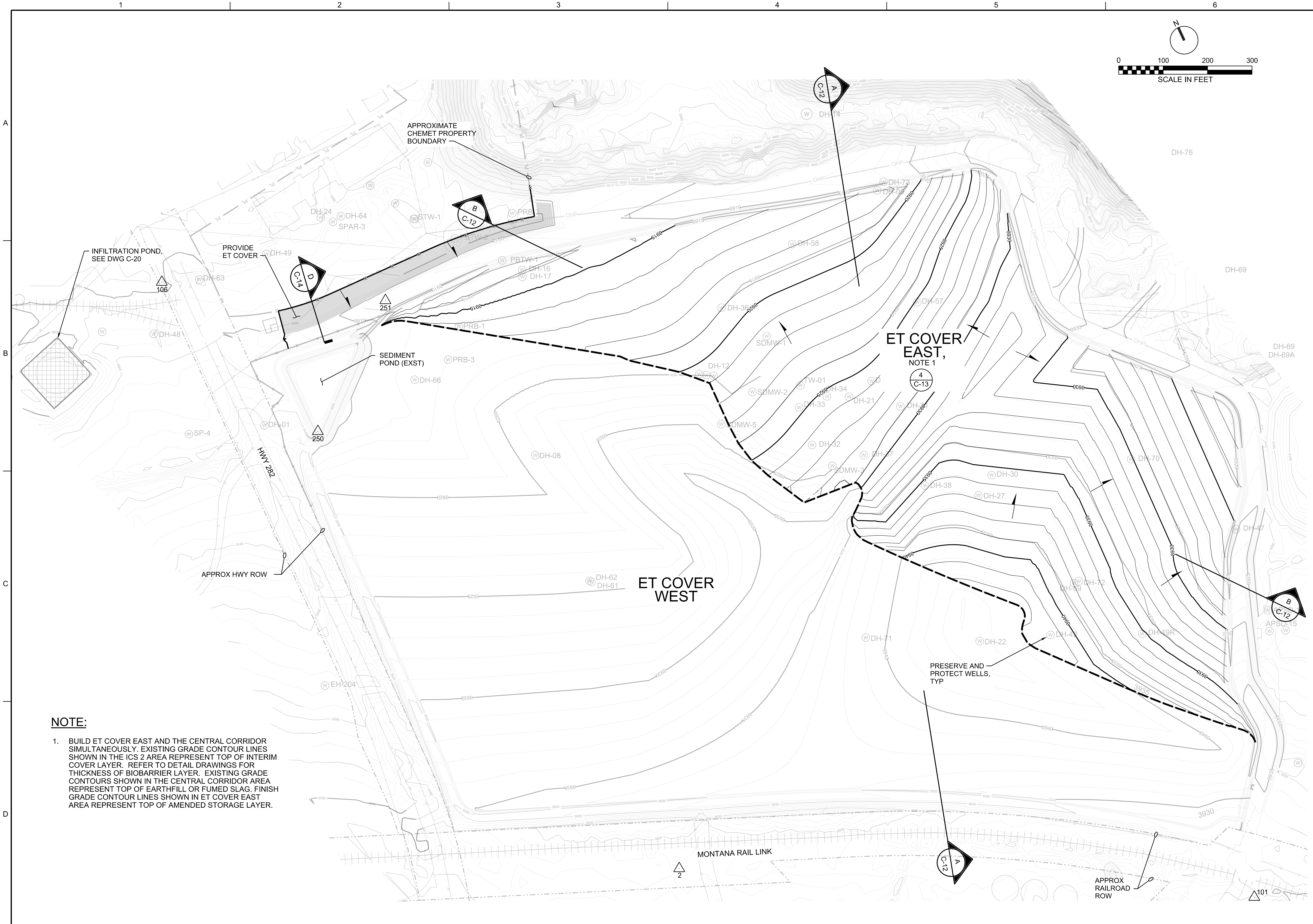
ET COVER SYSTEM, ICS2, AND DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

OVERALL INTERIM COVER GRADING AND SEQUENCING PLAN 2016

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	C-3
SHEET	6 OF 38



NOTE:

1. BUILD ET COVER EAST AND THE CENTRAL CORRIDOR SIMULTANEOUSLY. EXISTING GRADE CONTOUR LINES SHOWN IN THE ICS 2 AREA REPRESENT TOP OF INTERIM COVER LAYER. REFER TO DETAIL DRAWINGS FOR THICKNESS OF BIOBARRIER LAYER. EXISTING GRADE CONTOURS SHOWN IN THE CENTRAL CORRIDOR AREA REPRESENT TOP OF EARTHFILL OR FUMED SLAG. FINISH GRADE CONTOUR LINES SHOWN IN ET COVER EAST AREA REPRESENT TOP OF AMENDED STORAGE LAYER.

PRELIMINARY NOT FOR CONSTRUCTION

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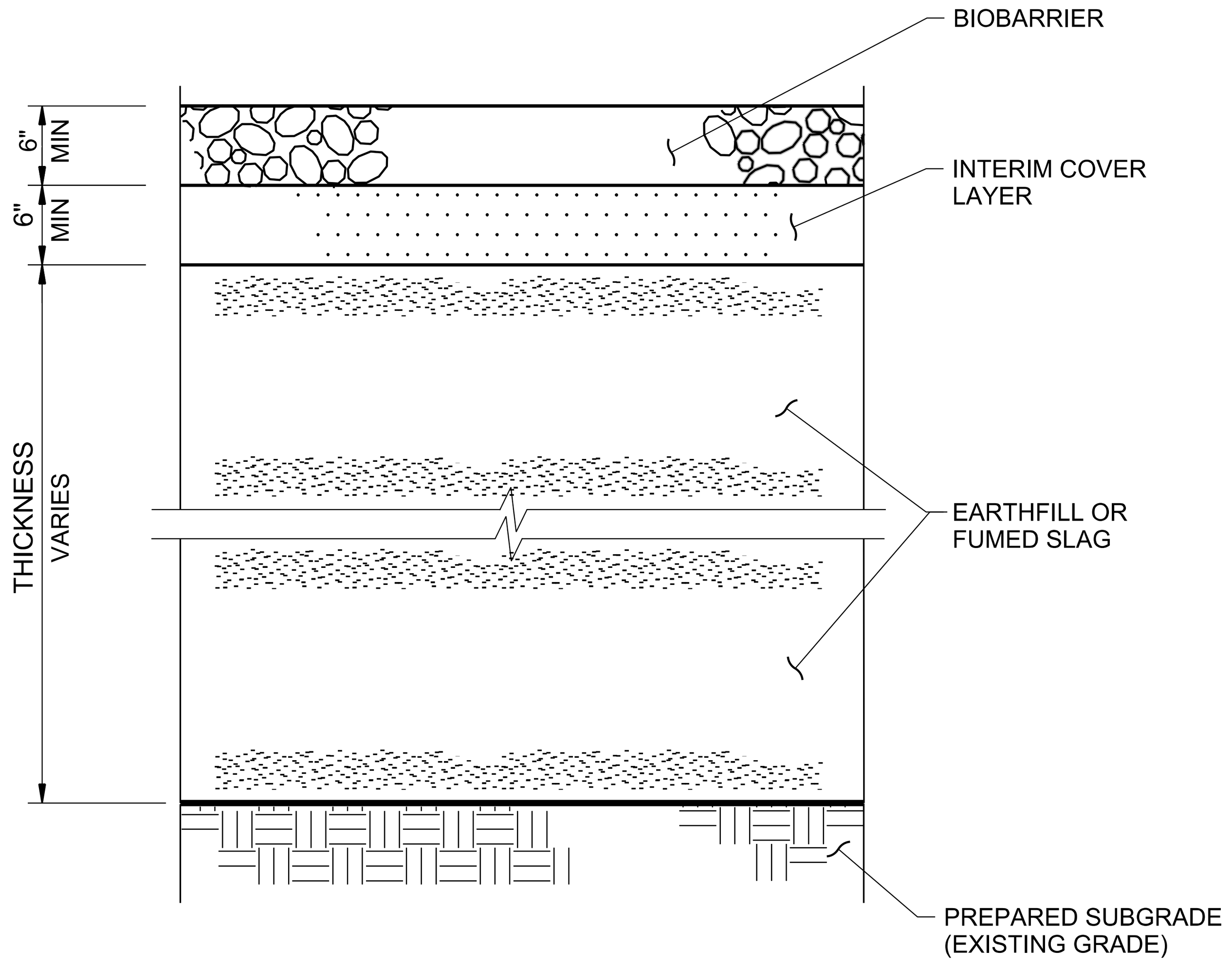
ET COVER SYSTEM, ICS 2, AND DEMOLITION PHASE 33
FORMER ASARCO EAST HELENA FACILITY

OVERALL ET COVER GRADING AND SEQUENCING PLAN 2016

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	C-4
SHEET	7 OF 36

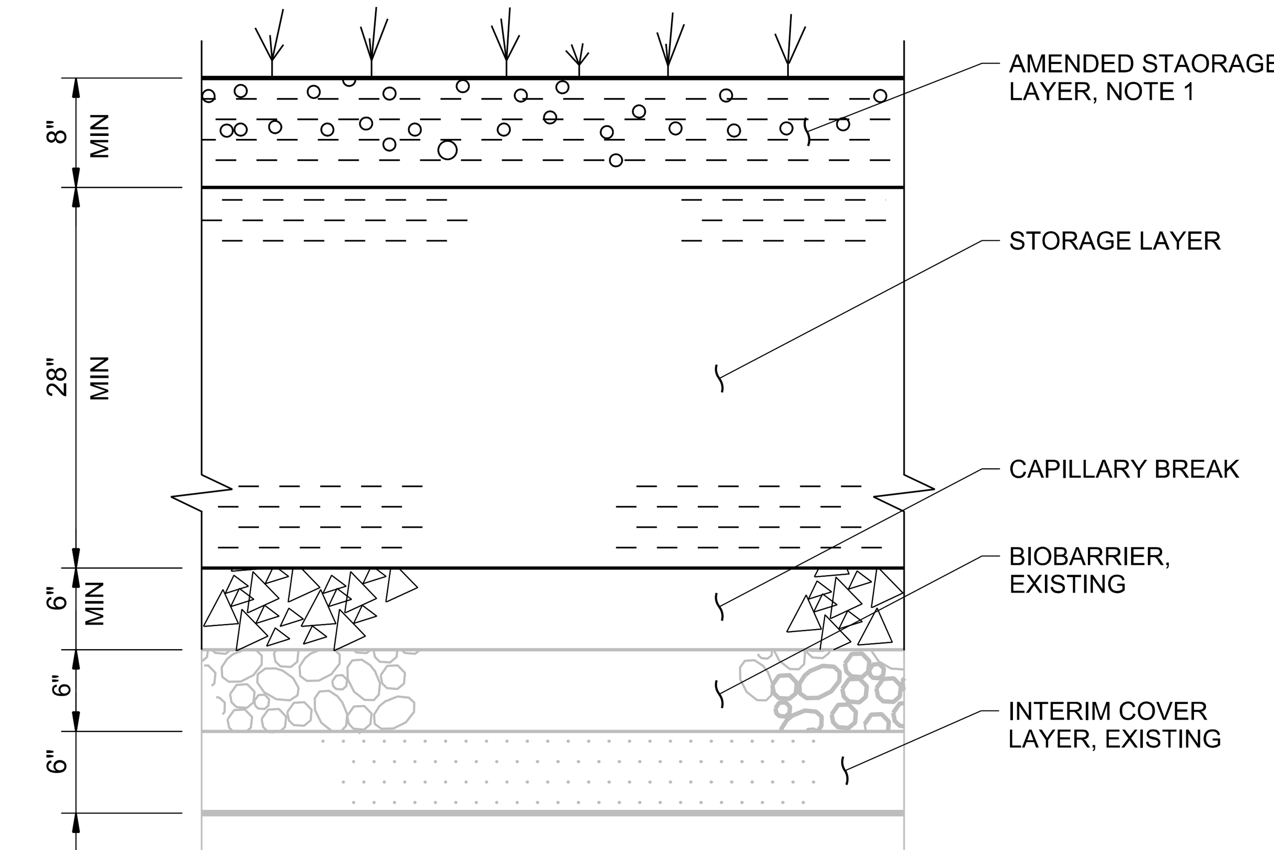
FILENAME: P043C004D_467300.dgn PLOT DATE: 2014\11\07 PLOT TIME: 3:42:12 PM



1 TYPICAL ICS 2 SECTION

NTS

C-1



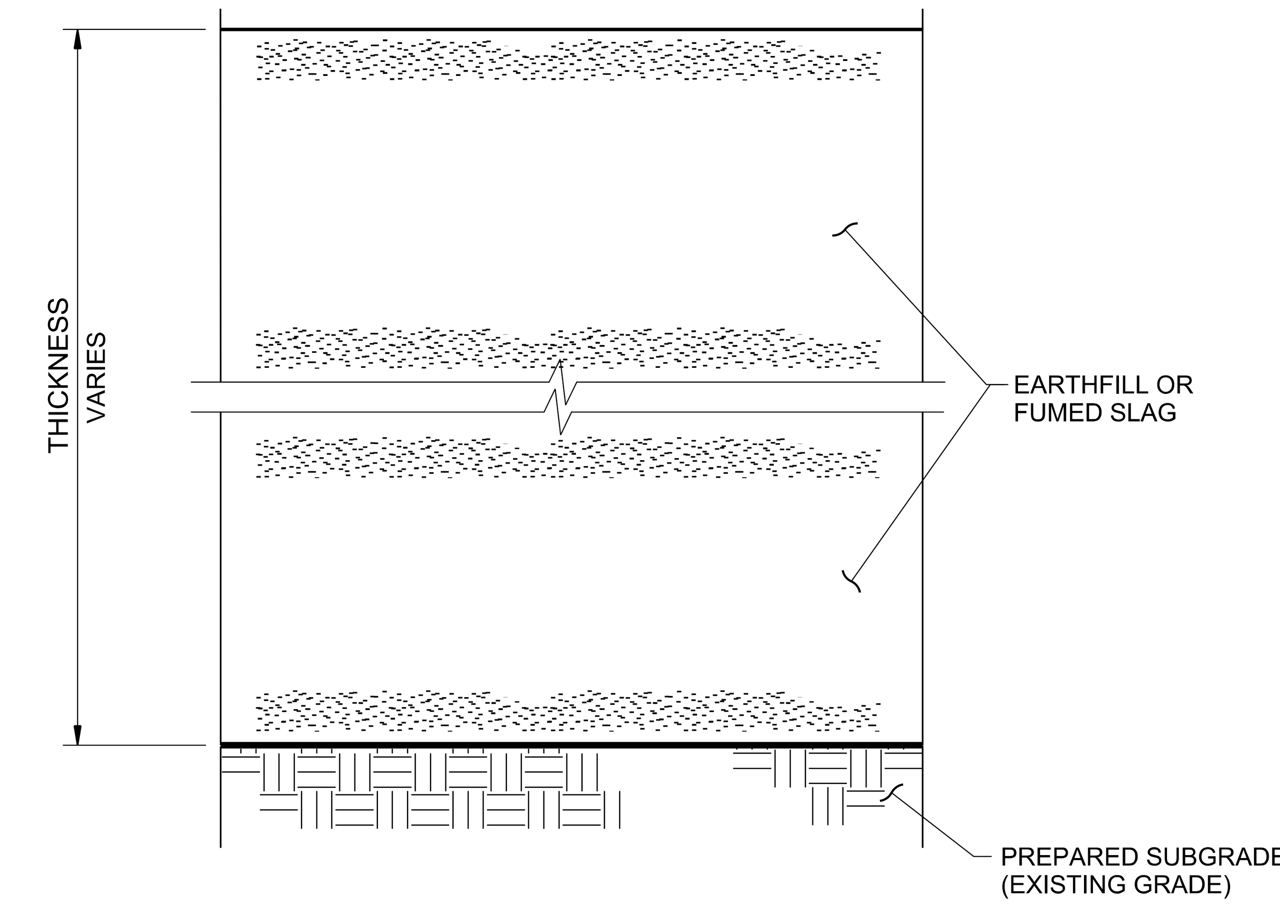
NOTE:

1. PREPARE, SEED, AND MAINTAIN LAYER AS SPECIFIED.

2 TYPICAL ET COVER WEST SECTION

NTS

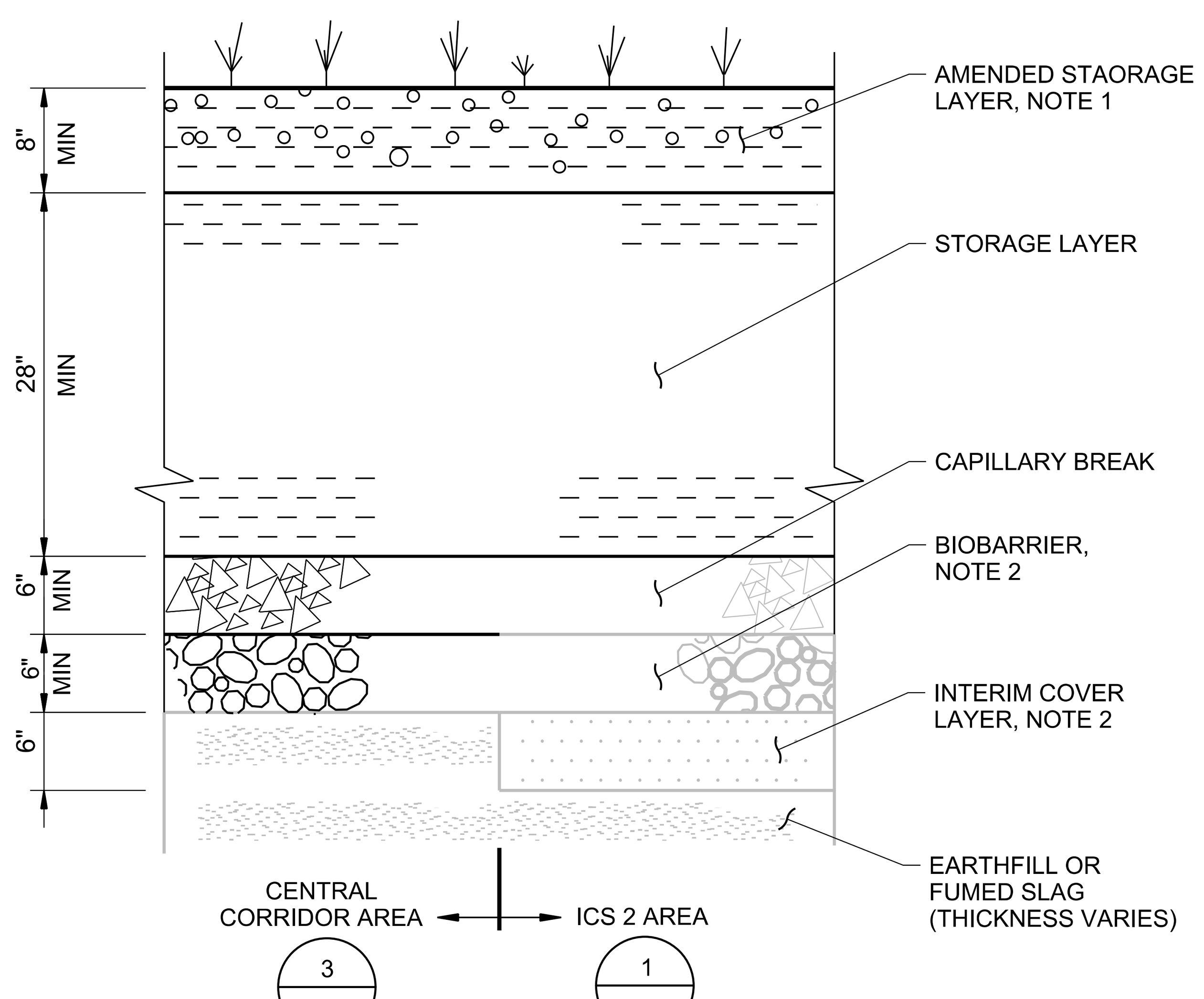
C-1
C-2



3 TYPICAL CENTRAL CORRIDOR SECTION

NTS

C-3



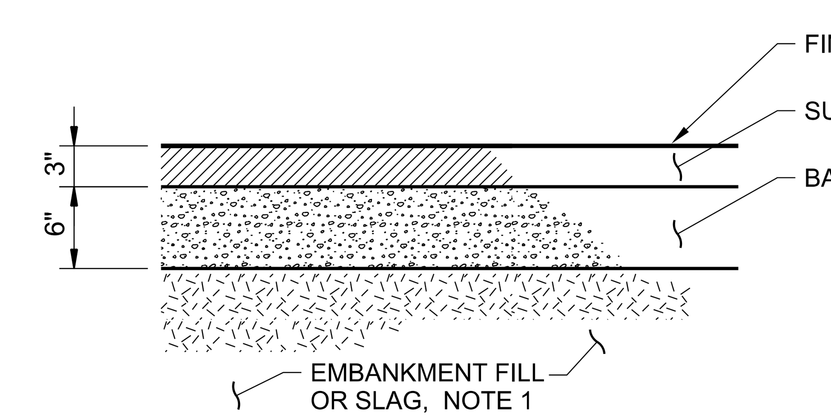
NOTES:

1. PREPARE, SEED, AND MAINTAIN LAYER AS SPECIFIED.
2. PROVIDE BIOBARRIER AND INTERIM COVER LAYER IN ICS 2 AREA IN 2015. PRESERVE AND PROTECT EXISTING LAYERS. PROVIDE BIOBARRIER IN CENTRAL CORRIDOR AREA IN 2016. DO NOT PROVIDE INTERIM COVER LAYER IN CENTRAL CORRIDOR AREA.

4 TYPICAL ET COVER EAST SECTION

NTS

C-4



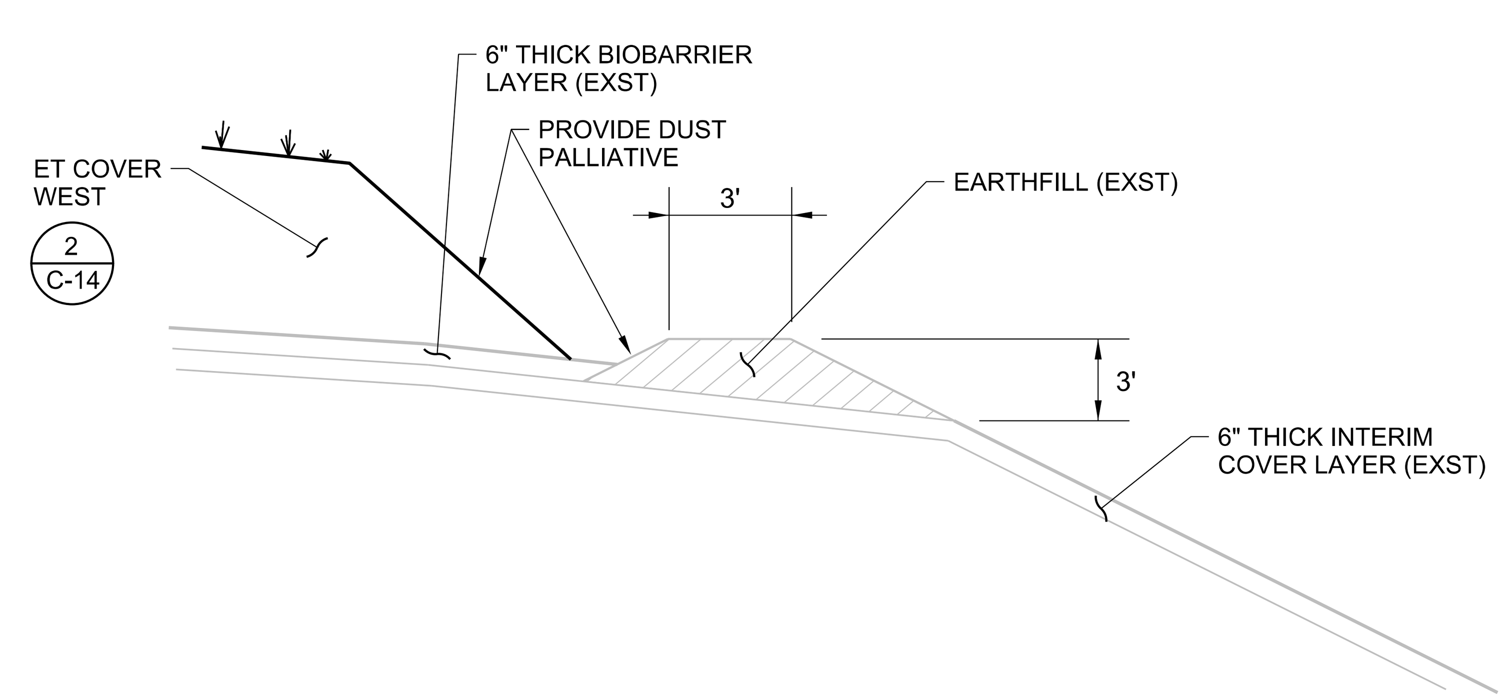
NOTE:

1. REFER TO SPECIFICATIONS FOR SPECIAL PLACEMENT AND COMPACTION UNDER ROADS

5 GRAVEL SURFACING

NTS

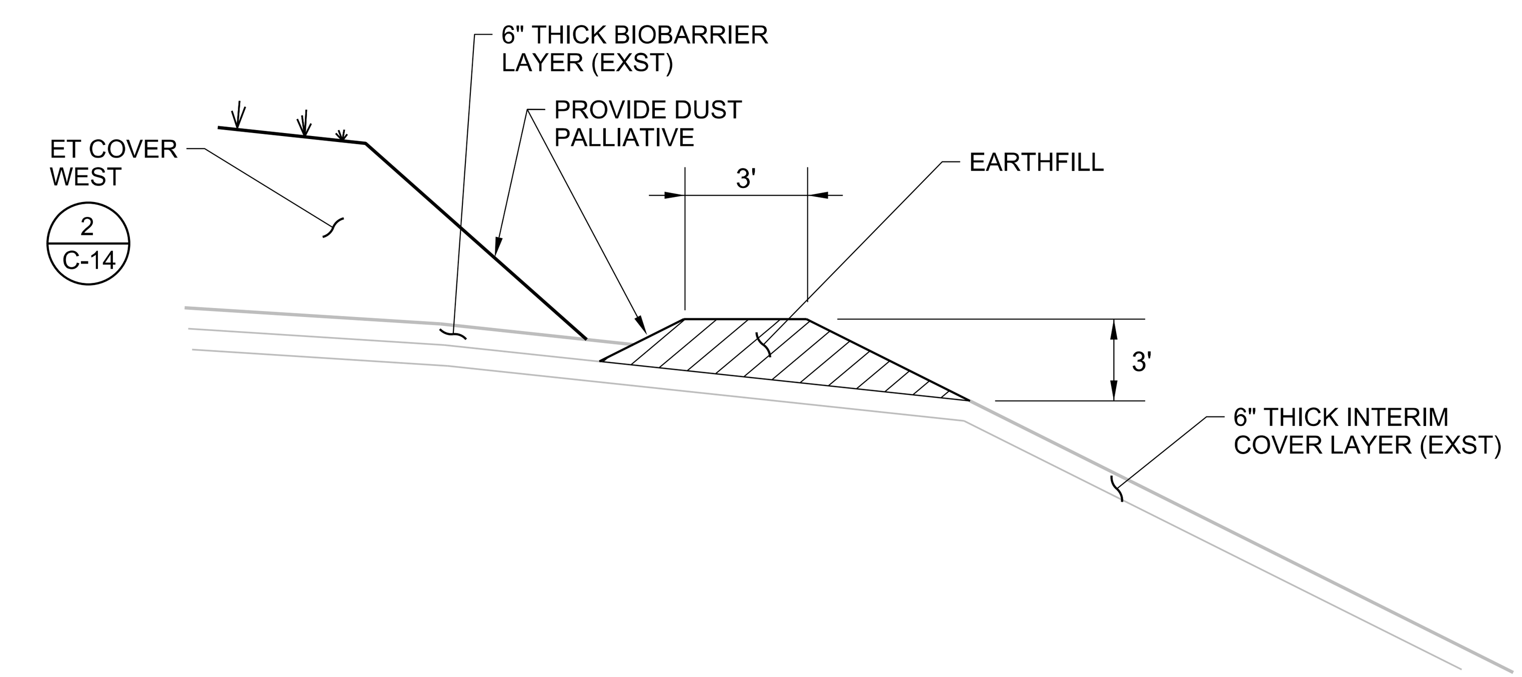
C -14



6 ET COVER TERMINATION - EXST BERM

NTS

C-2



7 ET COVER TERMINATION - NEW BERM

NTS

C-2

8 ET COVER TERMINATION - PERMANENT

TBD @ 90% DESIGN

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
B	11/07/14	60 PERCENT DESIGN	NB	JD
A	09/30/14	30 PERCENT DESIGN	NB	JD

DSGN N. BETTS | DR R. VILORIA | CHK J. SMESRUD | APVD J. DEHNER

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana
Montana Environmental Trust Group
East Helena, Montana

CH2MHILL
POWER BLOCK BUILDING
7 WEST 6TH AVE, # 519
HELENA, MT 59601-5036
PHONE: (406) 457-5494

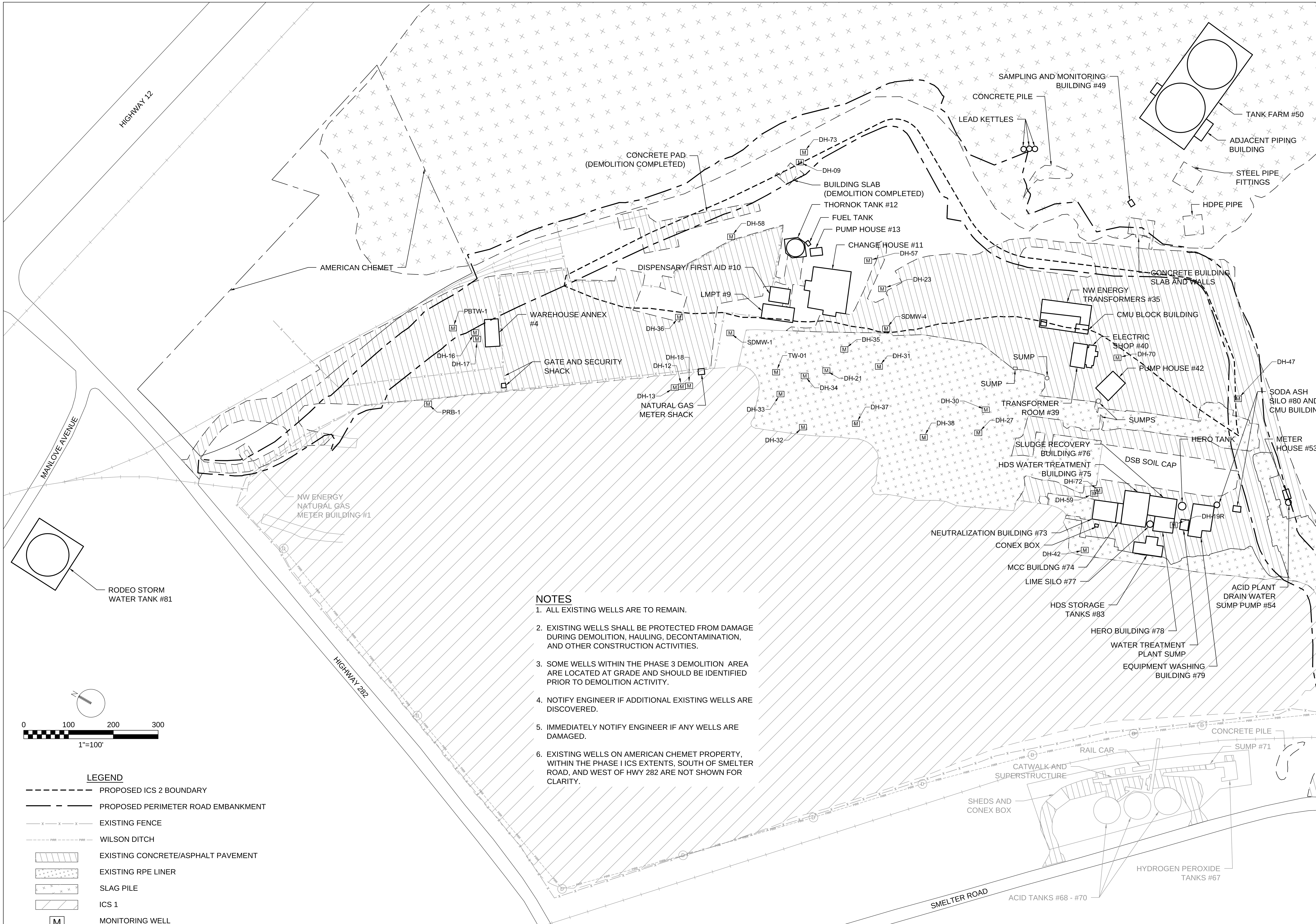
ET COVER SYSTEM, ICS 2, AND DEMOLITION PHASE 3
FORMER ASARCO EAST HELENA FACILITY

CIVIL DETAILS
1 OF 2

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	C-13
SHEET	16 OF 38

PRELIMINARY - NOT FOR CONSTRUCTION



NOTES

1. ALL EXISTING WELLS ARE TO REMAIN.
2. EXISTING WELLS SHALL BE PROTECTED FROM DAMAGE DURING DEMOLITION, HAULING, DECONTAMINATION, AND OTHER CONSTRUCTION ACTIVITIES.
3. SOME WELLS WITHIN THE PHASE 3 DEMOLITION AREA ARE LOCATED AT GRADE AND SHOULD BE IDENTIFIED PRIOR TO DEMOLITION ACTIVITY.
4. NOTIFY ENGINEER IF ADDITIONAL EXISTING WELLS ARE DISCOVERED.
5. IMMEDIATELY NOTIFY ENGINEER IF ANY WELLS ARE DAMAGED.
6. EXISTING WELLS ON AMERICAN CHEMET PROPERTY, WITHIN THE PHASE I ICS EXTENTS, SOUTH OF SMELTER ROAD, AND WEST OF HWY 282 ARE NOT SHOWN FOR CLARITY.

LEGEND

- PROPOSED ICS 2 BOUNDARY
- PROPOSED PERIMETER ROAD EMBANKMENT
- EXISTING FENCE
- WILSON DITCH
- EXISTING CONCRETE/ASPHALT PAVEMENT
- EXISTING RPE LINER
- SLAG PILE
- ICS 1
- M MONITORING WELL

NO.	DATE	REVISION	BY	APVD
B	11/07/14	60 PERCENT DESIGN	GL	JD
A	09/30/14	30 PERCENT DESIGN	GL	JD

DSGN	DR	CHK	APVD
G.LORENSON	A.JOURDONNAIS	M.RHODES	J.DEHNER

METG Montana Environmental Trust Group

Former ASARCO Smelter Site
East Helena, Montana

Montana Environmental Trust Group
East Helena, Montana

CH2MHILL

Hydrometrics, Inc.
Consulting Scientists and Engineers

ET COVER SYSTEM, ICS 2, AND DEMOLITION 3
FORMER ASARCO EAST HELENA FACILITY

MONITORING WELL LOCATIONS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	SEPTEMBER 2014
PROJ	467300
DWG	D-10
SHEET	38 of 38

FILENAME: 1201503H019.dwg PLOT DATE: 4–Nov–14 PLOT TIME: 6:19 PM

Evapotranspiration Cover System, Interim Cover System 2, and Demolition Phase 3 Technical Specifications List

MONTANA ENVIRONMENTAL TRUST GROUP (METG)

FORMER ASARCO EAST HELENA FACILITY

EAST HELENA, MONTANA

SPECIFICATIONS

for construction of

EVAPOTRANSPIRATION (ET) COVER SYSTEM, INTERIM COVER SYSTEM 2 (ICS 2), AND DEMOLITION PHASE 3

****

60 Percent

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CH2M HILL

Helena, MT

November 7, 2014

Project No. 467300 Copy No.____________________

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Pages

DIVISION 33—UTILITIES

DIVISIONS 34 THROUGH 49 (NOT USED)

DRAWINGS (BOUND SEPARATELY)

END OF SECTION

Technical Memorandum: Evapotranspiration Cover System Design, Construction, Operation, and Maintenance Criteria

Evapotranspirative Cover System Design, Construction, Operation, and Maintenance Criteria, Former ASARCO Smelter Site, East Helena, Montana

PREPARED FOR: Lauri Gorton/Custodial Trust

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Bob Anderson/Hydrometrics

DATE: February 17, 2014

PROJECT NUMBER: 486085.43.01.03

Introduction

This technical memorandum (TM) summarizes the criteria and approach that will be used to guide the different phases for implementing the Evapotranspirative (ET) Cover System Interim Measure (IM) planned for the former ASARCO smelter in East Helena, Montana. The ET Cover System IM is one of three inter-related, inter-dependent IMs proposed in the Interim Measures Work Plan 2012, and subsequently conceptually approved by the US Environmental Protection Agency (USEPA) on August 28, 2012. The IMs are being implemented by the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (the Custodial Trust) as part of the Custodial Trust's Resource Conservation and Recovery Act (RCRA) obligations pursuant to the First Modification to the 1998 Consent Decree (Dreher et al., 2012) for the East Helena Facility (Facility).

The primary purpose of the IMs is to reduce the migration of contaminants in groundwater from the former Smelter Site in order to protect public health and the environment. The ET Cover System is proposed to further reduce the potential for site-related soil contaminants leaching to groundwater by eliminating or substantially reducing the amount of precipitation that infiltrates through contaminated materials. The ET Cover System will also lessen human and ecological receptor exposure to inorganic-contaminated soil.

The ET Cover System design has been developed to an approximately 15 percent level of completion to outline the preliminary grading, material balances, and orientation of the site-wide layout. The design will be developed to a 30 percent level of completion to further define the grading and site drainage necessary to interface efficiently and effectively with the Interim Cover System Phase 1 design. However, prior to moving further forward in the design phase for the ET cover layering system (material types and thicknesses for the cover itself), it is necessary to establish the criteria that can be used to direct the completion of the design, construction, and long-term monitoring. The following sections discuss the proposed criteria for each phase of ET cover implementation. Those phases are engineering design, construction, and monitoring and maintenance.

Remedy Performance Criteria

In accordance with USEPA's RCRA regulations and guidance, the Custodial Trust is proposing the following remedy performance criteria in the draft Corrective Measures Study (CMS) Work Plan, currently being updated for re-submittal in first quarter 2014. These performance standards will be considered the primary criteria for use in remedy evaluation, and are defined for the purposes of the East Helena Facility as follows:

1. Protection of human health and the environment
    a. Human and ecological receptors—No direct contact (dermal, inhalation or ingestion) with environmental media having concentrations of COPCs exceeding relevant risk-based standards (see Media Cleanup Objectives below).
    b. Protection of the environment will appropriately consider the surrounding ecological setting during remedy alternative evaluation.
    c. Surface water—Prevent groundwater from discharging to surface water at concentrations that would cause the surface water to exceed Montana State Surface Water Standards and/or at concentrations that would degrade surface water quality beyond existing upstream water quality.
2. Source Control
    a. Soils
        i. Prevent migration of contaminated surface soils via wind-blown deposition or surface water runoff.
        ii. Reduce—to the extent practicable—the potential for groundwater to contact soils with COPC concentrations exceeding relevant protection to groundwater standards through the following activities
            1) Reducing and/or eliminating to the extent practicable infiltration of stormwater into and though areas of contaminated soils and sediments
            2) Reducing to the extent practicable the amount of contaminated soil in contact with groundwater
            3) Reducing to the extent practicable COPC concentrations or mass where such removal will yield immediate reductions in contaminant loading to groundwater.
    b. Slag
        i. Reduce—to the extent practicable—the potential for groundwater to contact slag through removal and recovery of recyclable slag.
            1) Reducing infiltration of stormwater
            2) Reducing contact with groundwater
3. Media Cleanup Objectives
    a. Soil
        i. Surface (0 to 2 feet below the ground surface [bgs])
            1) Soil cleanup levels based on protection of human health and the environment for current and/or future new land uses (as shown in Table 2-2). Note that if numeric standards cannot be achieved, engineering and or institutional controls will be implemented to interrupt pathways for exposure and to maintain protective conditions.
        ii. At depth (>2 feet bgs)
            1) Numeric standards based on protection of groundwater (as shown in Table 2-2, established regional background levels, <u>or</u>
            2) Non-numeric/concentration objective(s) based on impracticability associated with addressing large source mass (i.e., reduce toxicity, mobility, or ability of groundwater to come into contact with, leachable contaminant mass).
    b. Groundwater

i. Return usable groundwater to maximum beneficial uses wherever practicable, within a time that is reasonable considering all property-specific conditions.

ii. Reduce COPC concentrations in groundwater within the operating facility boundary such that the Montana Numeric Water Quality Standards (as defined in Circular DEQ-7, and hereafter referred to as DEQ-7) are met at the points of compliance established by USEPA.

iii. To the extent practicable maintain stability and continue attenuation of offsite (i.e., beyond the operating facility boundary) plumes such that COPC concentrations can be expected to meet DEQ-7 standards within a reasonable time.

iv. During the timeframe when attainment of the DEQ-7 standards has not been achieved, minimize further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction approaches. To the extent practical, control or eliminate other surface water and subsurface sources of contamination to groundwater within control of the Custodial Trust.

c. Surface Water—Meet DEQ-7 and other applicable surface water quality standards for surface water bodies contaminated by ASARCO's historical activities, including present migration of existing contamination.

d. Sediment—USEPA Region III's Biological Technical Assistance Group (BTAG) has developed values to be used for the evaluation of sampling data at Superfund sites. Referred to as the Region III BTAG Screening Benchmarks, they represent an appropriate set of screening criteria to evaluate ecological risk in freshwater sediment for the CMS properties (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm).

The ET Cover System is a source control measure and is being implemented as an IM, with the intention that it will become a part of the final remedy for the Facility. The remedy performance standards form the primary objectives shown below, from which the design criteria have been derived.

Engineering Design Phase

The overarching goal of the engineering design phase is to design a cover system that supports the overall site-wide remedy. The objectives, criteria, and demonstrations that will be used to design the ET cover are shown below in Table 1. The design objectives listed in the first column correspond directly to the remedy performance criteria to provide assurance that the design will support the overall site-wide final remedy. The design criteria listed in the second column are the standards to which the cover will be designed. The criteria are divided into groups to show which design objectives they support. The demonstrations listed in the third column will be used to show that the completed design meets the design criteria. The design deliverables will include engineered drawings and specifications.

The ET cover system will be designed in accordance with methods that have been successfully used to design ET cover systems under similar site conditions, including those in Helena, Montana. The thickness, gradation, and other characteristics of the ET cover soil layers will be selected to optimally and efficiently reduce the predicted volume of percolation. This selection will be based upon a water balance analysis, site-specific hydraulic modeling, a borrow source investigation, the expected vegetation community, and data gathered from nearby ET covers, test plots, and lysimeters. Developing an optimized storage layer thickness will be based on conservative soil characteristics and predicted percolation ranges from modeling, and not a predetermined percolation value. The performance will be based on the level of conservancy and extra storage capacity provided by the design, quality assurance and quality control conducted and documented during construction, and operational observations on cover maintenance. The effect of the predicted percolation volume on site-wide groundwater contamination is not part of the cover system evaluation, but will be addressed as part of a separate analysis performed under the groundwater component of the Corrective Measures Study.

TABLE 1
Engineering Design Criteria
ET Cover System, East Helena Facility

Design Objective	Design Criteria	Demonstration
1. Protect human health and the environment.	1a. The cover system will provide a physical separation between the contaminated soil and ground surface.	1a. The cover system will have a specified minimum thickness that will encompass the former smelter site with sufficient slope and drainage to provide for surface water runoff.
	1b. The cover system will inhibit bioturbation and contact with animals.	1b. The cover system design will have a burrowing animal barrier layer with a specified amount of cobble-sized rocks and a minimum thickness.
	1c. The cover system footprint will accommodate existing site access controls including fencing, signs, and gates.	1c. The cover system design will utilize existing site-security features and modify them as necessary to encircle the cover footprint.
2. Control potential sources of contamination migration.	2a. The cover system will resist wind erosion.	2a. The combination of soil and vegetation will resist wind erosion. The design will include vegetation specifications based on similar ET covers used in Montana and other similar climates. Temporary erosion control measures will be provided during the establishment of permanent cover vegetation.
	2b. The cover system will resist water erosion.	2b. The combination of soil, vegetation, slopes, and drainage features will resist water erosion. The design will include vegetation specifications based on similar ET covers used in Montana and other similar climates. Drainage features will be armored as necessary along flow concentration areas (e.g., ditches and channels). Temporary erosion control measures will be provided during the establishment of permanent cover vegetation.
	2c. The cover will not be subject to inundation from flooding.	2c. The cover will be outside the 100-year floodplain of Prickly Pear Creek.
	2d. The cover system thickness, soil gradation, soil-moisture holding characteristics, and vegetation community will store infiltrating precipitation, reduce percolation through contaminated soil, and reduce contact with groundwater.	2d. Hydrologic modeling will be performed with site-specific climate data, soil characteristics, and design vegetation conditions to estimate anticipated percolation rates for the cover system. The design will also be compared to other ET cover systems in Montana and in similar climates in the western USA.
3. Meet media cleanup objectives for soil.	3a. The cover system will be comprised of soils with contaminant levels that are below cleanup levels for shallow surface soil (<2 feet bgs).	3a. The design will specify frequencies for field sampling and laboratory testing and minimum standards for compliance.
	3b. The cover system will be constructed with a slope, thickness, gradation, and moisture holding capacity that provides for infiltration storage and percolation reduction; reducing the contribution of COPC to groundwater and attenuation of groundwater plumes.	3b. The design will specify frequencies for field and laboratory testing, construction observation, inspection, and minimum standards for compliance; including cover layer thickness, gradation, placement, density, and surface grades.
4. Meet media cleanup objectives for surface	4a. The cover system surface will be designed to manage and control stormwater runoff.	4a. The cover surface will be sloped to provide positive drainage and reduce surface water collection that could drive infiltration. Surface

TABLE 1
Engineering Design Criteria
ET Cover System, East Helena Facility

Design Objective	Design Criteria	Demonstration
water (i.e. DEQ-7 standards).		water runoff will be discharged to the perimeter drainage system without coming into contact with sources of contamination. Cover grading will divert stormwater run-on around the cover.
	4b. Ditches, swales, and other drainage features will be designed to accommodate stormwater runoff and limit erosion.	4b. Features will be sloped to provide positive drainage and convey the flow from a specified design storm (e.g., 100-year 24-hour precipitation event). Ditches and other stormwater management structures may be lined to further reduce potential contact with contaminated soil.

Construction Phase

The overarching goal of the construction phase is to provide an ET cover system that meets the design requirements listed previously in Table 1. The objectives, criteria, and demonstrations that will be used to construct the cover system are shown below in Table 2. The construction objectives listed in the first column correspond directly to important design elements to provide assurance that construction activities are aligned with the cover design. The construction criteria listed in the second column are the procedures that will be used to construct the cover. The criteria are divided into groups to show which construction objectives they support. The quantifiable standards for each construction criterion will be determined during the engineering design phase and the ET cover system will be constructed and quality controlled in accordance with methods that have been successfully used to construct similar ET covers. The demonstrations listed in the third column will be used to show that the construction meets the construction criteria. The frequency and procedures for each demonstration will be developed during engineering design.

TABLE 2
Construction Criteria
ET Cover System, East Helena Facility

Construction Objective	Construction Criteria	Demonstration
1. Implement construction quality management system.	1a. Construction subcontractor will develop and implement a contractor quality control plan.	1a. Plan will be reviewed and approved by the construction manager.
	1b. Construction subcontractor will provide the services of an independent material testing firm to conduct field and laboratory testing.	1b. The firm will be certified to conduct testing by nationally recognized associations.
	1c. Construction subcontractor will provide services of a land surveyor to conduct ground surveys.	1c. The surveyor will be licensed to conduct surveys in the State of Montana.
2. Provide soil layers and grades that meet design requirements.	2a. Construction subcontractor will test/measure the properties and thicknesses of the soil layers. Properties may include gradation, moisture content, relative compaction, agronomic properties (for vegetation layer), and chemical properties.	2a. The testing firm will certify test results and the surveyor will stamp survey deliverables.

TABLE 2
Construction Criteria
ET Cover System, East Helena Facility

Construction Objective	Construction Criteria	Demonstration
	2b. Owner will provide independent verification of construction quality control.	2b. Independent testing results and reporting conducted by Owner.
3. Provide a stand of vegetation that meets design requirements.	3. Construction subcontractor will maintain or enhance the vegetation until a satisfactory stand is established.	3. Construction subcontractor warranty or guarantee the vegetation.
4. Temporarily stabilize the cover surface to manage stormwater and limit erosion before vegetation has been established.	4. Construction subcontractor will provide temporary stormwater, erosion, and sediment controls during and at completion of construction.	4. Cover surfaces will be visually inspected for signs of erosion or ponding. Control measures will be visually inspected for proper installation and adequate coverage.

Monitoring and Maintenance Phase

The ET cover system will provide long-term performance if constructed to meet design requirements. As with any system, however, periodic monitoring and maintenance will be required to allow the cover system to perform as intended over time. The ET cover system will be monitored and maintained in accordance with methods that have been successfully used on similar ET cover projects as well as conventional geosynthetic cover systems. Monitoring and maintenance will be based on visual observations of the cover condition. If monitoring observations identify conditions that could potentially result in a lower performance (e.g., vegetation failure or overly-flat slopes due to settlement), then the condition would be addressed as part of ongoing maintenance. The criteria listed below in Table 3 will be used to monitor and maintain the ET cover system. The objectives and criteria correspond to key design elements.

The monitoring program focuses on visual observations because that is the best way to verify that the design requirements are being maintained over the long term. For example, checking that the system's storage capacity is being maintained is best done by looking for changes in the cover thickness due to erosion, settlement, and other actions. Similarly, checking that the system's ET capacity is being maintained is best done by observing the vegetation community.

TABLE 3
Monitoring and Maintenance Criteria
ET Cover System, Former ASARCO Smelter Site

Monitoring and Maintenance Objective	Monitoring and Maintenance Criteria	Demonstration
1. Conduct regular monitoring to identify required maintenance.	1. Develop and follow a monitoring and maintenance plan.	1. Plan will contain the elements outlined in this table.
2. Monitor the vegetation stand.	2. Maintain a stand of vegetation that meets requirements.	2. Visual inspection to check for signs of failing vegetation.
3. Monitor the cover soil surface and drainage systems.	3. Maintain a soil surface the resists erosion and promotes stormwater runoff.	3. Visual inspection for signs or erosion, settlement, changes in surface water flow, or ponding water.

Summary

The ET cover will be designed to meet the remedy performance criteria established in the draft CMS Work Plan and will consider existing performance information from existing ET Cover systems in the region to establish section properties. Technical evaluations to be conducted during final design will focus on identification of materials with the necessary physical properties. Construction documents will specify the materials and methods necessary to implement the design. Performance monitoring of the ET Cover system will be integrated into the overall groundwater monitoring plan for the East Helena Facility, to demonstrate that the cover is meeting the performance criteria and to assess the short- and long-term benefits to groundwater.

Appendix B
Technical Memorandum: Evapotranspiration Cover System Design for the East Helena Former ASARCO Smelter Site

Evapotranspiration Cover System Design for the East Helena Former ASARCO Smelter Site

PREPARED FOR: Jay Dehner/CH2M HILL
Nathan Betts/CH2M HILL

PREPARED BY: Robert Martin/CH2M HILL
Bill Albright/DRI
Craig Sauer/CH2M HILL

REVIEWED BY: Jason Smesrud/CH2M HILL
Dan Dolmar/CH2M HILL
Bob Anderson/Hydrometrics, Inc.

DATE: December 8, 2014

1.0 Introduction

An evaluation was conducted to support the design of a sitewide evapotranspiration (ET) cover system proposed for use at the former ASARCO smelter site (former Smelter site) in East Helena, Montana. This technical memorandum (TM) summarizes the evaluation results. The ET Cover System interim measure (IM) is designed in accordance with the *Former ASARCO East Helena Facility Interim Measures Work Plan–Conceptual Overview of Proposed Interim Measures and Details of 2012 Activities* (CH2M HILL, 2012).

A review of case studies was conducted to consider the applicability of the site for an ET cover system. The case studies included existing ET cover systems implemented in Montana under similar climatologic conditions, conclusions from the Alternative Cover Assessment Project (ACAP) Phase I report by the Desert Research Institute (Albright et al., 2002), and *USEPA Fact Sheet on ET Cover Systems for Waste Containment* (U.S. Environmental Protection Agency [USEPA], 2011). Case studies were reviewed for applicability and compared to the proposed ET Cover System. The ACAP consisted of two sites in Montana: the Polson Municipal Landfill (Lake County) and the Helena Valley Municipal Landfill (Clark County). Additionally, the Valley View Landfill (VVL) is located approximately 1 mile from the former Smelter site and was completed with an ET cover system using similar soil types and borrow materials. The existing ET cover recommendations and designs were reviewed and incorporated into this evaluation.

Two different methods were used to evaluate site-specific climate conditions and soil, a water balance method and unsaturated hydrologic numerical modeling. The water balance method used was based on results from the ACAP funded by the USEPA and described in *Water Balance Covers for Waste Containment: Principles and Practice* (Albright et al., 2010). The hydrologic modeling was performed using the HYDRUS-1D model (PC-Progress, 2014) which requires a large amount of site-specific input parameters encompassing daily meteorological data, vegetation properties, and borrow source soil hydraulic properties. The development of the HYDRUS model was guided by hydraulic modeling previously conducted for conceptual design (CH2M HILL, 2013) and also by the results of the water balance analysis conducted by Hydrometrics (Hydrometrics and CH2M HILL, 2012).

Hydrometrics conducted a borrow source field investigation on July 2, 3, and 25 of 2014, to provide borrow-specific soil sample analytical results (Attachment 1) for use in the evaluation. The borrow sources included area from the adjacent VVL (described in more detail in Section 3.0) and borrows located adjacent to the former Smelter site.

The results of the evaluation were used to define an ET cover storage layer thickness based on borrow soil samples and define engineering parameters for use in the design and construction of the ET Cover System section.

2.0 Purpose and Objectives

The primary purpose of the ET Cover System IM is summarized as follows:

- Further reduce the potential for inorganic soil contaminants to leach to groundwater by eliminating or substantially reducing the amount of infiltration through contaminated materials.
- Provide a clean surface for runoff.
- Eliminate human and ecological receptor exposure to inorganic-contaminated soil.

The specific objectives of the ET Cover System IM are as follows:

- Reduce the percolation of precipitation and associated leaching of inorganic contaminants in vadose zone soil to groundwater.
- Replace the existing temporary cover system, which is deteriorating.
- Eliminate the potential for people and wildlife to have direct contact with contaminated surface soil and from windblown sediment.
- Reduce the volume and improve the quality of contaminated stormwater that is being collected and treated by the onsite high-density sludge water treatment system.

The uppermost vegetated soil layer of the ET Cover System will be designed to store and release infiltration through evaporation and transpiration processes, and provide for shedding of clean stormwater in the event of runoff. The cover system uses the water storage capacity of the soil layer to minimize percolation, as an alternative to lower-permeability barriers using traditional cover materials (for example, clays, asphalt, and geotextiles), where performance primarily is based on increased runoff as a trade-off to decreased infiltration. Under appropriate, site-specific conditions, the ET Cover System can be a more cost-effective and sustainable (long-term) alternative for minimizing infiltration than traditional engineered cover designs.

3.0 Case Study Evaluations

This section summarizes the case study evaluations conducted by Hydrometrics as part of the *ET Cover System Hydrologic Evaluation and Interim Measures Engineer Plan* (Hydrometrics and CH2M HILL, 2012). The ACAP was a 6-year, multistate, multitechnology research collaboration intended to answer questions regarding the adequacy of alternative cover designs to be protective as landfill applications. The field study data report (Albright and Benson, 2005) provides a field dataset and summarizes the data and supporting analysis. The ACAP included two sites in Montana that have conditions similar to those found in the East Helena site: one located in Polson and the other located in the Helena Valley. Both were constructed with an ET cover that included a capillary break layer. Additionally, the ET cover system installed at the VVL, located approximately 1 mile from the former Smelter site, was evaluated as it was completed using similar soil types and borrow materials proposed for the ET Cover System. Finally, studies of ET covers for mine waste were incorporated into the evaluation.

3.1 Alternative Cover Assessment Project Case Study

The test section at the Polson Municipal Landfill in Lake County was constructed with a 115-centimeter (cm) (45-inch) storage layer comprising sandy gravel, silty sand, silt, and topsoil. The sandy gravel, silty sand, and topsoil were obtained onsite. The silty sand was obtained from a local borrow source approximately 3 miles from the site. Numerical modeling was performed for the alternative cover using HYDRUS for a ten year period, using the highest precipitation year on record (1998) for all ten years. The results predicted approximately 0.6 millimeter (mm) of percolation in the first year, and 0.1 mm per year for the remaining years in the 10-year simulation (Albright and Benson, 2005). Field data collected from November 1999 to October 2004 measured a total percolation through the ET cover of 0.8 mm (0.2 mm per year average). The Polson site receives approximately 25 percent more precipitation annually than the former Smelter site.

The test section at the Helena Valley Municipal Landfill in Lewis and Clark County was constructed with a 135-cm (53-inch) storage layer consisting of gravel, sandy clay, and topsoil. The gravel was used to simulate an interim cover and was obtained from a local gravel pit. The sandy clay for the ET cover was obtained onsite and is currently being used for daily cover at the landfill. Numerical modeling was performed with HYDRUS for a 10-year period, using the highest precipitation year on record (1975) for all 10 years. The results predicted a percolation rate of less than 1 mm per year average over the 10-year period simulated. Field data collected from October 1999 to October 2004 measured a total percolation of 0.1 mm at the site.

As part of the ACAP, performance data were developed for ET covers, including threshold values. The threshold values are based on conditions under which a percolation rate of less than 3 mm per year can be readily met. Threshold values are intended for use in establishing general guidelines to help evaluate a site for potential applicability of a successful ET cover. The exceedance of threshold value indicates that it might be more difficult to design and meet the target percolation rate with an ET cover. However, detailed site-specific hydrologic evaluations are necessary to address all factors influencing cover performance. Table 1 shows the ACAP threshold values (USEPA, 2006) and precipitation values for the Helena area.

The Helena area precipitation values are from the National Weather Service meteorological station at the Helena Regional Airport. The precipitation and potential evapotranspiration (PET) values are from the Helena Valley Agrimet Station (Bureau of Reclamation, 2012). Table 1 shows the ACAP threshold values (USEPA, 2006) and that the Helena area conditions are within the threshold values for ET cover performance with the exception of the ratio of precipitation to potential evapotranspiration (precipitation/PET), which is slightly higher. The exceedance of the precipitation to PET ratio indicates that additional detailed evaluation and design are required for application of an ET cover in the Helena area. Additional evaluations were conducted as summarized in this TM.

TABLE 1
Alternative Cover Assessment Project Evapotranspiration Performance Data*

Factor	Threshold	Helena Area
Annual precipitation	<325 mm	270 mm
Spring/summer precipitation	<380 mm	206 mm
Fall/winter precipitation	<190 mm	64 mm
Snow and spring precipitation	<250 mm	184 mm
Precipitation/PET	<0.20	0.24

*Modified from November 2006 U.S. Environmental Protection Agency *Proceedings from Alternative Covers for Landfills, Waste Repositories and Mine Wastes Workshop, Denver, CO.*

3.2 Valley View Landfill Case Study

In addition to the ACAP study and performance data, the VVL has an ET cover and is located approximately 1 mile southeast of the East Helena site. The VVL design was based on the use of onsite source materials and was evaluated by numerical modeling using HYDRUS (Albright, 2003).

The ET cover at the VVL was monolithic, meaning it did not include a capillary break layer that would help increase storage within the storage layer. However, on the basis of soil testing for onsite materials and HYDRUS modeling evaluating different soil types and ET cover thickness, a 60-cm (24-inch) storage layer was determined to be adequate for reducing the average annual percolation rate to less than 3 mm per year over the 10-year model simulation period (Albright, 2003). Soil conditions are similar between the two locations, suggesting that onsite materials may be similar to those found at the VVL and may be adequate for use in the ET cover.

ACAP study results and more site-specific data available from the VVL strongly suggest that the use of an ET cover at the site could provide adequate performance. These results were used to further refine a conceptual ET cover design for the site, and evaluate that conceptual design through analytical and numerical methods described in the following sections.

3.3 Mine Waste Studies

In addition to municipal waste type landfills, soil-based covers that employ water storage and evapotranspiration for reducing percolation have been used in Montana for mine waste, including Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund sites related to historical mine activities. Table 2 provides a summary of ET covers, including comments regarding their use. Several of the covers contain soil amendments such as lime. The use of these amendments appears to reduce infiltration rather than increase ET performance. In particular, South Emma Dump was designed with a 6-inch amended vegetated layer and a 39-inch storage and release layer. The South Emma Dump cover is similar to the cover considered for the former Smelter site; however, it did not include a performance-enhancing capillary break layer.

TABLE 2
ET Covers for Mine Waste Approved in Montana

Project/Location	Program	Cover Design	Annual Precip. (Inch)	Waste Type and Amount	Comments
Mineral Hill Mine[a] Park County, Montana 2000-2001	Montana Mine Reclamation Act Operating Permit	Topsoil (12-inch). Subsoil (36-inch). No capillary break.	10	1 Mt mine tailings. Repository area = 13 acres	Includes synthetic underliner and drainage collection system. Placed synthetic liner over portion of cap in 2005; reduced toe seepage from 2.5 to 1.5 gallons per minute. Seepage believed attributable in part to lateral groundwater inflow.
Subarea 1 Streamside Tailings Operable Unit[b] Silver Bow County, Montana Ongoing	CERCLA	Amended soil. No capillary break (22-inch).	13	Fluvial tailings. 197,750 CY	Lime added to uppermost 3 feet of tailings. Design plan requirements include depth to groundwater < 10 to 20 feet. Percolation through repository cannot cause exceedances of groundwater quality standards.
Corbin Flats[c] Jefferson County, Montana 2009	CERCLA Voluntary Cleanup Program	Topsoil (12-inch). Capillary break (6-inch).	12	Tailings 307,600 CY	Geotextile filter fabric above capillary break. Fertilizer and mulch applied. Cap includes only soil, not specifically designed as ET cap.
Anaconda-Deer Lodge Old Works/East Anaconda Operable Unit[d] Silver Bow County, Montana	CERCLA	Topsoil (18-inch). No capillary break.	13	Mine waste	Original temporary 6-inch soil cover increased to 18 inches in 2010.
Milltown Sediments and Opportunity Ponds Remedial Design Unit[e] Silver Bow County, Montana	CERCLA	Amended topsoil (12-inch). No capillary break.	13	Mine waste/ sediments 600 acres	Amended upper 6 inches of tailings with Lime Kiln Dust. Amended upper 4 inches of cover with 1.5 percent OM to enhance water-holding capacity. Cover failure resulting from phytotoxic soil cover conditions and failure of vegetation growth.
Emma Dump; Silver Bow Creek/Butte NPL Site; Butte Priority Soils Operable Unit[f]	CERCLA	Soil North Emma Dump (12-inch). Soil South Emma	12	Tailings 130,828 CY	Upper 6 inches of soil amended with OM (manure) plus fertilizer, straw mulch crimped on top.

TABLE 2
ET Covers for Mine Waste Approved in Montana

Project/Location	Program	Cover Design	Annual Precip. (Inch)	Waste Type and Amount	Comments
Silver Bow County, Montana		Dump (39-inch). No capillary break.			Only South Emma Dump designed as true ET cover.

Notes:

[a] *Mineral Hill Mine: As-Built Report TSF and OTS Reclamation, Mineral Hill Mine Site, Jardine, MT*. Bronson Engineering, Inc. and Shepherd Miller. February 2002. Three volumes.

[b] *Final Design Report – Reach A of Subarea 1 – Streamside Tailings Operable Unit*. Maxim Technologies, Inter-Fluve, Reclamation Research Unit, and Bighorn Environmental. June 1999.

[c] *Corbin Flats Tailings Site Voluntary Cleanup Plan*. Olympus Technical Services, Inc. July 1997.

[d] *Request for Change to Final Vegetative Cover, July 2010. Old Works/East Anaconda Development Area Operable Unit. Remedial Action Work Plan/Final Design Report*. Volume III Addenda. August 1996.

[e] Letter from S. Dunlap ARCO to C. Coleman, USEPA Region 8, dated December 21, 2011. Re: Final Cover Plan for Milltown Sediments at the Opportunity Ponds RDU 8.

[f] *Silver Bow Creek/Butte Area NPL Site Butte Priority Soils OU Final Construction Completion Report*. Emma Dump. October 1999.

Abbreviations:

CY = cubic yards

Mt = million tons

OM = organic matter amendment

4.0 Water Balance Analysis

A water balance analysis was conducted to calculate an estimate of the required thickness of the ET Cover using site-specific climatologic data and borrow source soil types. The results of the water balance analysis were used as the starting point for the final design and refined with hydrologic modeling using HYDRUS for the cover design. An initial water balance analysis was conducted by Hydrometrics to evaluate site conditions, applicability of the site, and potential borrow sources for an ET cover (Hydrometrics and CH2M HILL, 2012). The following water balance analysis builds on the Hydrometrics evaluation using additional borrow source locations and sampling data.

The method employed in this water balance analysis is described in Albright et al. (2010). This method uses the precipitation and PET values, and empirical factors developed through the ACAP program to estimate the monthly change in soil water storage. The monthly changes in soil water storage are then summed to required water storage capacity to prevent deep percolation through the cover, for a particular year. The required cover thickness is than calculated from the required storage capacity, using the soil water storage capacity (field capacity - wilting point) obtained from laboratory analysis of the soil water characteristic curves.

The application of the method for the site was conducted by Dr. William Albright of the Desert Research Institute and is described in Attachment 2. A summary of the analytical method, input values used, and results of the analytical evaluation follows.

The analytical method uses a monthly calculated water balance with the following formulas. The precipitation and PET values were for the Helena area from years 1979 to 2011. The maximum annual required storage calculated over this period was 49 mm (1985 – 1986). The soil thickness required to store 49 mm of infiltration was calculated for 18 different soil types from various borrow locations. The estimates were completed for the large range of soil types to help qualify the uncertainty of soil across the site, and from specific borrow sources.

Monthly Computation of Required Storage (S_r)

$$S_r = \sum_{m=1}^{6} \{(P_m - \beta_{FW} PET_m) - \Lambda_{FW}\}$$

Fall-Winter Months

$$+ \sum_{m=1}^{6} \{(P_m - \beta_{SS} PET_m) - \Lambda_{SS}\}$$

Spring-Summer Months

Include only months that exceed P/PET threshold

If $\Delta S_m < 0$, set $\Delta S_m = 0$

P_m = monthly precipitation

PET_m = monthly PET

β_{FW} = ET/PET in fall-winter

β_{SS} = ET/PET in spring-summer

Λ_{FW} = runoff & other losses in fall-winter

Λ_{SS} = runoff & other losses in spring-summer

The required soil thickness ranged from 0.24 to 1.17 meters (see Table 3). The calculations show that two of the soil types were considered less desirable for the ET Cover, samples EB-ET-1 and EB-ET-2, derived from a relatively coarse soil with low fines content from the east field excavations.

TABLE 3
Unsaturated Soil Hydraulic Parameters and Layer Thickness of Each Soil Required for Maximum Storage

			Volumetric Water Content (%)					
Soil Sample	**α (cm^{-1})**	**N**	**Residual**	**Saturated**	**Field Capacity**	**Wilting Point**	**Plant Available**	**Soil Thickness (m) Required to Store 49 mm of Water***
EB-ET-1	0.0441 (0.0573)	1.29 (1.42)	0	20.2	9.1 (5.8)	3.0 (1.2)	6.1 (4.6)	0.80 (1.07)
EB-ET-2	0.0164 (0.0213)	1.34 (1.48)	0	25.2	13.6 (9.6)	3.8 (1.6)	9.8 (8.0)	0.50 (0.61)
EB-ET-3	0.0155 (0.0202)	1.31 (1.45)	1.42	39.9	23.8 (17.4)	8.4 (4.3)	15.4 (13.1)	0.32 (0.37)
VV-ET-1	0.0090 (0.0117)	1.20 (1.33)	0	45.2	34.7 (27.8)	16.5 (8.2)	18.2 (19.6)	0.27 (0.25)
VV-ET-2	0.0095 (0.0124)	1.23 (1.36)	1.81	38.8	28.9 (23.2)	13.4 (7.4)	15.5 (15.8)	0.32 (0.31)
VV-ET-3	0.0121 (0.0157)	1.28 (1.41)	1.83	35.6	23.9 (18.5)	9.6 (5.4	14.3 (13.1)	0.34 (0.37)
VVL Comp 0-10	0.0061 (0.0079)	1.30 (1.43)	1.12	44.6	28.9 (24.1)	10.5 (5.8)	18.4 (18.3)	0.27 (0.27)
VVL Comp 11-15	0.0140 (0.0181)	1.32 (1.45)	0.27	43.0	22.7 (16.7)	7.2 (3.3)	15.5 (13.4)	0.32 (0.37)
VVL Comp 16-20	0.0094 (0.0123)	1.26 (1.39	0.00	46.9	30.3 (23.9)	11.6 (5.6)	18.7 (18.3)	0.26 (0.27)

TABLE 3
Unsaturated Soil Hydraulic Parameters and Layer Thickness of Each Soil Required for Maximum Storage

Soil Sample	α (cm^{-1})	N	Volumetric Water Content (%)					Soil Thickness (m) Required to Store 49 mm of Water*
			Residual	Saturated	Field Capacity	Wilting Point	Plant Available	
VVL Comp 21-30	0.0089 (0.0116)	1.26 (1.39)	0.00	48.7	30.7 (24.4)	11.8 (5.7)	18.9 (18.7)	0.26 (0.26)
VVL Comp 31+	0.0065 (0.0837)	1.21 (1.46)	0.00	57.4	43.2 (11.7)	20.3 (2.0)	22.9 (9.7)	0.21 (0.51)
VVL Comp TP-10	0.0231 (0.0300)	1.31 (1.44)	1.43	43.9	20.4 (14.4)	7.2 (3.7)	13.2 (10.7)	0.37 (0.46)
VVL Comp TP-12	0.0059 (0.0077)	1.30 (1.43)	3.43	46.8	32.0 (26.9)	13.0 (8.0)	19.0 (18.9)	0.26 (0.26)
VVL Comp TP-13	0.0083 (0.0108)	1.25 (1.37)	0.00	49.4	34.0 (27.3)	14.0 (7.0)	20.0 (20.3)	0.25 (0.24)
WB Borrow-1	0.0179 (0.0233)	1.29 (1.42)	1.94	47.4	26.6 (19.4)	10.3 (5.4)	16.3 (14.0)	0.30 (0.35)
WB Stockpile-1	0.0118 (0.1522)	1.29 (1.54)	1.45	44.3	27.8 (6.2	10.6 (2.0)	17.3 (4.2)	0.28 (1.17)
WB Stockpile-2	0.0153 (0.0199)	1.36 (1.50)	3.35	47.1	22.7 (17.0)	7.9 (5.0)	14.8 (12.0)	0.33 (0.41)
Topsoil-1	0.0137 (0.0177)	1.39 (1.52)	3.92	59.7	34.0 (25.6)	11.1 (7.0)	22.9 (18.6)	0.21 (0.26)

* Numbers in parentheses are corrected by the method described in the NRC report (Benson et al., 2011).

Abbreviations:

α = empirical related to inverse of the air entry suction

m = meter

mm = millimeter

N = empirical related to pore-size distribution

The effect of natural pedogenic processes including wet-dry and freeze-thaw cycles and biointrusion were included in the evaluated soil types. The laboratory soil parameters were adjusted to reflect these processes and the required soil thickness recalculated. Some soil is more susceptible to changes over time (Benson et al., 2011). Two soil types (WL Comp 31+ and WB Stockpile-1) indicated significant increases in required soil thickness. Both consisted of soil types that are considered highly plastic (unified soil classification system types CL and CH) and less desirable for the ET Cover. When adjusted for the effects of pedogenesis, cover thickness for desirable soil types ranged between 0.24 and 0.46 meter. However, this range is based solely on storage, and the required thickness to establish and maintain vegetation for adequate transpiration is greater, as discussed in Section 5.0.

A factor of safety for design of ET covers helps offset some of the uncertainties associated with in-place soil properties, and vegetation growth. A reasonable factor of safety based on field performance of ET covers to use as a guide is 1.25 times the calculated required soil thickness, or 0.9 meter, whichever is greater (USEPA, 2004). Given the results of the water balance analysis and soil types selected for use in construction, maintenance, and successful vegetation critical for an ET cover, the 0.9-meter (approximately 36-inch) soil thickness was selected for hydraulic modeling. The modeling was then used to refine and validate the design with more realistic (daily) meteorological data and soil characteristics. Results of the modeling were used for design and quality control during construction.

5.0 Evapotranspiration Cover System HYDRUS Modeling

The ET Cover System is defined by the following layers (from top to bottom): an amended storage layer (storage layer blended with Upper Lake Marsh (ULM) material), storage layer, and capillary break layer. The ET Cover is proposed to be placed over the interim cover system. The HYDRUS modeling employed the results from laboratory analysis of borrow source samples proposed for use in the ET Cover System IM. The soil sample results from previously conducted sampling and analysis (CH2M HILL, 2013) and additional samples collected from the VVL and West Fields borrow area were used as part of this evaluation. In addition, field investigation and sampling was conducted by Hydrometrics to support this evaluation and is documented in Attachment 1. A summary of the sample results is provided in Table 4. A total of 15 soil types were used in the HYDRUS evaluation, of which 14 soil types were used for the storage layers and one soil type was used as the capillary break layer.

The ET Cover System was evaluated using the HYDRUS-1D finite element numerical model designed for simulating saturated/unsaturated flow through soil. HYDRUS has been used to model ET covers for the Montana Department of Environmental Quality and others (such as USEPA and the Desert Research Institute) and was also used in the case study evaluations. This modeling evaluated an ET Cover scenario, considering conservative but reasonable site conditions. Previously conducted model scenarios with varying key design parameters were run to evaluate sensitivity of the cover performance (CH2M HILL, 2013). This modeling evaluated the variability of soil types proposed for use as potential borrow sources and guided the selection of design characteristics to be used in construction.

5.1 Model Inputs

The following sections describe the key parameters used to develop the ET Cover base case scenario. Key parameters in the HYDRUS model input are as follows:

- Top boundary condition (precipitation, potential evaporation, and potential transpiration)
- Bottom boundary condition (flow past base of capillary break layer – percolation)
- Soil properties (soil water retention hydraulic parameters, saturated hydraulic conductivity)
- ET Cover thickness (individual soil layer thickness, root depth, and relative root density)
- Initial condition (soil moisture representative of relatively steady state conditions)

A conceptual diagram of the HYDRUS model inputs is shown in Attachment 3. The modeling was conducted for a 35-year period. The highest percolation over 10 consecutive years was used to calculate an average annual percolation rate for evaluation of ET Cover performance. Specific information required for processes simulated in the HYDRUS-1D package are described in the HYDRUS user manual (Simunek et al., 2012).

5.1.1 Top Boundary Condition

The top boundary condition of the soil profile was defined by three atmosphere-land surface interaction processes: precipitation, potential evaporation (PE), and potential transpiration (PT). PT relates mainly to atmospheric conditions and leaf coverage of the surface and is therefore discussed here along with PE as part of the climatological data that define the upper boundary condition of the HYDRUS-1D model. The upper boundary is flat; however, runoff is addressed when precipitation exceeds the infiltration capacity of the soil type. The infiltration is reduced at the volume of precipitation exceeding the saturated hydraulic conductivity of the soil to account for runoff.

Precipitation data from the Helena, Montana, station (Weather Source COOP ID: 244055, managed by the Great Falls Weather Forecast Office) from 1979 through 2013 were used.

The reference evapotranspiration (ET_0) was calculated using the American Society of Civil Engineers (ASCE) Penman-Monteith Standardized Form using the Ref-ET software (Allen, 2012) for the 1997 to 2013 meteorological data from the AgriMet station located in Helena, Montana. The calculation used the daily maximum and minimum temperature, solar, humidity, and wind data. The ET_0 for the remaining precipitation period was post-processed using correlations developed between the AgriMet/REF-ET and NLDAS dataset for 1997 through 2013 and applied to the 1979 through 1997 dataset.

Total PET was calculated according to the ASCE Penman-Monteith Standardized Form ET_0 using grass as the reference crop. The leaf area index (LAI) and Ritchie-Burnett-Ankeny Function (Albright et al., 2010) [$PT=0.52xPETxLAI^{0.5}$] were then used to calculated the PT for the design ET cover vegetation community. The PE was calculated as the remainder of the PET: PE = PET - PT.

A seasonal distribution of LAI was developed to represent ranges of probable LAIs for western wheatgrass under similar climate conditions. The design LAI is based on the average monthly values reported by Frank (2002), which are considered conservative. Annual precipitation at the Frank (2002) study sites near Mandan, North Dakota, averaged 13.3 inches per year during the study period compared to the Helena site average of approximately 10.6 inches per year. The grasses at the Frank (2002) study sites were also grazed, suggesting lower LAI values than for an ungrazed site such as the design ET Cover. For the model, input for the LAI was interpolated linearly between adjacent end-of-the-month values that could be calculated directly, in order to generate the daily LAIs that were required.

TABLE 4
Soil Sample Analytical Summary

	Summary of Moisture Retention				Calculated Unsaturated Hydraulic Properties									
	Oversize Correction			Hydraulic Conductivity - Constant Head	As Tested		Oversize Corrected							
Sample ID	1/3 Bar Point Volumetric (% cm³/cm³)	15 Bar Point Volumetric (% cm³/cm³)	Water Holding Capacity (% cm³/cm³)	Oversize Corrected K_{sat} (cm/sec)	α (cm^{-1})	N	θ_r (% vol)	θ_s (% vol)	AWHC (oversized corrected)	Percent Gravel (% USCS)	Passing #200	Max. Dry Bulk Density (oversized corrected g/cm³)	Relative Compaction of Test Samples	USCS
EB-ET-1	8.2	2.4	5.8	1.10E-02	0.0441	1.2937	0.0	20.16	0.058	57.1	5.3	2.27	85	GP
EB-ET-2	13	8.2	4.8	7.70E-03	0.0164	1.3434	0.0	25.06	0.048	49.4	9.3	2.17	85	GM
EB-ET-3	25.3	8.2	17.1	6.70E-04	0.0155	1.3145	1.4	40	0.17	10	44	1.87	85	SM
VV-ET-1	35.7	16	19.8	6.00E-05	0.009	1.2048	0.0	45	0.20	36	34	1.73	85	GC
VV-ET-2	29.3	12.6	16.7	2.90E-04	0.0095	1.2335	1.8	39	0.17	40	27	1.86	85	GC
VV-ET-3	24.3	9.6	14.7	7.90E-04	0.0121	1.282	1.8	36	0.15	49	15	1.89	85	GC
VVL-Comp 0-10	29.8	10.5	19.4	2.20E-04	0.0061	1.3021	1.0	38	0.19	39	25	1.87	85	GC
VVL-Comp 11-15	24	7.1	16.9	1.20E-03	0.014	1.317	0.2	38	0.17	38	20	1.88	85	SM
VVL-Comp 16-20	31.7	11.5	20.2	4.50E-04	0.0094	1.2646	0.0	43	0.20	40	28	1.8	85	GC
VVL-Comp 21-30	31.7	11.7	20	2.60E-04	0.0089	1.2641	0.0	43	0.20	40	29	1.76	85	GC
VVL-Comp 31+	43.8	20.2	23.6	9.50E-05	0.0065	1.213	0.0	54	0.24	18	60	1.52	85	CH
VVL Comp TP-10	20.7	7.1	13.6	2.00E-03	0.0231	1.3099	1.2	38	0.14	34	22	1.9	85	SC
VVL Comp TP-12	32.4	12.9	19.6	9.60E-05	0.0059	1.3005	3.0	41	0.20	36	30	1.78	85	GC
VVL Comp TP-13	35.4	14	21.4	2.30E-04	0.0083	1.245	0.0	46	0.21	29	33	1.69	85	SC
WB Borrow-1	24.5	10.3	14.3	4.40E-04	0.0179	1.2868	1.8	44	0.14	12	47	1.75	85	SC
WB Stockpile-1	26.7	10.5	16.2	3.80E-04	0.0118	1.2869	1.4	42	0.16	9	62	1.84	85	CL
WB Stockpile-2	21.8	7.9	13.9	3.70E-04	0.0153	1.3648	2.8	40	0.14	24	48	1.89	85	SC
Topsoil-1	32.9	11	21.9	4.40E-04	0.0137	1.3859	3.9	60	0.22	0	62	1.3	85	ML

Abbreviations:
AWHC = available water holding capacity
cm³ = cubic centimeter
cm/sec = centimeter per second
USCS = United Soil Classification System

Table 5 shows the average LAI values reported for the end-of-month value. The average LAI was used to calculate the PE and PT for the base case simulation and is considered representative. The average value was used based on the sensitivity analysis conducted as part of the previously conducted HYDRUS modeling, and was used as the recommended values (CH2M HILL, 2013). LAI values of zero were used for the months of October through March of each year.

TABLE 5
Leaf Area Index End-of-Month Values for Potential Transpiration Calculation

Month	Average (Design Values)
Apr	0.11
May	0.36
Jun	0.45
Jul	0.43
Aug	0.35
Sep	0.22

5.1.2 Bottom Boundary Condition

A free draining boundary condition was placed at the base of the capillary break layer. Flow through this bottom boundary was counted as percolation that escaped evapotranspiration and migrated below the cover system.

5.1.3 Soil Properties

Table 3 summarizes the laboratory soil water retention hydraulic properties (laboratory results found in Attachment 1). The soil hydraulic parameters for the capillary break layer were from the EB-ET-2 material. The corrected values represent the parameters for the soil including the 3-inch to ¾-inch fraction. A simulation was run for each of the VVL and West Fields (WB) borrow soil types. The simulation was used to evaluate the percolation rates across a broad range of potential borrow sources and soil types.

The laboratory testing was conducted at 85 percent of maximum soil compaction density to mimic naturally occurring in-situ borrow soil density. This lower compaction at construction provides a less restrictive structure to establish plant rooting in the cover material and vegetation. Therefore, the modeling used the soil properties from the laboratory results based on a target soil density of 85 percent.

5.1.4 Evapotranspiration Storage Layer Thickness

The results of water balance analysis were used to determine a design storage layer thickness of 36 inches. The storage layer consists of a combined amended storage and storage layer of 36 inches overlying a capillary break layer of 6 inches. Previously conducted HYDRUS modeling (Hydrometrics and CH2M HILL, 2012, and CH2M HILL, 2013) indicated relatively low percolation rates with thinner storage sections. However, the minimum design thickness of 36 inches was used as the basis of this evaluation to allow for vegetation growth, uncertainties in precipitation, modeling, material properties, and long-term potential for erosion as recommended by USEPA guidance (USEPA, 2004). This guidance is considered appropriate for the former Smelter site.

The amended portion of the storage layer (upper 8 inches) includes addition of a to-be-determined volume of ULM material to help establish vegetation growth on the cover. The HYDRUS model simulation used the same properties of the storage layer for the amended layer. This is considered a conservative assumption given that the addition of the ULM material silt would increase the water-holding capacity of the amended layer.

The cover is assumed to be planted with mixed perennial bunchgrasses dominated by wheatgrass species. The rooting depth was assumed to be 36 inches, which meant that the combined vegetated and storage layer was assumed to have roots present throughout. Root density distributions for similar grassland plant communities were measured as part of the ACAP on a test site near Helena. The measured root density with depth was reported in Albright (2003) and is used in this modeling effort for the ET cover (see Table 6). Table 7 shows the plant stress parameters, which are representative of wheatgrass-dominated vegetation, used in the model. The depth of the root distribution was limited to the first 32 inches of the storage layer and was not extended into the capillary break or deeper layers.

TABLE 6
Rooting Depth Relative Distribution

Depth (cm)	Relative Root Density (cm^{-1})
0-10	0.284
10-20	0.213
20-30	0.159
30-40	0.119
40-50	0.089
50-60	0.067
60-70	0.050
70-80	0.037
80-90	0.028

Abbreviation: cm = centimeter

TABLE 7
Plant Water Stress Parameters for the Wheatgrass-Dominated Vegetation Community

Parameter	Description	Units	Values for Model
P0	Upper water content limit for root uptake to occur	cm	-10
Popt	Upper limit of optimum uptake range	cm	-25
P2H	Lower limit of optimum range (for pt of r2H)	cm	-5099
P2L	Lower limit of optimum range (for pt of r2L)	cm	-5099
P3	Lower water content limit for root uptake to occur-wilting point	cm	-30591
r2H	Potential transpiration rate at P2H	cm/day	0.5
r2L	Potential transpiration rate at P2L	cm/day	0.1

Sources: Trlica and Biondini, 1990; Frank and Ries, 1990

Abbreviations: cm = centimeters, cm/day = centimeters per day

5.2 Initial Condition

The initial soil water pressure potential was set to an arbitrary -8 cm. The simulation was conducted for a 35-year time period (1979 to 2013), with model runs including an additional 10 years, repeating the first 10 years of climatic data (1979 to 1988), to provide for calibration of initial soil moisture profile conditions in the model. This procedure allows a length of time for initial soil water volumes and profile distribution in the soil column to approach representative equilibrium conditions prior to evaluation of the percolation over the 35-year period of evaluation. Check runs were conducted looking at soil profile moisture conditions at the end of this “stabilization” period and at the end of 10 years in the evaluation period. The check runs confirm that initial soil conditions had stabilized and the results were not influenced artificially by transitory initial soil conditions. For evaluation of percolation rates, the 35-year period after the initial 10 years of stabilization was used.

5.3 HYDRUS Model Results

The model results for all soil types were reviewed over the entire period of simulation from 1979 to 2013 to determine the consecutive 10 years with the highest cumulative percolation for calculating an average annual percolation rate based on the highest percolation decade. The 10-year "highest" percolation was the simulation period from 1981 to 1990. The percolation rates calculated in the model were used because the highest precipitation events do not necessarily result in the highest percolation under ET cover conditions. Using a 10-year average annual percolation rate provides a representative but conservative estimate of cover performance for consistent comparison over a range of soil types.

Table 8 summarizes the HYDRUS modeling results for each soil type and average annual percolation rates. A more detailed summary is provided in Attachment 4. As shown in Table 8, the percolation rates ranged from 0.001 to 0.68 mm per year. The percolations rates are all relatively low for a 36-inch-thick ET storage layer, which is consistent with the water balance analysis.

TABLE 8
Summary of HYDRUS Modeling Results

Soil Type	Average Annual Bottom Percolation Rate (mm/year)
VV-ET-1	0.002
VV-ET-2	0.075
VV-ET-3	0.490
VVL-Comp 0-10	0.090
VVL-Comp 11-15	0.360
VVL-Comp 16-20	0.034
VVL-Comp 21-30	0.011
VVL-Comp 31+	0.001
VVL-Comp TP-10	0.680
VVL-Comp TP-12	0.017
VVL-Comp TP-13	0.006
WB-Borrow-1	0.003
WB Stockpile-1	0.023
WB Stockpile-2	0.006

Abbreviation:
mm/year = millimeter per year

The next step was to consider the water balance analysis, HYDRUS model results, and individual soil type properties to establish design criteria that would result in the predicted ET storage layer performance from a selected borrow source.

6.0 Design Criteria

The water balance analysis and the HYDRUS model results show that various borrow sources and soil types are acceptable for use as an ET cover. The results also show that some soil types are less desirable for the storage layer owing to potential pedogenic effects on the soil properties. Table 9 summarizes the soil types, soil characteristics, percolation rates, and evaluation of design criteria on selected borrow soil types.

In the evaluation, the two soil types VVL-Comp 31+ and WB Stockpile-1 initially were eliminated because of a potential pedogenic process that could influence ET storage performance. Both soil types as tested resulted in relatively low percolation rates, yet are greater than 50 percent fines (passing sieve size 200) and have higher plasticity (classified as a CH and CL soil). Based on the evaluation, soil types that are greater than 50 percent fines would only be desirable if they classify with low plasticity, as a ML or CL-ML soil. The soil types used in the evaluation that meet this criteria are highlighted dark green.

Gravel content influences the performance of the storage layer given a specified thickness. The greater the gravel content, the decreased storage available with the 36-inch storage layer. However, a certain volume of gravel is allowable and considered as part of this evaluation. Based on the borrow sample results and the HYDRUS model for storage layer, 40 percent gravel or lower is reasonable (equal to or greater than 60 percent passing ¾ inches). Only one soil type, VV-ET-E, did not meet this criterion. All other soil types were considered acceptable based on this criterion and are shaded a lighter green.

The fines content is a critical component to the ET storage layer performance. Given the soil types characterized, a reasonable fines percentage of 25 percent to 50 percent was selected as a design criterion based on the percolation rates. While soil types with less fines can result in acceptable percolation rates, the design criterion of 25 percent to 50 percent is reasonable from selected borrow sources, provides a conservative design criterion during construction, and allows for variability in source materials and placement in the ET cover. Fines greater than 50 percent would be allowable if the soil classifies as a ML or CL-ML as discussed previously.

Application of these design criteria results in five general soil types and gradations that would provide percolation rates in the range of 0.002 to 0.060 mm per year, which are extremely low rates through the ET Cover. The following design criteria are proposed based on this evaluation and to provide for an as-constructed cap that meets the design performance:

- 100 percent passing 3 inch
- Greater than 60 percent passing ¾ inch
- Greater than 25 percent passing No. 200 sieve
- Less than 50 percent passing No. 200 for high plasticity soil

Figure 1 shows the application of these design criteria for the different borrow sources and soil type gradations. This figure provides another method of review and analysis of the selected design criteria to the potential borrow soil types, similar to Table 9. Figure 1 shows that the soil types should be readily available from selected borrow sources, though some selection and processing during placement might be necessary to ensure the cover meets the criteria as constructed.

TABLE 9

Evaluation of Soil Types, Percolation Rates, and Pedogenic Influences on Design Criteria

	Summary of Moisture Retention				Calculated Unsaturated Hydraulic Properties										
	Oversize Correction			Hydraulic Conductivity - Constant Head	As Tested		Oversize Corrected								
Sample ID	1/3 Bar Point Volumetric (% cm³/cm³)	15 Bar Point Volumetric (% cm³/cm³)	Water Holding Capacity (% cm³/cm³)	Oversize Corrected K_{sat} (cm/sec)	α (cm-1)	N	θ_r (% vol)	θ_s (% vol)	AWHC (oversized corrected)	Percent Gravel (% USCS)	Passing #200	Percolation (mm/yr)	Max. Dry Bulk Density (oversized corrected g/cm³)	Relative Compaction of Test Samples	USCS
VV-ET-1	35.7	16	19.8	6.00E-05	0.0090	1.2048	0	45.21	0.20	35.6	33.87	0.002	1.73	85	GC
VV-ET-2	29.3	12.6	16.7	2.90E-04	0.0095	1.2335	1.8	39	0.17	40	27	0.075	1.86	85	GC
VV-ET-3	24.3	9.6	14.7	7.90E-04	0.0121	1.282	1.8	36	0.15	49	15	0.494	1.89	85	GC
VVL-Comp 0-10	29.8	10.5	19.4	2.20E-04	0.0061	1.3021	1.0	38	0.19	39	25	0.090	1.87	85	GC
VVL-Comp 11-15	24	7.1	16.9	1.20E-03	0.014	1.317	0.2	38	0.17	38	20	0.360	1.88	85	SM
VVL-Comp 16-20	31.7	11.5	20.2	4.50E-04	0.0094	1.2646	0.0	43	0.20	40	28	0.034	1.8	85	GC
VVL-Comp 21-30	31.7	11.7	20	2.60E-04	0.0089	1.2641	0.0	43	0.20	40	29	0.011	1.76	85	GC
VVL-Comp 31+	43.8	20.2	23.6	9.50E-05	0.0065	1.213	0.0	54	0.24	18	60	0.001	1.52	85	CH
VVL Comp TP-10	20.7	7.1	13.6	2.00E-03	0.0231	1.3099	1.2	38	0.14	34	22	0.676	1.9	85	SC
VVL Comp TP-12	32.4	12.9	19.6	9.60E-05	0.0059	1.3005	3.0	41	0.20	36	30	0.017	1.78	85	GC
VVL Comp TP-13	35.4	14	21.4	2.30E-04	0.0083	1.245	0.0	46	0.21	29	33	0.006	1.69	85	SC
WB Borrow-1	24.5	10.3	14.3	4.40E-04	0.0179	1.2868	1.8	44	0.14	12	47	0.003	1.75	85	SC
WB Stockpile-1	26.7	10.5	16.2	3.80E-04	0.0118	1.2869	1.4	42	0.16	9	62	0.023	1.84	85	CL
WB Stockpile-2	21.8	7.9	13.9	3.70E-04	0.0153	1.3648	2.8	40	0.14	24	48	0.060	1.89	85	SC

Notes:

Darker green highlight = soil types that are greater than 50 percent fines and are classified with low plasticity, as a ML or CL-ML soil.

Lighter green highlight = soil types less than 40 percent gravel.

Bold text = desirable soil types.

Abbreviations:

AWHC = available water holding capacity

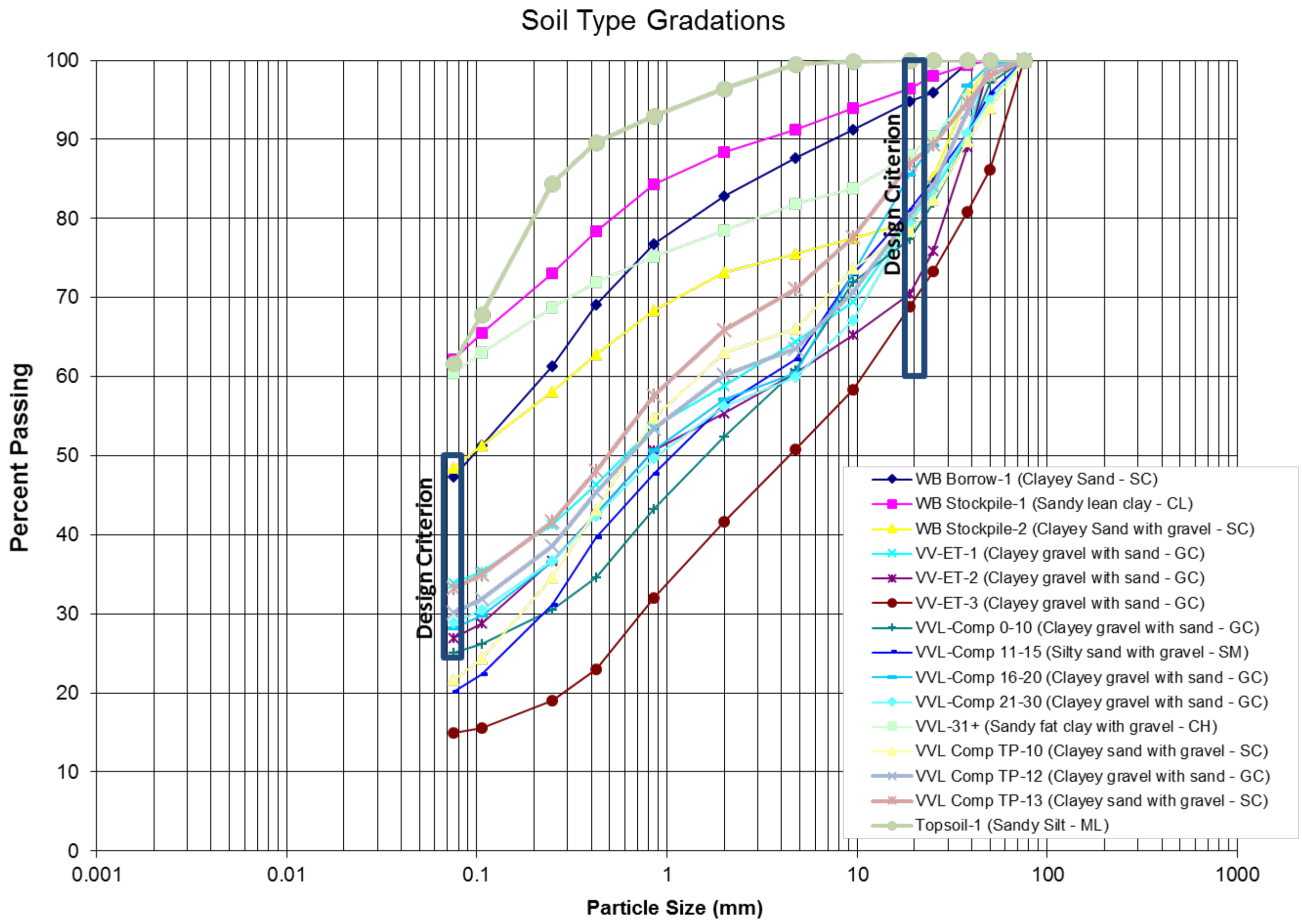
cm³ = cubic centimeters

cm/sec = centimeters per second

g/cm³ = grams per cubic centimeter

USCS = United Soil Classification System

FIGURE 1
Soil Type Gradation and Design Criteria



7.0 Conclusions

The water balance evaluation and hydraulic modeling support the use of an ET cover and predict that it would be effective under site conditions and available borrow source soil types. The evaluation determined soil types that are less desirable because of potential site pedogenic effects after construction. The evaluation also determined that required storage layers thicknesses are well within the recommended thickness for other cover considerations such as viable vegetation and variability in as-constructed conditions. The HYDRUS model results evaluated the performance of a 36-inch combined vegetated/storage layer with a 6-inch-thick capillary break layer for the remaining, desirable soil types. These results were used to refine the cover design and define the borrow soil design criteria.

8.0 Recommendations

Based on the results of the water balance evaluation and HYDRUS modeling, the following recommendations are provided:

- Both borrow sources could provide desirable ET cover soil types for a recommended 36-inch storage layer.
- The ULM material can be used as an amendment as long as the final, as-placed material meets the defined storage layer design criteria.

- Storage layer design criteria for either borrow source should include the following:
  - 100 percent passing 3 inch
  - Greater than 60 percent passing ¾ inch
  - Greater than 25 percent passing No. 200 sieve
  - Less than 50 percent passing No. 200 sieve unless classified as low plasticity (ML, CL-ML)
  - Placement density of 85 percent

9.0 References

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Attachment 1
Field Sampling and Analytical Testing Results for Potential Borrow Material

ET Cover System:
Valley View Landfill and West Bench Soil Sampling and Analysis

PREPARED FOR: Nathan Betts, P.E., CH2M Hill

PREPARED BY: Mark Rhodes, P.E., Hydrometrics

DATE: November 7, 2014

Summary

Soil samples were collected for analysis as part of the ET Cover System Final Design for the East Helena Facility. Collected samples were then analyzed for suitability as borrow soil for the ET cover. Field sampling at Valley View Landfill (VVL) took place on July 2 and 3, 2014, and sampling of the West Bench area soils was conducted on July 25, 2014. This memorandum discusses the sampling procedure, preparation for laboratory analysis, and laboratory results.

Field Sampling

A Field Sampling and Analysis Plan (FSAP) was prepared prior to field sampling to provide guidance on sample collection and analysis. The FSAP anticipated sampling from 15 test pit locations spaced approximately 100 feet apart in the VVL future Cell 4 expansion area.

An excavator operated by VVL was used to construct test pits at locations specified by Hydrometrics. Actual test pit locations were based on the FSAP and observations made in the field. A survey grade GPS was used to record test pit location and ground surface elevation, as shown in Attachment A. Test pits were excavated to the maximum depth possible with the excavator, which ranged from 23 to 26 feet below ground surface (BGS).

Soils were documented on field logs and photographed during excavation. Lithological information recorded on field logs included soil color, texture, moisture, and estimated percentage of 3-inch-plus material. Information was recorded for each visually distinct layer within the test pit. Field data were used to generate test pit logs, which are included in Attachment B.

Soil samples were also collected from each visually distinct layer. Material was collected with a shovel from the test pit spoils as it was excavated. Material greater than three inches, as verified with a tape measure, was removed from the sample. Soil was collected throughout the sample depth interval and placed in a five-gallon bucket. Each bucket was sealed with a lid immediately after sample collection. Sample number, date, time, and depth were recorded on each bucket and field log. A total of 53 samples were collected.

Based on initial visual estimates of oversized material in the VVL samples, the design team determined sampling of additional soils from an alternate borrow area was necessary. Previous geotechnical investigations of soils located on the west bench indicated suitable ET

Cover materials may be available in the area. Two soil samples were collected from the CAMU 2 excavation soil stockpile, and one sample was collected from the former CAMU 2 clay liner borrow area. Soil samples were collected from several locations within the soil stockpile and borrow area using a shovel and placed in five-gallon buckets. Each bucket was sealed with a lid immediately after sample collection and the sample number, date, time, and location were recorded on the bucket. Approximate sample locations are shown in Attachment A.

Sample Analysis

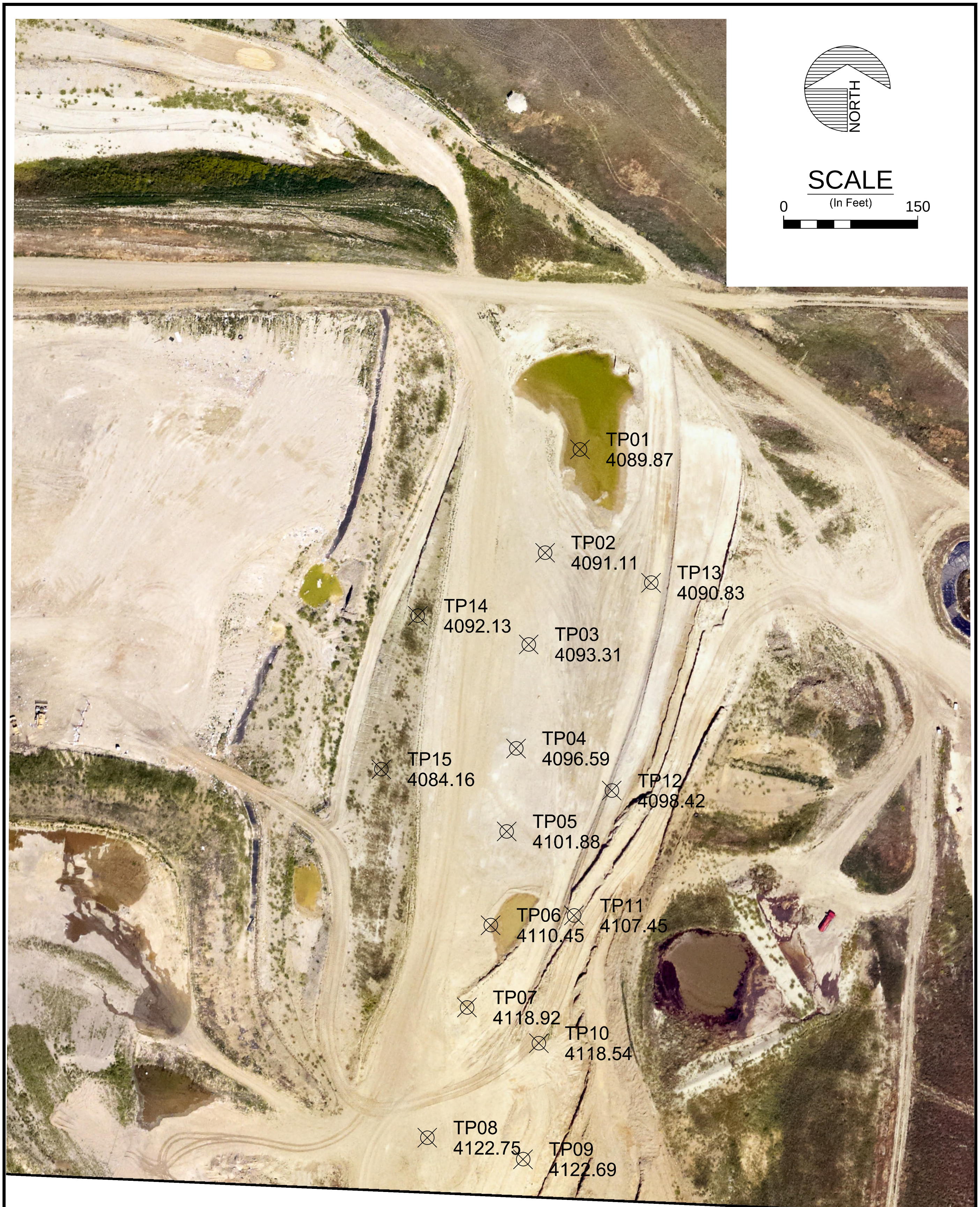
VVL soil samples were taken to the Hydrometrics lab for analysis of the fraction finer than the #200 sieve as well as preparation for additional laboratory analysis. Thirty of the 53 samples were selected for fine fraction analysis. The thirty samples represented the visually distinct layers of material spatially distributed throughout the sampling area. Five-gallon samples were reduced to approximately 500 grams for sieve analysis. Samples were spread on a clean tarp, mixed to homogenize, and reduced by quartering until an appropriate sample size was obtained. Leftover material was returned to sealed five-gallon buckets. The reduced samples were dried in an oven and weighed. Wet sieve analysis was completed with the #200 sieve. The remaining material was again dried and weighed, and the percentage passing the #200 sieve was calculated.

Extensive gradation testing of the west bench soils had been conducted during previous geotechnical investigations and no additional gradation testing was conducted on these soils.

Field data and percentage of fines results were circulated to the design team to determine which samples to composite and ship to the Daniel B Stephens and Associates (DBSA) laboratory in Albuquerque, New Mexico. The design team determined eight composite samples were to be produced from the VVL samples, each composed of two to three individual samples. Individual samples were reduced by quartering to generate five-gallon composite samples. Initial gradation results and the individual samples included in each composite sample are shown in Attachment C.

The VVL composite samples and three west bench samples were shipped with a chain-of-custody form and cover letter to DBSA for lab analysis on August 5, 2014. Due to the coarse nature of the VVL soil samples, DBSA requested additional material for analysis. An additional five-gallon bucket was prepared for each composite sample and shipped to DBSA with a chain-of-custody form and cover letter on August 14, 2014. Laboratory analysis at DBSA consisted of particle size analysis with hydrometer, soil water characteristic curves, rigid wall saturated hydraulic conductivity, calculated unsaturated K, van Genuchten modeling parameters, field capacity, wilting point, moisture content, bulk density, total porosity, and standard proctor tests. The DBSA lab report is included as Attachment D.

Attachment A
Sample Locations



ET COVER SYSTEM TECHNICAL MEMORANDUM	**VVL TEST PIT LOCATIONS**	FIGURE **A-1**

UPDATE TIME: 11:37 AM
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ET COVER SYSTEM
TECHNICAL MEMORANDUM

WEST BENCH SOIL SAMPLE APPROXIMATE LOCATIONS

FIGURE

A-2

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Attachment B
VVL Test Pit Logs

Hydrometrics, Inc.
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Helena, Montana

Test Pit Log

Hole Name: TP01

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

COORDINATES
Northing: 853299.32
Easting: 1365764.62
Ground Elevation: 4089.87

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 24
Water Table Depth (ft):

Remarks: Sample 001 is a 5-gallon bucket from 0.0 to 4.0 feet, Sample 002 is a 5-gallon bucket from 4.0 to 7.5 feet, Sample 003 is a 5-gallon bucket from 7.5 to 14.0 feet, Sample 004 is a 5-gallon bucket from 14.0 to 22.5 feet with material greater than 3 inch diameter excluded. Water observed in test pit at depth of 21.5 feet on July 3, 2014.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–4	001												0.0 - 4.0' **Gravelly Sand** Some reddish mottles, cobbles to 8 inches, little clay, slightly moist, loose.	
5	002										5		4.0 - 7.5' **Sandy Loam** Consolidated clay, slightly moist, stiff.	
10	003										10		7.5 - 14.0' **Sandy Loam with Gravels** Loose, slightly moist, more gravel at 12 feet, few red and black lenses, subrounded fractured gravels.	
15, 20	004										15, 20		14.0 - 24.0' **Gravelly Sand** Moist, cobbles to 10 inches, increased fine sand/fines, loose.	
25											25			

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Helena, Montana

Test Pit Log

Hole Name: TP02

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
COORDINATES
Legal Description: T9N R2W S6
Northing: 853183.79
Location Description: Valley View Landfill Cell 4
Easting: 1365725.61
Ground Elevation: 4091.11

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 23
Water Table Depth (ft):

Remarks: Sample 005 is a 5-gallon bucket from 0.0 to 2.5 feet, Sample 006 is a 5-gallon bucket from 2.5 to 8.5 feet, Sample 007 is a 5-gallon bucket from 8.5 to 19.0 feet with material greater than 3 inch diameter excluded. Water observed in test pit at depth of 22.0 feet on July 3, 2014.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
	005												0.0 - 2.5' **Sand** Reddish mottles to 18 inch depth, loose, transition to sandy clay, slightly moist.	
5	006										5		2.5 - 8.5' **Sandy Loam** Consolidated, slightly moist, few white mottles, sand lenses, red mottles past 6 feet.	
10											10		8.5 - 12.5' **Gravelly Sand** Slightly moist, loose, few red, black, greenish mottles.	
15	007										15		12.5 - 23.0' **Gravelly Sand** Same as above with slightly more gravel, moist.	
20											20			

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Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP03

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 583081.18
Easting: 1365707.32
Ground Elevation: 4093.31

County: Lewis and Clark
State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 26
Water Table Depth (ft):

Remarks: Sample 008 is a 5-gallon bucket from 0.0 to 5.5 feet, Sample 009 is a 5-gallon bucket from 5.5 to 10.0 feet, Sample 010 is a 5-gallon bucket from 10.0 to 14.0 feet, Sample 011 is a 5-gallon bucket from 14.0 to 19.0 feet, Sample 012 is a 5-gallon bucket from 19.0 to 23.5 feet with material greater than 3 inch diameter excluded. Water observed in test pit at depth of 23.5 feet on July 3, 2014.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–5.5	008												0.0 - 5.5' **Sand** Slightly moist, loose, red mottles.	
5.5–10	009												5.5 - 10.0' **Cobbles and Sand** Partially consolidated, more fines.	
10–14	010												10.0 - 14.0' **Sandy Loam** Consolidated, slightly moist, stiff.	
14–19	011												14.0 - 19.0' **Sand** Slightly moist, loose.	
19–23.5	012												19.0 - 26.0' **Sand** Some gray, slightly more moist, loose.	
23.5–26														

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Helena, Montana

Test Pit Log

Hole Name: TP04

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 852964.77
Easting: 1365693.23
Ground Elevation: 4096.59

County: Lewis and Clark
State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 25.5
Water Table Depth (ft):

Remarks: Sample 013 is a 5-gallon bucket from 0.0 to 5.5 feet, Sample 014 is a 5-gallon bucket from 5.5 to 14.5 feet, Sample 015 is a 5-gallon bucket from 17.5 to 24.5 feet with material greater than 3 inch diameter excluded. Water observed in test pit at depth of 25.0 feet on July 3, 2014.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)	GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–5.5	013											0.0 - 5.5' **Sand** Red mottles, slightly moist, loose.	
5.5–14.5	014											5.5 - 17.5' **Sandy Loam** Consolidated, slightly moist, stiff.	
17.5–24.5	015											17.5 - 25.5' **Sand** Gray lenses, slightly moist, loose.	

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Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP05

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
COORDINATES
Legal Description: T9N R2W S6
Northing: 852964.77
Location Description: Valley View Landfill Cell 4
Easting: 1365693.23
Ground Elevation: 4101.88

Recorded By: George Metzger
Sample Hammer Drop System:
Drilling Company:
Inner Rod Size (ID/OD, in):
Driller:
Hole Diameter (in):
Drilling Method:
Total Depth Drilled (ft): 25
Drilling Machine:
Water Table Depth (ft):
Drilling Fluid:

Remarks: Sample 016 is a 5-gallon bucket from 0.0 to 13.0 feet, Sample 017 is a 5-gallon bucket from 13.0 to 21.0 feet, Sample 018 is a 5-gallon bucket from 21.0 to 25.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0 – 13	016												0.0 - 13.0' **Sand** Some gray in top 2 feet, thin partially consolidated layer at 2 feet, slightly moist, loose, some red mottles.	
13 – 21	017												13.0 - 21.0' **Sandy Loam** Consolidated, slightly moist, stiff.	
21 – 25	018												21.0 - 25.0' **Sand** Slightly moist, loose.	

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Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP06

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 852767.02
Easting: 1365664.71
Ground Elevation: 4110.45

County: Lewis and Clark State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 26
Water Table Depth (ft):

Remarks: Sample 019 is a 5-gallon bucket from 0.0 to 5.0 feet, Sample 020 is a 5-gallon bucket from 5.0 to 16.0 feet, Sample 021 is a 5-gallon bucket from 17.0 to 23.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–5	019												0.0 - 5.0' **Sandy Loam** Slightly moist, loose, some clay lenses.	
5–16	020												5.0 - 17.0' **Sand** Rust color prevalent, slightly moist, loose.	
17–23	021												17.0 - 26.0' **Gravelly Sand** Moist, loose.	

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Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP07

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

COORDINATES
Northing: 852674.93
Easting: 1365638.29
Ground Elevation: 4118.92

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 26
Water Table Depth (ft):

Remarks: Sample 022 is a 5-gallon bucket from 0.0 to 3.5 feet, Sample 023 is a 5-gallon bucket from 3.5 to 12.0 feet, Sample 024 is a 5-gallon bucket from 12.0 to 21.0 feet, Sample 025 is a 5-gallon bucket from 21.0 to 26.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0.0 - 3.5	022												0.0 - 3.5' **Fine Sandy Loam** Slightly moist, loose.	
3.5 - 12.0	023												3.5 - 12.0' **Sand** Slightly moist, loose.	
12.0 - 21.0	024												12.0 - 21.0' **Gray/Brown Sand** Slightly moist, loose.	
21.0 - 26.0	025												21.0 - 26.0' **Sand** Slightly moist, loose.	

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Helena, Montana

Test Pit Log

Hole Name: TP08

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 852529.23
Easting: 13365593.84
Ground Elevation: 4122.75

County: Lewis and Clark
State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 24
Water Table Depth (ft):

Remarks: Sample 026 is a 5-gallon bucket from 0.0 to 10.0 feet, Sample 027 is a 5-gallon bucket from 13.0 to 24.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0													**0.0 - 13.0' Fine Sand** Slightly moist, loose.	
5	026										5			
10											10			
13													**13.0 - 24.0' Sand** Green mottles past 18 feet, slightly moist, loose, plastic.	
15											15			
20	027										20			
25											25			

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Hydrometrics, Inc.
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Helena, Montana

Test Pit Log

Hole Name: TP09

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 852505.15
Easting: 1365700.96
Ground Elevation: 4122.69

County: Lewis and Clark
State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 25
Water Table Depth (ft):

Remarks: Sample 028 is a 5-gallon bucket from 0.0 to 10.0 feet, Sample 029 is a 5-gallon bucket from 10.0 to 19.0 feet, Sample 030 is a 5-gallon bucket from 19.0 to 23.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–10	028												**0.0 - 10.0' Fine Sand** Slightly moist, loose.	
10–19	029												**10.0 - 19.0' Sand** Slightly more moist, loose.	
19–22	030												**19.0 - 22.0' Sand** Slightly moist, loose, green mottles.	
22–25													**22.0 - 25.0' Sand** Same as above with slightly less oversize material.	

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Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP10

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
Project:
COORDINATES
Northing: 852634.99
Easting: 1365718.59
Ground Elevation: 4118.54

County: Lewis and Clark State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 25
Water Table Depth (ft):

Remarks: Sample 031 is a 5-gallon bucket from 0.0 to 7.5 feet, Sample 032 is a 5-gallon bucket from 7.5 to 15.0 feet, Sample 033 is a 5-gallon bucket from 16.0 to 17.0 feet, Sample 034 is a 5-gallon bucket from 17.0 to 25.0 feet with material greater than 3 inch diameter excluded. Water observed in test pit at depth of 24.0 feet on July 3, 2014.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0.0 - 7.5	031												0.0 - 7.5' **Sand** Slightly moist, loose, red and gray lenses.	
7.5 - 15.0	032												7.5 - 12.5' **Sand** Some gray, slightly plastic, slightly moist, loose, approximately 5%, 10 inches plus. 12.5 - 16.0' **Sand** Same with little more gray and 12 inches plus material.	
16.0 - 17.0	033												16.0 - 17.0' **Sand** Gray lenses, wet, loose, water at 16 feet, perched this layer seeped for 5 minutes and stopped.	
17.0 - 25.0	034												17.0 - 25.0' **Sandy Loam** Moist, loose, more plastic, green mottles, few red at bottom of pit.	

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Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP11

Date Hole Started: 7/2/2014 Date Hole Finished: 7/2/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
COORDINATES
Legal Description: T9N R2W S6
Northing: 852777.95
Location Description: Valley View Landfill Cell 4
Easting: 1365758.02
Ground Elevation: 4107.45

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 25
Water Table Depth (ft):

Remarks: Sample 035 is a 5-gallon bucket from 0.0 to 4.0 feet, Sample 036 is a 5-gallon bucket from 4.0 to 9.0 feet, Sample 037 is a 5-gallon bucket from 9.0 to 13.0 feet, Sample 038 is a 5-gallon bucket from 13.0 to 23.0 feet, Sample 039 is a 5-gallon bucket from 23.0 to 25.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–4	035												0.0 - 4.0' **Fine Sandy Loam** Slightly moist, loose, plastic.	
5	036										5		4.0 - 9.0' **Sand** Slightly moist, loose, red mottles.	
10	037										10		9.0 - 13.0' **Sand** Discontinuous consolidated layers, loose, slightly moist.	
15	038										15		13.0 - 19.0' **Sand** Slightly more moist, loose, plastic, few green mottles.	
20											20		19.0 - 23.0' **Sand** Same as above, 15% oversize.	
25	039										25		23.0 - 25.0' **Sandy Loam** Consolidated, moist, loose.	

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Hydrometrics, Inc.
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Helena, Montana

Test Pit Log

Hole Name: TP12

Date Hole Started: 7/3/2014 Date Hole Finished: 7/3/2014

Client: CH2M Hill
Project:
County: Lewis and Clark
State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

COORDINATES
Northing: 852917.64
Easting: 1365800.2
Ground Elevation: 4098.42

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 25.5
Water Table Depth (ft):

Remarks: Sample 040 is a 5-gallon bucket from 0.0 to 4.0 feet, Sample 041 is a 5-gallon bucket from 4.0 to 14.5 feet, Sample 042 is a 5-gallon bucket from 14.5 to 21.5 feet, Sample 043 is a 5-gallon bucket from 21.5 to 25.5 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–4.0	040												0.0 - 4.0' **Sand** Slightly moist, loose.	
5, 10	041										5, 10		4.0 - 14.5' **Sandy Loam** Slightly moist, loose, plastic, red mottles.	
15, 20	042										15, 20		14.5 - 21.5' **Sandy Loam** Consolidated, slightly moist.	
25	043										25		21.5 - 25.5' **Sand with Gravel** Moist, loose.	

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Hydrometrics, Inc.
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Helena, Montana

Test Pit Log

Hole Name: TP13

Date Hole Started: 7/3/2014   Date Hole Finished: 7/3/2014

Client: CH2M Hill
Project:

COORDINATES
Northing: 853150.26
Easting: 1365844.2
Ground Elevation: 4090.83

County: Lewis and Clark   State: Montana
Property Owner: MT Environmental Trust Group
Legal Description: T9N R2W S6
Location Description: Valley View Landfill Cell 4

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 24
Water Table Depth (ft):

Remarks: Sample 044 is a 5-gallon bucket from 0.0 to 3.0 feet, Sample 045 is a 5-gallon bucket from 3.0 to 9.0 feet, Sample 046 is a 5-gallon bucket from 9.0 to 24.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0.0 - 3.0	044												0.0 - 3.0' **Sandy Loam** Loose, slightly moist.	
3.0 - 9.0 (5)	045										5		3.0 - 9.0' **Sandy Loam** Consolidated, slightly moist, green mottles, small seep developed at 5 feet after 10 minutes.	
9.0 - 13.0 (10)	046										10		9.0 - 13.0' **Sand** Moist, loose, plastic, few red and green mottles, few black striations.	
13.0 - 24.0 (15, 20)											15, 20		13.0 - 24.0' **Sand** Same with little more gray, slightly more consolidated material.	
25											25			

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Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP14

Date Hole Started: 7/3/2014 Date Hole Finished: 7/3/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
COORDINATES
Legal Description: T9N R2W S6
Northing: 853113.27
Location Description: Valley View Landfill Cell 4
Easting: 1365583.14
Ground Elevation: 4092.13

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 24
Water Table Depth (ft):

Remarks: Sample 047 is a 5-gallon bucket from 0.0 to 4.5 feet, Sample 048 is a 5-gallon bucket from 4.5 to 10.0 feet, Sample 049 is a 5-gallon bucket from 10.0 to 14.0 feet, Sample 050 is a 5-gallon bucket from 14.0 to 24.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0.0–4.5	047												0.0 - 4.5' **Silty Sand** Slightly moist, loose.	
4.5–10.0	048												4.5 - 10.0' **Sandy Loam** Partially consolidated, slightly moist to moist.	
10.0–14.0	049												10.0 - 14.0' **Sand** Slightly moist, loose.	
14.0–24.0	050												14.0 - 24.0' **Sand** Moist, loose, red mottles.	

Hydrometrics, Inc.
Consulting Scientists and Engineers
Helena, Montana

Test Pit Log

Hole Name: TP15

Date Hole Started: 7/3/2014 Date Hole Finished: 7/3/2014

Client: CH2M Hill
County: Lewis and Clark
State: Montana
Project:
Property Owner: MT Environmental Trust Group
COORDINATES
Legal Description: T9N R2W S6
Northing: 852941.53
Location Description: Valley View Landfill Cell 4
Easting: 1365542.42
Ground Elevation: 4084.16

Recorded By: George Metzger
Drilling Company:
Driller:
Drilling Method:
Drilling Machine:
Drilling Fluid:

Sample Hammer Drop System:
Inner Rod Size (ID/OD, in):
Hole Diameter (in):
Total Depth Drilled (ft): 26
Water Table Depth (ft):

Remarks: Sample 051 is a 5-gallon bucket from 0.0 to 4.5 feet, Sample 052 is a 5-gallon bucket from 4.5 to 21.0 feet, Sample 053 is a 5-gallon bucket from 21.0 to 26.0 feet with material greater than 3 inch diameter excluded.

DEPTH	SAMPLE NUMBER	SPT(N) BPF	(N1)60 BPF	RECOVERY (feet)	Qu (tsf) PENETROMETER	Cu (tsf) SHEAR VANE	USCS	DRY DENSITY (pcf)	PI (%)	MOISTURE CONTENT (%)		GRAPHICS	GEOLOGICAL DESCRIPTION	PIEZOMETER COMPLETION
0–4.5	051												0.0 - 4.5' **Silty Sand** Slightly moist, partially consolidated.	
5											5			
4.5–21.0	052												4.5 - 21.0' **Sand** Green mottles, moist, loose, slightly more 12 inches plus as depth increases.	
10											10			
15											15			
20											20			
21.0–26.0	053												21.0 - 26.0' **Sandy Silt** Consolidated, moist, sand and gravel pockets, very stiff.	
25											25			

Attachment C
VVL Sample Summary Table

VVL SAMPLE SUMMARY TABLE

Sample	Test Pit	Depth	Estimated % >3"	% of 3" Minus Passing #200 Sieve	DBSA Composite Sample
VV-TP-13-001	TP01	0-4	15%	26%	
VV-TP-13-002	TP01	4-7.5	<5%	25%	
VV-TP-13-003	TP01	7.5-14	10%	8%	
VV-TP-13-004	TP01	14-22.5	15%	11%	
VV-TP-13-005	TP02	0-2.5	5%	19%	
VV-TP-13-006	TP02	2.5-8.5	<5%		
VV-TP-13-007	TP02	8.5-19	10%		
VV-TP-13-008	TP03	0-5.5	10%		
VV-TP-13-009	TP03	5.5-10	15%	23%	VVL_Composite_21-30
VV-TP-13-010	TP03	10-14	<5%		
VV-TP-13-011	TP03	14-19	5%	9%	VVL_Composite_0-10
VV-TP-13-012	TP03	19-23.5	5%		
VV-TP-13-013	TP04	0-5.5	10%	9%	VVL_Composite_0-10
VV-TP-13-014	TP04	5.5-17.5	<2%	42%	
VV-TP-13-015	TP04	17.5-24.5	15%		
VV-TP-13-016	TP05	0-13	10%		
VV-TP-13-017	TP05	13-21	<2%		
VV-TP-13-018	TP05	21-25	10%		
VV-TP-13-019	TP06	0-5	5%	36%	VVL_Composite_31+
VV-TP-13-020	TP06	5-17	10%	7%	VVL_Composite_0-10
VV-TP-13-021	TP06	17-23	10%	16%	VVL_Composite_16-20
VV-TP-13-022	TP07	0-3.5	0%		
VV-TP-13-023	TP07	3.5-12	10%		
VV-TP-13-024	TP07	12-21	10%	21%	VVL_Composite_21-30
VV-TP-13-025	TP07	21-26	10%		
VV-TP-13-026	TP08	0-10	<2%	30%	
VV-TP-13-027	TP08	13-24	5%	19%	VVL_Composite_16-20
VV-TP-13-028	TP09	0-10	<2%	15%	VVL_Composite_11-15
VV-TP-13-029	TP09	10-19	5%		
VV-TP-13-030	TP09	19-23	5%	20%	
VV-TP-13-031	TP10	0-7.5	10%		VVL_CompositeTP-10
VV-TP-13-032	TP10	7.5-15	15%		VVL_CompositeTP-10
VV-TP-13-033	TP10	16-17	5%		
VV-TP-13-034	TP10	17-25	5%	14%	VVL_CompositeTP-10
VV-TP-13-035	TP11	0-4	<2%		
VV-TP-13-036	TP11	4-9	10%	25%	
VV-TP-13-037	TP11	9-13	5%	28%	VVL_Composite_21-30
VV-TP-13-038	TP11	13-23	10%		
VV-TP-13-039	TP11	23-25	<5%	56%	VVL_Composite_31+
VV-TP-13-040	TP12	0-4	10%		
VV-TP-13-041	TP12	4-14.5	15%		VVL_CompositeTP-12
VV-TP-13-042	TP12	14.5-21.5	<2%		VVL_CompositeTP-12
VV-TP-13-043	TP12	21.5-25.5	10%	13%	VVL_CompositeTP-12
VV-TP-13-044	TP13	0-3	5%	46%	
VV-TP-13-045	TP13	3-9	<2%	47%	VVL_CompositeTP-13
VV-TP-13-046	TP13	9-24	15%		VVL_CompositeTP-13
VV-TP-13-047	TP14	0-4.5	5%	17%	VVL_Composite_16-20
VV-TP-13-048	TP14	4.5-10	<2%	58%	
VV-TP-13-049	TP14	10-14	5%	9%	
VV-TP-13-050	TP14	14-24	10%	14%	VVL_Composite_11-15
VV-TP-13-051	TP15	0-4.5	<2%		
VV-TP-13-052	TP15	4.5-21	15%	11%	VVL_Composite_11-15
VV-TP-13-053	TP15	21-26	5%	43%	VVL_Composite_31+

Attachment D
Daniel B Stephens & Associates Lab Report

Laboratory Report for

Hydrometrics, Inc.

VVL Composite Samples #12015

October 16, 2014

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

October 16, 2014

Mark Rhodes
Hydrometrics, Inc.
3020 Bozeman Ave.
Helena, MT 59601
(406) 443-4150

Re: DBS&A Laboratory Report for the Hydrometrics, Inc. Project: VVL Composite Samples PO#12015

Dear Mr. Rhodes:

Enclosed is the report for the Hydrometrics, Inc. Project: VVL Composite Samples PO#12015 samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Hydrometrics, Inc. and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines

Joleen Hines
Laboratory Supervising Manager

Enclosure

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
VVL Composite 0-10																X	X				X	X
VVL Composite 0-10 (85%, 1.46)	X	X		X			X	X		X	X		X	X								
VVL Composite 11-15																X	X				X	X
VVL Composite 11-15 (85%, 1.50)	X	X		X			X	X		X	X		X	X								
VVL Composite 16-20																X	X				X	X
VVL Composite 16-20 (85%, 1.45)	X	X		X			X	X		X	X		X	X								
VVL Composite 21-30																X	X				X	X
VVL Composite 21-30 (85%, 1.38)	X	X		X			X	X		X	X		X	X								
VVL Composite 31+																X	X				X	X
VVL Composite 31+ (85%, 1.22)	X	X		X			X	X		X	X		X	X								
VVL Composite TP-10																X	X				X	X
VVL Composite TP-10 (85%, 1.51)	X	X		X			X	X		X	X		X	X								
VVL Composite TP-12																X	X				X	X
VVL Composite TP-12 (85%, 1.40)	X	X		X			X	X		X	X		X	X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall
[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Summary of Tests Performed (Continued)

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
VVL Composite TP-13																X	X				X	X
VVL Composite TP-13 (85%, 1.37)	X	X		X			X	X		X	X		X	X								
WB Borrow-1																X	X				X	X
WB Borrow-1 (85%, 1.42)	X	X		X			X	X		X	X		X	X								
WB Stockpile-1																X	X				X	X
WB Stockpile-1 (85%, 1.52)	X	X		X			X	X		X	X		X	X								
WB Stockpile-2																X	X				X	X
WB Stockpile-2 (85%, 1.48)	X	X		X			X	X		X	X		X	X								
Topsoil-1																X	X				X	X
Topsoil-1 (85%, 1.10)	X	X		X			X	X		X	X		X	X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall
[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Twelve samples arrived, each in a full 5-gallon bucket sealed with a lid and tape, on August 7, 2014. Eight buckets of additional sample material arrived, each in a full 5-gallon bucket sealed with a lid and tape, on August 19, 2014.

Preparation and Testing Notes:
Each of the twelve samples were subjected to standard proctor compaction testing. Based on the proctor compaction test results, a sub-sample was prepared for each sample by remolding each material into a testing ring to target 85% of the respective maximum dry bulk density at 1% below the respective optimum moisture content. The actual percent of maximum density reached and dry bulk density achieved were added to each sub-sample ID. The remolded sub-samples were subjected to initial properties testing, saturated hydraulic conductivity testing, and the hanging column and pressure chamber portions of the moisture retention testing. Based on the standard proctor compaction method, material larger than 3/4" (19.0mm) or #4 (4.75mm), as appropriate, was removed from the sample material prior to compacting or remolding. Oversize correction calculations are presented if the fraction removed was greater than 5% of the bulk sample mass.

Remaining sample material was used for the particle size analysis, Atterberg limits testing, and the dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

The reported volumetric moisture contents are adjusted for volume changes, when applicable. Due to the irregularities formed on the sample surfaces, volume measurements obtained after the initial reading should be considered estimates.

Porosity calculations, and the particle diameter calculations in the hydrometer portion of the particle size analysis testing, are based on the use of an assumed specific gravity value of 2.65.

Summary of Sample Preparation/Volume Changes

Sample Number	Proctor Data: Opt. Moist. Cont. (%, g/g)	Proctor Data: Max. Dry Density (g/cm^3)	Target Remold Parameters[1]: Moist. Cont. (%, g/g)	Target Remold Parameters[1]: Dry Bulk Density (g/cm^3)	Target Remold Parameters[1]: % of Max. Density (%)	Actual Remold Data: Moist. Cont. (%, g/g)	Actual Remold Data: Dry Bulk Density (g/cm^3)	Actual Remold Data: % of Max. Density (%)	Volume Change Post Saturation[2]: Dry Bulk Density (g/cm^3)	Volume Change Post Saturation[2]: % Volume Change (%)	Volume Change Post Saturation[2]: % of Max. Density (%)	Volume Change Post Drying Curve[3]: Dry Bulk Density (g/cm^3)	Volume Change Post Drying Curve[3]: % Volume Change (%)	Volume Change Post Drying Curve[3]: % of Max. Density (%)
VVL Composite 0-10 (85%, 1.46)	17.6	1.72	16.6	1.46	85%	16.5	1.46	85.0%	1.46	---	85.0%	1.46	---	85.0%
VVL Composite 11-15 (85%, 1.50)	15.0	1.76	14.0	1.50	85%	13.9	1.50	85.1%	1.50	---	85.1%	1.52	-1.2%	86.1%
VVL Composite 16-20 (85%, 1.45)	17.9	1.71	16.9	1.45	85%	17.1	1.45	85.1%	1.45	---	85.1%	1.45	---	85.1%
VVL Composite 21-30 (85%, 1.38)	19.5	1.62	18.5	1.38	85%	18.1	1.38	85.3%	1.38	---	85.3%	1.38	---	85.3%
VVL Composite 31+ (85%, 1.22)	27.5	1.44	26.5	1.22	85%	27.1	1.22	84.6%	1.22	---	84.6%	1.22	---	84.6%
VVL Composite TP-10 (85%, 1.51)	16.7	1.77	15.7	1.50	85%	15.7	1.51	85.1%	1.51	---	85.1%	1.59	-5.6%	90.1%
VVL Composite TP-12 (85%, 1.40)	19.5	1.65	18.5	1.40	85%	18.6	1.40	85.1%	1.40	---	85.1%	1.49	-5.6%	90.1%
VVL Composite TP-13 (85%, 1.37)	22.2	1.61	21.2	1.37	85%	21.1	1.37	85.4%	1.37	---	85.4%	1.35	1.8%	83.9%
WB Borrow-1 (85%, 1.42)	18.9	1.67	17.9	1.42	85%	18.3	1.42	84.8%	1.42	---	84.8%	1.42	---	84.8%
WB Stockpile-1 (85%, 1.52)	15.8	1.79	14.8	1.52	85%	14.8	1.52	84.7%	1.52	---	84.7%	1.52	---	84.7%
WB Stockpile-2 (85%, 1.48)	17.3	1.74	16.3	1.47	85%	16.6	1.48	85.3%	1.48	---	85.3%	1.48	---	85.3%
Topsoil-1 (85%, 1.10)	29.2	1.30	28.2	1.11	85%	28.7	1.10	84.7%	1.10	---	84.7%	1.10	---	84.7%

[1]Target Remold Parameters: Provided by the client: 85% of maximum dry density at 1% below optimum moisture content.

[2]Volume Change Post Saturation: Volume change measurements were obtained after saturated hydraulic conductivity testing.

[3]Volume Change Post Drying Curve: Volume change measurements were obtained throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point.

Notes:

"+" indicates sample swelling, "-" indicates sample settling, and "---" indicates no volume change occurred.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	As Received Volumetric (%, cm³/cm³)	Remolded Gravimetric (%, g/g)	Remolded Volumetric (%, cm³/cm³)	Dry Bulk Density (g/cm³)	Wet Bulk Density (g/cm³)	Calculated Porosity (%)
VVL Composite 0-10 (85%, 1.46)	NA	NA	16.5	24.1	1.46	1.70	44.8
VVL Composite 11-15 (85%, 1.50)	NA	NA	13.9	20.9	1.50	1.71	43.4
VVL Composite 16-20 (85%, 1.45)	NA	NA	17.1	24.8	1.45	1.70	45.2
VVL Composite 21-30 (85%, 1.38)	NA	NA	18.1	25.1	1.38	1.64	47.7
VVL Composite 31+ (85%, 1.22)	NA	NA	27.1	33.0	1.22	1.55	54.0
VVL Composite TP-10 (85%, 1.51)	NA	NA	15.7	23.7	1.51	1.74	43.2
VVL Composite TP-12 (85%, 1.40)	NA	NA	18.6	26.1	1.40	1.66	47.1
VVL Composite TP-13 (85%, 1.37)	NA	NA	21.1	28.9	1.37	1.66	48.2
WB Borrow-1 (85%, 1.42)	NA	NA	18.3	26.0	1.42	1.68	46.4
WB Stockpile-1 (85%, 1.52)	NA	NA	14.8	22.4	1.52	1.74	42.8
WB Stockpile-2 (85%, 1.48)	NA	NA	16.6	24.5	1.48	1.72	44.2
Topsoil-1 (85%, 1.10)	NA	NA	28.7	31.7	1.10	1.42	58.4

NA = Not analyzed

--- = This sample was not remolded

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head	Method of Analysis: Falling Head
VVL Composite 0-10 (85%, 1.46)	2.9E-04	2.2E-04	X	
VVL Composite 11-15 (85%, 1.50)	1.5E-03	1.2E-03	X	
VVL Composite 16-20 (85%, 1.45)	5.3E-04	4.5E-04	X	
VVL Composite 21-30 (85%, 1.38)	3.3E-04	2.6E-04	X	
VVL Composite 31+ (85%, 1.22)	1.1E-04	9.5E-05	X	
VVL Composite TP-10 (85%, 1.51)	2.5E-03	2.0E-03	X	
VVL Composite TP-12 (85%, 1.40)	1.2E-04	9.6E-05	X	
VVL Composite TP-13 (85%, 1.37)	2.6E-04	2.3E-04	X	
WB Borrow-1 (85%, 1.42)	5.0E-04	4.4E-04	X	
WB Stockpile-1 (85%, 1.52)	4.1E-04	3.8E-04	X	
WB Stockpile-2 (85%, 1.48)	4.9E-04	3.7E-04	X	
Topsoil-1 (85%, 1.10)	4.4E-04	---	X	

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite 0-10 (85%, 1.46)	0	44.8
	13	44.7
	35	43.5
	105	38.7
	337	34.7
	17235	11.3
	70060	8.0
	215994	6.3
	851293	4.6
VVL Composite 11-15 (85%, 1.50)	0	42.7
	8	42.7
	24	41.7
	77	34.1
	337	27.2 ‡‡
	15093	7.0 ‡‡
	52010	5.4 ‡‡
	460950	3.1 ‡‡
	851293	3.0 ‡‡
VVL Composite 16-20 (85%, 1.45)	0	47.2
	13	47.0
	35	44.1
	108	38.9
	337	34.7
	18968	11.1
	60066	8.8
	285136	6.1
	851293	4.3

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite 21-30 (85%, 1.38)	0	48.7
	12	48.7
	31	46.9
	104	41.3
	337	36.0
	9076	14.5
	41506	10.3
	164596	7.3
	851293	4.7
VVL Composite 31+ (85%, 1.22)	0	57.2
	12	57.2
	32	56.6
	93	51.8
	337	46.6
	19070	20.3
	52112	16.8
	449630	10.7
	851293	8.8
VVL Composite TP-10 (85%, 1.51)	0	43.3
	8	43.0
	21	41.7
	73	33.2 ‡‡
	337	24.1 ‡‡
	13971	8.4 ‡‡
	54559	5.9 ‡‡
	146545	4.8 ‡‡
	851293	3.6 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite TP-12 (85%, 1.40)	0	46.7
	12	46.6
	32	46.2
	105	41.6
	337	36.9 ‡‡
	5303	17.7 ‡‡
	22742	14.1 ‡‡
	185502	9.4 ‡‡
	851293	6.2 ‡‡
VVL Composite TP-13 (85%, 1.37)	0	49.8
	13	49.3 ‡‡
	34	47.3 ‡‡
	103	42.1 ‡‡
	337	38.1 ‡‡
	20090	13.5 ‡‡
	82196	10.1 ‡‡
	148381	8.7 ‡‡
	851293	5.7 ‡‡
WB Borrow-1 (85%, 1.42)	0	46.7
	7	46.2
	29	45.8
	102	37.7
	337	26.4
	23251	11.8
	67307	8.8
	220379	5.7
	851293	3.5

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
WB Stockpile-1 (85%, 1.52)	0	43.6
	8	43.6
	27	43.2
	91	38.5
	337	28.2
	32430	10.2
	164494	6.5
	510308	4.8
	851293	3.9
WB Stockpile-2 (85%, 1.48)	0	46.2
	8	46.1
	29	45.6
	91	37.2
	337	25.7
	24883	9.5
	64961	7.8
	285646	5.1
	851293	3.5
Topsoil-1 (85%, 1.10)	0	58.8
	9	58.2
	30	58.0
	103	46.4
	337	32.9
	12646	12.6
	78729	8.5
	412101	5.6
	851293	4.3

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Retention (-1/3 Bar, -15 Bar, and Water Holding Capacity*)

Sample Number	-1/3 Bar Point Volumetric (%, cm^3/cm^3)	-15 Bar Point Volumetric (%, cm^3/cm^3)	Water Holding Capacity (%, cm^3/cm^3)	Oversize Corrected -1/3 Bar Point Volumetric (%, cm^3/cm^3)	Oversize Corrected -15 Bar Point Volumetric (%, cm^3/cm^3)	Oversize Corrected Water Holding Capacity (%, cm^3/cm^3)
VVL Composite 0-10 (85%, 1.46)	34.7	12.2	22.5	29.8	10.5	19.4
VVL Composite 11-15 (85%, 1.50)	27.2	8.1	19.2	24.0	7.1	16.9
VVL Composite 16-20 (85%, 1.45)	34.7	12.6	22.1	31.7	11.5	20.2
VVL Composite 21-30 (85%, 1.38)	36.0	13.3	22.7	31.7	11.7	20.0
VVL Composite 31+ (85%, 1.22)	46.6	21.5	25.0	43.8	20.2	23.6
VVL Composite TP-10 (85%, 1.51)	24.1	8.3	15.8	20.7	7.1	13.6
VVL Composite TP-12 (85%, 1.40)	36.9	14.6	22.2	32.4	12.9	19.6
VVL Composite TP-13 (85%, 1.37)	38.1	15.1	23.0	35.4	14.0	21.4
WB Borrow-1 (85%, 1.42)	26.4	11.0	15.4	24.5	10.3	14.3
WB Stockpile-1 (85%, 1.52)	28.2	11.1	17.1	26.7	10.5	16.2
WB Stockpile-2 (85%, 1.48)	25.7	9.3	16.4	21.8	7.9	13.9
Topsoil-1 (85%, 1.10)	32.9	11.0	21.9	---	---	---

*Water Holding Capacity (WHC) is defined here as the difference in the moisture content of the sample at -1/3 bar of water potential (commonly referred to as 'Field Capacity') and the moisture content of the sample at -15 bars of water potential (commonly referred to as 'Wilting Point').

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
VVL Composite 0-10	0.00024	1.6	4.4	1.8E+04	50	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 11-15	0.0069	1.1	3.4	493	2.1	WS/H	Silty sand with gravel (SM)g	Sandy Loam †
VVL Composite 16-20	2.8E-05	0.81	4.2	1.5E+05	103	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 21-30	0.00020	0.89	4.8	2.4E+04	9.2	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 31+	2.3E-10	0.021	0.058	2.5E+08	5877	WS/H	Sandy fat clay with gravel s(CH)g	Clay † (Est)
VVL Composite TP-10	0.0082	0.64	1.5	183	2.3	WS/H	Clayey sand with gravel (SC)g	Sandy Loam †
VVL Composite TP-12	1.2E-06	0.63	1.9	1.6E+06	2274	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite TP-13	0.00038	0.49	1.1	2895	4.4	WS/H	Clayey sand with gravel (SC)g	Sandy Clay Loam † (Est)
WB Borrow-1	0.0013	0.095	0.22	169	3.1	WS/H	Clayey sand (SC)	Sandy Loam † (Est)
WB Stockpile-1	0.00028	0.035	0.063	225	9.6	WS/H	Sandy lean clay s(CL)	Loam † (Est)
WB Stockpile-2	0.0011	0.091	0.31	282	2.0	WS/H	Clayey sand with gravel (SC)g	Loam † (Est)
Topsoil-1	0.0036	0.047	0.070	19	1.3	WS/H	Sandy silt s(ML)	Loam

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
VVL Composite 0-10	39.3	35.6	11.4	13.7
VVL Composite 11-15	37.8	42.0	12.7	7.5
VVL Composite 16-20	39.6	32.3	14.7	13.4
VVL Composite 21-30	40.1	31.0	13.4	15.5
VVL Composite 31+	18.2	21.4	27.6	32.8
VVL Composite TP-10	34.1	44.3	15.1	6.5
VVL Composite TP-12	36.4	33.5	13.8	16.3
VVL Composite TP-13	28.9	37.8	15.6	17.6
WB Borrow-1	12.4	40.3	35.7	11.6
WB Stockpile-1	8.7	29.1	46.9	15.3
WB Stockpile-2	24.4	27.1	35.3	13.1
Topsoil-1	0.4	37.9	53.6	8.0

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
VVL Composite 0-10	75	25	50	CH
VVL Composite 11-15	33	27	6	ML
VVL Composite 16-20	54	24	30	CH
VVL Composite 21-30	68	25	43	CH
VVL Composite 31+	65	30	35	CH
VVL Composite TP-10	38	24	14	CL
VVL Composite TP-12	72	25	47	CH
VVL Composite TP-13	66	26	40	CH
WB Borrow-1	34	23	11	CL
WB Stockpile-1	31	19	12	CL
WB Stockpile-2	32	21	11	CL
Topsoil-1	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Proctor Compaction Tests

Sample Number	Measured: Optimum Moisture Content (% g/g)	Measured: Maximum Dry Bulk Density (g/cm^3)	Oversize Corrected: Optimum Moisture Content (% g/g)	Oversize Corrected: Maximum Dry Bulk Density (g/cm^3)
VVL Composite 0-10	17.6	1.72	13.6	1.87
VVL Composite 11-15	15.0	1.76	12.2	1.88
VVL Composite 16-20	17.9	1.71	15.3	1.80
VVL Composite 21-30	19.5	1.62	15.5	1.76
VVL Composite 31+	27.5	1.44	24.2	1.52
VVL Composite TP-10	16.7	1.77	13.1	1.90
VVL Composite TP-12	19.5	1.65	15.7	1.78
VVL Composite TP-13	22.2	1.61	19.3	1.69
WB Borrow-1	18.9	1.67	16.6	1.75
WB Stockpile-1	15.8	1.79	14.4	1.84
WB Stockpile-2	17.3	1.74	13.0	1.89
Topsoil-1	29.2	1.30	---	---

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density
Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
VVL Composite 0-10 (85%, 1.46)	NA	NA	16.5	24.1	1.46	1.70	44.8
VVL Composite 11-15 (85%, 1.50)	NA	NA	13.9	20.9	1.50	1.71	43.4
VVL Composite 16-20 (85%, 1.45)	NA	NA	17.1	24.8	1.45	1.70	45.2
VVL Composite 21-30 (85%, 1.38)	NA	NA	18.1	25.1	1.38	1.64	47.7
VVL Composite 31+ (85%, 1.22)	NA	NA	27.1	33.0	1.22	1.55	54.0
VVL Composite TP-10 (85%, 1.51)	NA	NA	15.7	23.7	1.51	1.74	43.2
VVL Composite TP-12 (85%, 1.40)	NA	NA	18.6	26.1	1.40	1.66	47.1
VVL Composite TP-13 (85%, 1.37)	NA	NA	21.1	28.9	1.37	1.66	48.2
WB Borrow-1 (85%, 1.42)	NA	NA	18.3	26.0	1.42	1.68	46.4
WB Stockpile-1 (85%, 1.52)	NA	NA	14.8	22.4	1.52	1.74	42.8
WB Stockpile-2 (85%, 1.48)	NA	NA	16.6	24.5	1.48	1.72	44.2
Topsoil-1 (85%, 1.10)	NA	NA	28.7	31.7	1.10	1.42	58.4

NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10 (85%, 1.46)
Project Name: VVL Composite Samples
PO Number: 12015

	As Received	Remolded
Test Date:	NA	5-Sep-14
Field weight of sample* (g):		3970.40
Tare weight, ring (g):		265.08
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3181.06
Sample volume (cm^3):		2175.34
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		16.5
Volumetric Moisture Content (% vol):		24.1
Dry bulk density (g/cm^3):		1.46
Wet bulk density (g/cm^3):		1.70
Calculated Porosity (% vol):		44.8
Percent Saturation:		53.8

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15 (85%, 1.50)
Project Name: VVL Composite Samples
PO Number: 12015

	As Received	Remolded
Test Date:	NA	5-Sep-14
Field weight of sample* (g):		4068.50
Tare weight, ring (g):		270.65
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3332.92
Sample volume (cm^3):		2220.20
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		13.9
Volumetric Moisture Content (% vol):		20.9
Dry bulk density (g/cm^3):		1.50
Wet bulk density (g/cm^3):		1.71
Calculated Porosity (% vol):		43.4
Percent Saturation:		48.3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite 16-20 (85%, 1.45)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	5-Sep-14
Field weight of sample* (g):		3999.70
Tare weight, ring (g):		269.93
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3186.29
Sample volume (cm^3):		2194.77
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		17.1
Volumetric Moisture Content (% vol):		24.8
Dry bulk density (g/cm^3):		1.45
Wet bulk density (g/cm^3):		1.70
Calculated Porosity (% vol):		45.2
Percent Saturation:		54.8

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

	As Received	Remolded
Test Date:	NA	5-Sep-14
Field weight of sample* (g):		3872.50
Tare weight, ring (g):		271.14
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3048.84
Sample volume (cm^3):		2201.91
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.1
Volumetric Moisture Content (% vol):		25.1
Dry bulk density (g/cm^3):		1.38
Wet bulk density (g/cm^3):		1.64
Calculated Porosity (% vol):		47.7
Percent Saturation:		52.6

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite 31+ (85%, 1.22)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		3705.80
Tare weight, ring (g):		272.82
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		2700.23
Sample volume (cm^3):		2217.25
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		27.1
Volumetric Moisture Content (% vol):		33.0
Dry bulk density (g/cm^3):		1.22
Wet bulk density (g/cm^3):		1.55
Calculated Porosity (% vol):		54.0
Percent Saturation:		61.1

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-10 (85%, 1.51)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		4140.03
Tare weight, ring (g):		272.60
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3342.18
Sample volume (cm^3):		2220.60
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		15.7
Volumetric Moisture Content (% vol):		23.7
Dry bulk density (g/cm^3):		1.51
Wet bulk density (g/cm^3):		1.74
Calculated Porosity (% vol):		43.2
Percent Saturation:		54.7

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-12 (85%, 1.40)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		3935.70
Tare weight, ring (g):		270.01
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3091.19
Sample volume (cm^3):		2203.81
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.6
Volumetric Moisture Content (% vol):		26.1
Dry bulk density (g/cm^3):		1.40
Wet bulk density (g/cm^3):		1.66
Calculated Porosity (% vol):		47.1
Percent Saturation:		55.4

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13 (85%, 1.37)
Project Name: VVL Composite Samples
PO Number: 12015

	As Received	Remolded
Test Date:	NA	5-Sep-14
Field weight of sample* (g):		4012.10
Tare weight, ring (g):		275.53
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3086.05
Sample volume (cm^3):		2250.16
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		21.1
Volumetric Moisture Content (% vol):		28.9
Dry bulk density (g/cm^3):		1.37
Wet bulk density (g/cm^3):		1.66
Calculated Porosity (% vol):		48.2
Percent Saturation:		59.9

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Borrow-1 (85%, 1.42)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		247.63
Tare weight, ring (g):		53.27
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		164.29
Sample volume (cm^3):		115.77
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.3
Volumetric Moisture Content (% vol):		26.0
Dry bulk density (g/cm^3):		1.42
Wet bulk density (g/cm^3):		1.68
Calculated Porosity (% vol):		46.4
Percent Saturation:		55.9

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Stockpile-1 (85%, 1.52)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		263.07
Tare weight, ring (g):		55.22
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		181.10
Sample volume (cm^3):		119.42
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		14.8
Volumetric Moisture Content (% vol):		22.4
Dry bulk density (g/cm^3):		1.52
Wet bulk density (g/cm^3):		1.74
Calculated Porosity (% vol):		42.8
Percent Saturation:		52.4

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Stockpile-2 (85%, 1.48)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		267.66
Tare weight, ring (g):		72.21
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		167.66
Sample volume (cm^3):		113.33
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		16.6
Volumetric Moisture Content (% vol):		24.5
Dry bulk density (g/cm^3):		1.48
Wet bulk density (g/cm^3):		1.72
Calculated Porosity (% vol):		44.2
Percent Saturation:		55.5

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	Topsoil-1 (85%, 1.10)
Project Name:	VVL Composite Samples
PO Number:	12015

	As Received	Remolded
Test Date:	NA	28-Aug-14
Field weight of sample* (g):		451.75
Tare weight, ring (g):		133.75
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		247.04
Sample volume (cm^3):		224.14
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		28.7
Volumetric Moisture Content (% vol):		31.7
Dry bulk density (g/cm^3):		1.10
Wet bulk density (g/cm^3):		1.42
Calculated Porosity (% vol):		58.4
Percent Saturation:		54.2

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Saturated Hydraulic Conductivity

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head	Method of Analysis: Falling Head
VVL Composite 0-10 (85%, 1.46)	2.9E-04	2.2E-04	X	
VVL Composite 11-15 (85%, 1.50)	1.5E-03	1.2E-03	X	
VVL Composite 16-20 (85%, 1.45)	5.3E-04	4.5E-04	X	
VVL Composite 21-30 (85%, 1.38)	3.3E-04	2.6E-04	X	
VVL Composite 31+ (85%, 1.22)	1.1E-04	9.5E-05	X	
VVL Composite TP-10 (85%, 1.51)	2.5E-03	2.0E-03	X	
VVL Composite TP-12 (85%, 1.40)	1.2E-04	9.6E-05	X	
VVL Composite TP-13 (85%, 1.37)	2.6E-04	2.3E-04	X	
WB Borrow-1 (85%, 1.42)	5.0E-04	4.4E-04	X	
WB Stockpile-1 (85%, 1.52)	4.1E-04	3.8E-04	X	
WB Stockpile-2 (85%, 1.48)	4.9E-04	3.7E-04	X	
Topsoil-1 (85%, 1.10)	4.4E-04	---	X	

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g):	11.01
Sample Number:	VVL Composite 0-10 (85%, 1.46)	*Sample length* (cm):	12.24
Project Name:	VVL Composite Samples	*Sample diameter* (cm):	15.04
PO Number:	12015	*Sample x-sectional area* (cm^2):	177.75

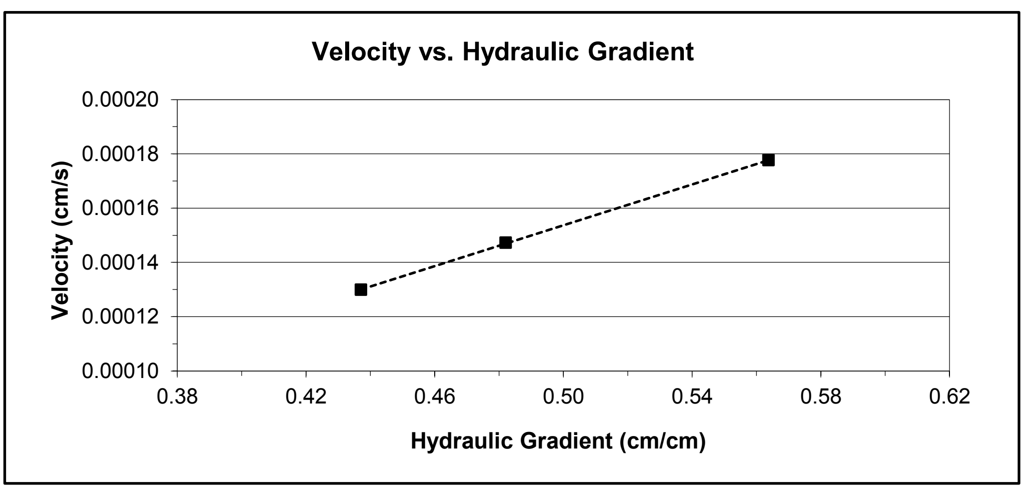
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
8-Sep-14	9:46:41	22.5	6.9	16.82	5.8	184	3.2E-04	3.0E-04
8-Sep-14	9:49:45							
Test # 2:								
8-Sep-14	10:00:36	22.5	5.9	19.80	8.8	336	3.1E-04	2.9E-04
8-Sep-14	10:06:12							
Test # 3:								
8-Sep-14	10:14:21	22.5	5.35	18.26	7.3	314	3.0E-04	2.8E-04
8-Sep-14	10:19:35							

***Average Ksat* (cm/sec): 2.9E-04**

***Oversize Corrected Ksat* (cm/sec): 2.2E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10 (85%, 1.46)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol)*:* 44.8

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	22.66	77.34	100.00
Bulk Density (g/cm^3):	2.65	1.46	1.63
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Mass Fraction (%):	22.66	77.34	100.00
Ksat (cm/sec):	NM	2.9E-04	2.2E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

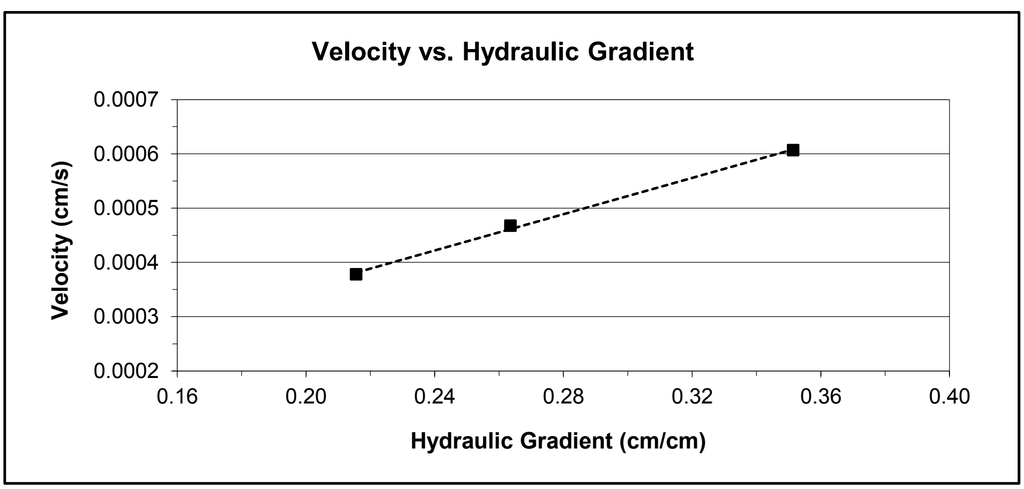
Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15 (85%, 1.50)
Project Name: VVL Composite Samples
PO Number: 12015

Type of water used: TAP
Collection vessel tare (g)*:* 10.98
Sample length (cm)*:* 12.52
Sample diameter (cm)*:* 15.03
Sample x-sectional area (cm^2)*:* 177.37

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
8-Sep-14	9:45:30	22.5	4.4	29.83	18.9	191	1.6E-03	1.5E-03
8-Sep-14	9:48:41							
Test # 2:								
8-Sep-14	9:59:55	22.5	3.3	31.33	20.4	275	1.6E-03	1.5E-03
8-Sep-14	10:04:30							
Test # 3:								
8-Sep-14	10:14:00	22.5	2.7	28.07	17.1	294	1.5E-03	1.4E-03
8-Sep-14	10:18:54							

Average Ksat* (cm/sec)*: **1.5E-03**
Oversize Corrected Ksat* (cm/sec)*: **1.2E-03**

Comments:
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite 11-15 (85%, 1.50)
Project Name:	VVL Composite Samples
PO Number:	12015
Split (3/4", 3/8", #4):	3/4
Calculated Porosity of Fines (% vol):	43.4

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	18.97	81.03	100.00
Bulk Density (g/cm^3):	2.65	1.50	1.64
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	23.40	23.40
Total Volume (cm^3):	7.16	53.98	61.14
Volumetric Fraction (%):	11.71	88.29	100.00
Mass Fraction (%):	18.97	81.03	100.00
Ksat (cm/sec):	NM	1.5E-03	1.2E-03

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	11.00
Sample Number:	VVL Composite 16-20 (85%, 1.45)	*Sample length* (cm)*:*	12.47
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	14.97
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	176.03

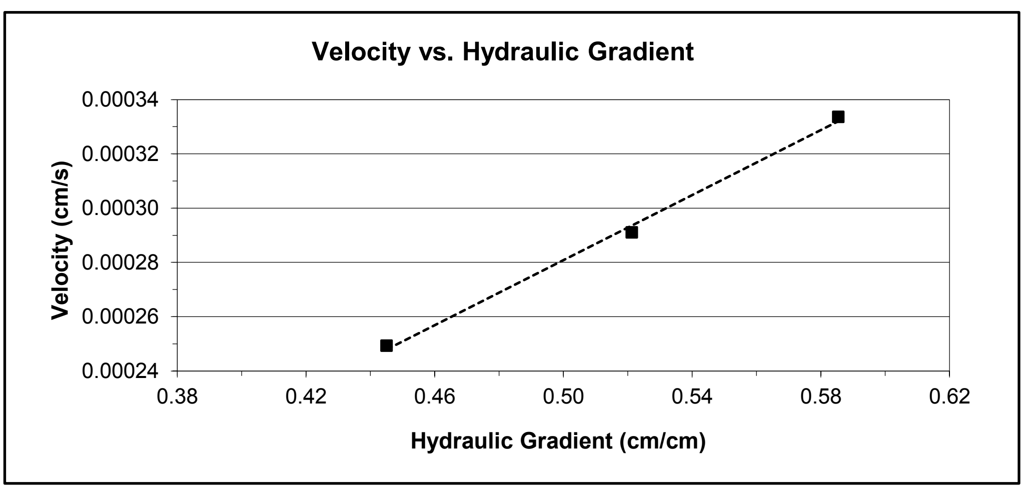
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
8-Sep-14	9:46:14	22.5	7.3	20.98	10.0	170	5.7E-04	5.4E-04
8-Sep-14	9:49:04							
Test # 2:								
8-Sep-14	10:00:04	22.5	6.5	28.67	17.7	345	5.6E-04	5.3E-04
8-Sep-14	10:05:49							
Test # 3:								
8-Sep-14	10:14:12	22.5	5.55	24.29	13.3	303	5.6E-04	5.3E-04
8-Sep-14	10:19:15							

***Average Ksat* (cm/sec): 5.3E-04**

***Oversize Corrected Ksat* (cm/sec): 4.5E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20 (85%, 1.45)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol)*:* 45.2

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g)*:*	14.48	85.52	100.00
Bulk Density (g/cm^3)*:*	2.65	1.45	1.55
Volume of Solids (cm^3)*:*	5.46	32.27	37.74
Volume of Voids (cm^3)*:*	0.00	26.64	26.64
Total Volume (cm^3)*:*	5.46	58.91	64.37
Volumetric Fraction (%)*:*	8.49	91.51	100.00
Mass Fraction (%)*:*	14.48	85.52	100.00
Ksat (cm/sec)*:*	NM	5.3E-04	4.5E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g):	11.02
Sample Number:	VVL Composite 21-30 (85%, 1.38)	*Sample length* (cm):	12.44
Project Name:	VVL Composite Samples	*Sample diameter* (cm):	15.01
PO Number:	12015	*Sample x-sectional area* (cm^2):	176.97

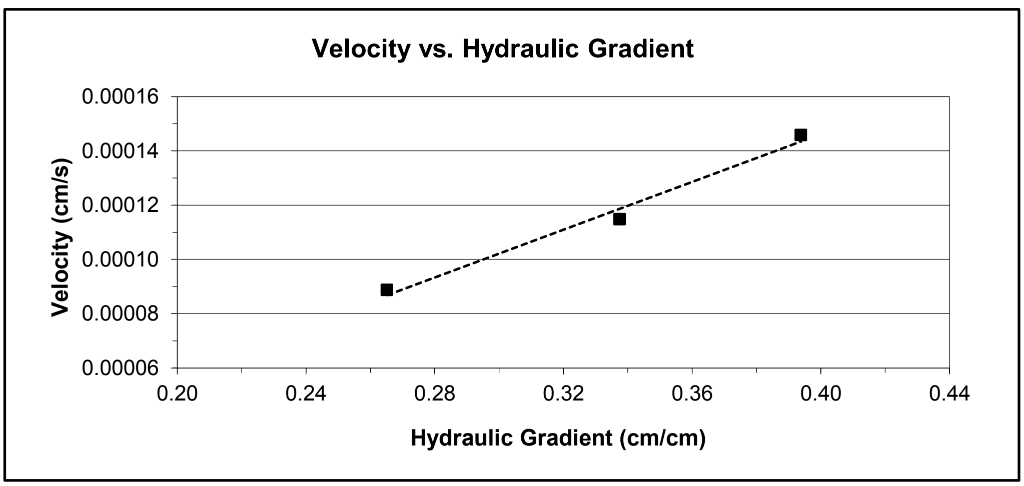
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
8-Sep-14	9:45:03	22.5	4.9	15.12	4.1	159	3.7E-04	3.5E-04
8-Sep-14	9:47:42							
Test # 2:								
8-Sep-14	9:59:33	22.5	4.2	17.60	6.6	324	3.4E-04	3.2E-04
8-Sep-14	10:04:57							
Test # 3:								
8-Sep-14	10:13:33	22.5	3.3	15.27	4.3	271	3.3E-04	3.2E-04
8-Sep-14	10:18:04							

***Average Ksat* (cm/sec): 3.3E-04**

***Oversize Corrected Ksat* (cm/sec): 2.6E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol)*:* 47.7

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	20.52	79.48	100.00
Bulk Density (g/cm^3):	2.65	1.38	1.54
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Mass Fraction (%):	20.52	79.48	100.00
Ksat (cm/sec):	NM	3.3E-04	2.6E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	10.95
Sample Number:	VVL Composite 31+ (85%, 1.22)	*Sample length* (cm)*:*	12.53
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	15.01
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	176.93

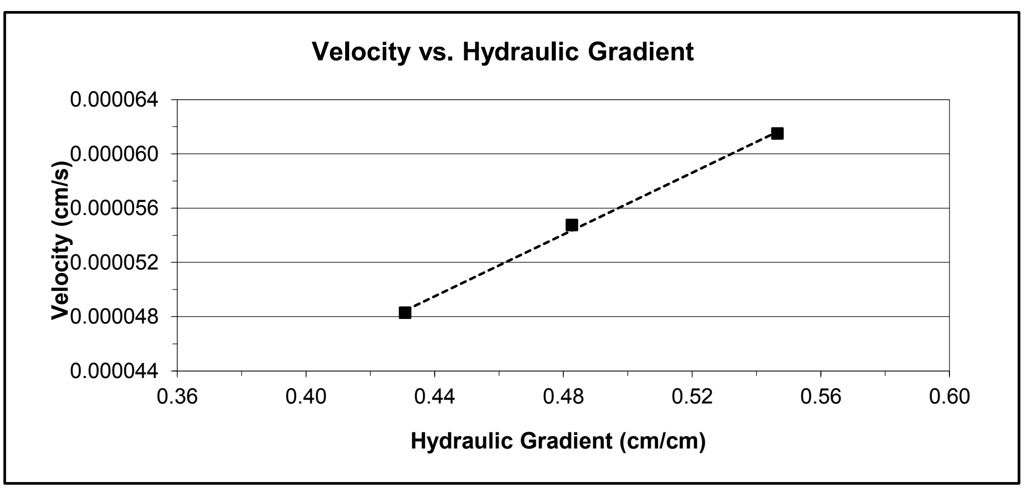
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:56:59	22.0	6.85	12.81	1.9	171	1.1E-04	1.1E-04
2-Sep-14	12:59:50							
Test # 2:								
2-Sep-14	13:16:30	22.0	6.05	12.80	1.9	191	1.1E-04	1.1E-04
2-Sep-14	13:19:41							
Test # 3:								
2-Sep-14	13:30:14	22.0	5.4	12.53	1.6	185	1.1E-04	1.1E-04
2-Sep-14	13:33:19							

Average Ksat* (cm/sec)*: **1.1E-04**

Oversize Corrected Ksat* (cm/sec)*: **9.5E-05**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+ (85%, 1.22)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol): 54.0

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	12.02	87.98	100.00
Bulk Density (g/cm^3):	2.65	1.22	1.30
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Mass Fraction (%):	12.02	87.98	100.00
Ksat (cm/sec):	NM	1.1E-04	9.5E-05

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

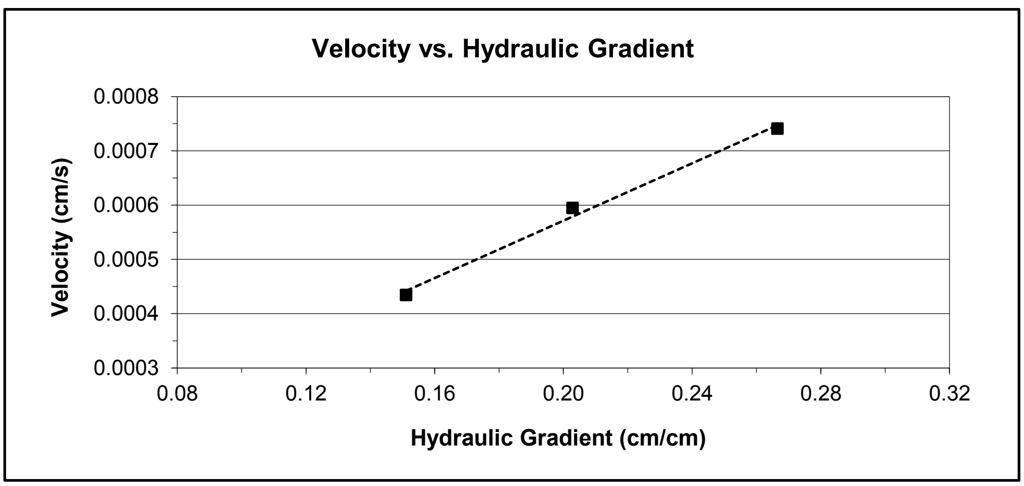
Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10 (85%, 1.51)
Project Name: VVL Composite Samples
PO Number: 12015

Type of water used: TAP
Collection vessel tare (g): 10.98
Sample length (cm): 12.57
Sample diameter (cm): 15.00
Sample x-sectional area (cm^2): 176.71

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:55:00	22.0	3.35	18.30	7.3	60	2.6E-03	2.5E-03
2-Sep-14	12:56:00							
Test # 2:								
2-Sep-14	13:16:00	22.0	2.55	16.75	5.8	60	2.7E-03	2.6E-03
2-Sep-14	13:17:00							
Test # 3:								
2-Sep-14	13:30:00	22.0	1.9	15.05	4.1	60	2.5E-03	2.4E-03
2-Sep-14	13:31:00							

***Average Ksat* (cm/sec): 2.5E-03**
***Oversize Corrected Ksat* (cm/sec): 2.0E-03**

Comments:
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10 (85%, 1.51)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol): 43.2

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	21.58	78.42	100.00
Bulk Density (g/cm^3):	2.65	1.51	1.66
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	22.51	22.51
Total Volume (cm^3):	8.14	52.10	60.25
Volumetric Fraction (%):	13.52	86.48	100.00
Mass Fraction (%):	21.58	78.42	100.00
Ksat (cm/sec):	NM	2.5E-03	2.0E-03

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

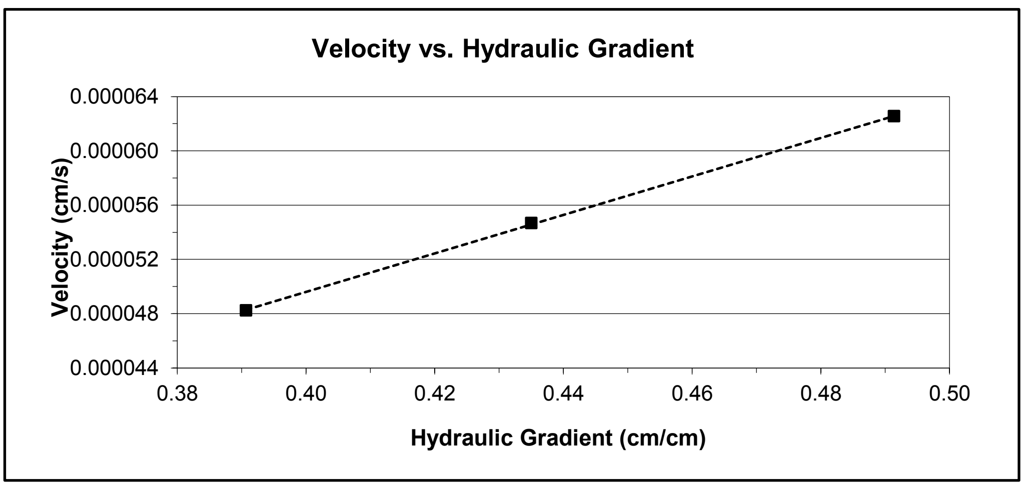
Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12 (85%, 1.40)
Project Name: VVL Composite Samples
PO Number: 12015

Type of water used: TAP
Collection vessel tare (g)*:* 10.96
Sample length (cm)*:* 12.41
Sample diameter (cm)*:* 15.04
Sample x-sectional area (cm^2)*:* 177.54

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:56:44	22.0	6.1	12.77	1.8	163	1.3E-04	1.2E-04
2-Sep-14	12:59:27							
Test # 2:								
2-Sep-14	13:16:18	22.0	5.4	12.61	1.7	170	1.3E-04	1.2E-04
2-Sep-14	13:19:08							
Test # 3:								
2-Sep-14	13:30:04	22.0	4.85	12.39	1.4	167	1.2E-04	1.2E-04
2-Sep-14	13:32:51							

***Average Ksat* (cm/sec):** **1.2E-04**
***Oversize Corrected Ksat* (cm/sec):** **9.6E-05**

Comments:
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12 (85%, 1.40)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4
Calculated Porosity of Fines (% vol): 47.1

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	19.61	80.39	100.00
Bulk Density (g/cm^3):	2.65	1.40	1.55
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	26.98	26.98
Total Volume (cm^3):	7.40	57.31	64.71
Volumetric Fraction (%):	11.44	88.56	100.00
Mass Fraction (%):	19.61	80.39	100.00
Ksat (cm/sec):	NM	1.2E-04	9.6E-05

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g):	11.02
Sample Number:	VVL Composite TP-13 (85%, 1.37)	*Sample length* (cm):	12.66
Project Name:	VVL Composite Samples	*Sample diameter* (cm):	15.04
PO Number:	12015	*Sample x-sectional area* (cm^2):	177.68

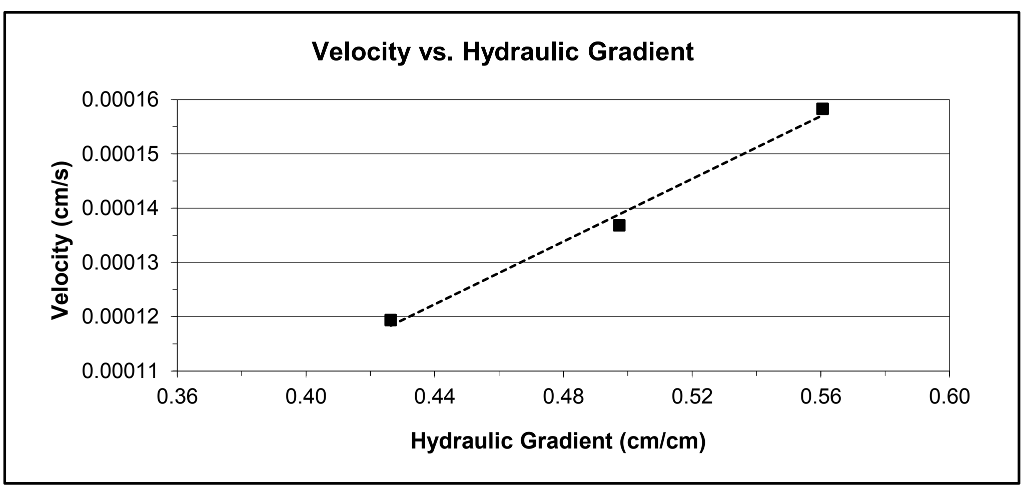
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
8-Sep-14	9:45:13	22.5	7.1	15.94	4.9	175	2.8E-04	2.7E-04
8-Sep-14	9:48:08							
Test # 2:								
8-Sep-14	9:59:43	22.5	6.3	19.26	8.2	339	2.7E-04	2.6E-04
8-Sep-14	10:05:22							
Test # 3:								
8-Sep-14	10:13:41	22.5	5.4	17.19	6.2	291	2.8E-04	2.6E-04
8-Sep-14	10:18:32							

***Average Ksat* (cm/sec): 2.6E-04**

***Oversize Corrected Ksat* (cm/sec): 2.3E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-13 (85%, 1.37)
Project Name:	VVL Composite Samples
PO Number:	12015
Split (3/4", 3/8", #4):	3/4
Calculated Porosity of Fines (% vol):	48.2

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	13.14	86.86	100.00
Bulk Density (g/cm^3):	2.65	1.37	1.46
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	30.56	30.56
Total Volume (cm^3):	4.96	63.33	68.29
Volumetric Fraction (%):	7.26	92.74	100.00
Mass Fraction (%):	13.14	86.86	100.00
Ksat (cm/sec):	NM	2.6E-04	2.3E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	11.02
Sample Number:	WB Borrow-1 (85%, 1.42)	*Sample length* (cm)*:*	3.81
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	6.22
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	30.39

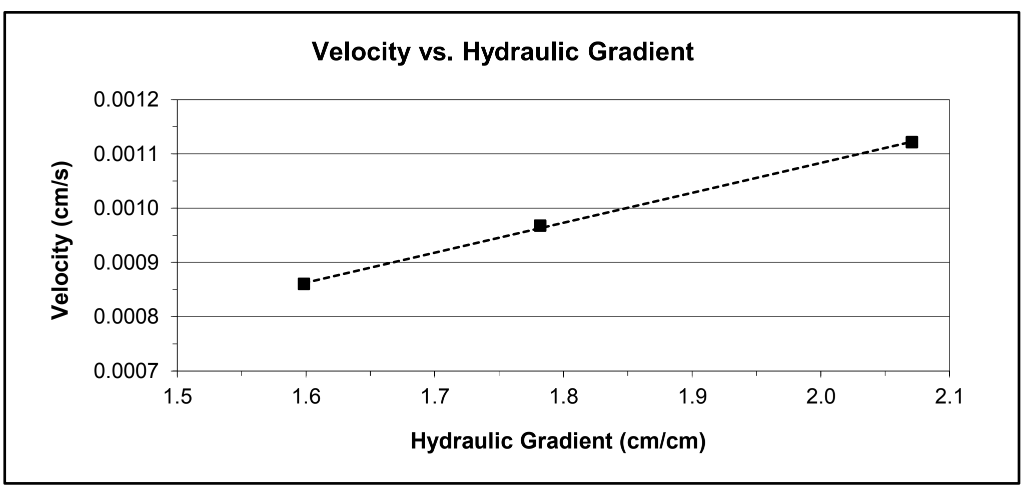
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:57:19	22.0	7.7	17.27	6.3	192	5.3E-04	5.1E-04
2-Sep-14	13:00:31							
Test # 2:								
2-Sep-14	13:17:25	22.0	6.6	16.37	5.4	192	5.3E-04	5.1E-04
2-Sep-14	13:20:37							
Test # 3:								
2-Sep-14	13:30:33	22.0	5.9	16.68	5.7	230	5.2E-04	5.0E-04
2-Sep-14	13:34:23							

Average Ksat* (cm/sec)*: **5.0E-04**

Oversize Corrected Ksat* (cm/sec)*: **4.4E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1 (85%, 1.42)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol)*:* 46.4

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g)*:*	12.36	87.64	100.00
Bulk Density (g/cm^3)*:*	2.65	1.42	1.51
Volume of Solids (cm^3)*:*	4.66	33.07	37.74
Volume of Voids (cm^3)*:*	0.00	28.68	28.68
Total Volume (cm^3)*:*	4.66	61.76	66.42
Volumetric Fraction (%)*:*	7.02	92.98	100.00
Mass Fraction (%)*:*	12.36	87.64	100.00
Ksat (cm/sec)*:*	NM	5.0E-04	4.4E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	11.02
Sample Number:	WB Stockpile-1 (85%, 1.52)	*Sample length* (cm)*:*	3.93
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	6.22
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	30.39

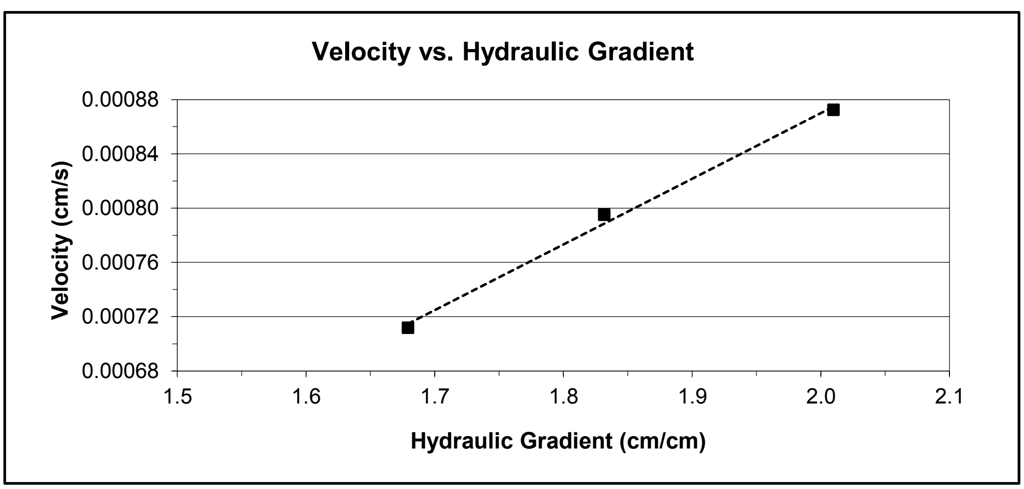
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:57:58	22.0	7.9	16.40	5.4	203	4.3E-04	4.1E-04
2-Sep-14	13:01:21							
Test # 2:								
2-Sep-14	13:17:43	22.0	7.2	16.60	5.6	231	4.3E-04	4.1E-04
2-Sep-14	13:21:34							
Test # 3:								
2-Sep-14	13:30:54	22.0	6.6	16.62	5.6	259	4.2E-04	4.0E-04
2-Sep-14	13:35:13							

Average Ksat* (cm/sec)*: **4.1E-04**

Oversize Corrected Ksat* (cm/sec)*: **3.8E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-1 (85%, 1.52)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol)*:* 42.8

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	8.73	91.27	100.00
Bulk Density (g/cm^3):	2.65	1.52	1.58
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Mass Fraction (%):	8.73	91.27	100.00
Ksat (cm/sec):	NM	4.1E-04	3.8E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	11.03
Sample Number:	WB Stockpile-2 (85%, 1.48)	*Sample length* (cm)*:*	3.84
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	6.13
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	29.51

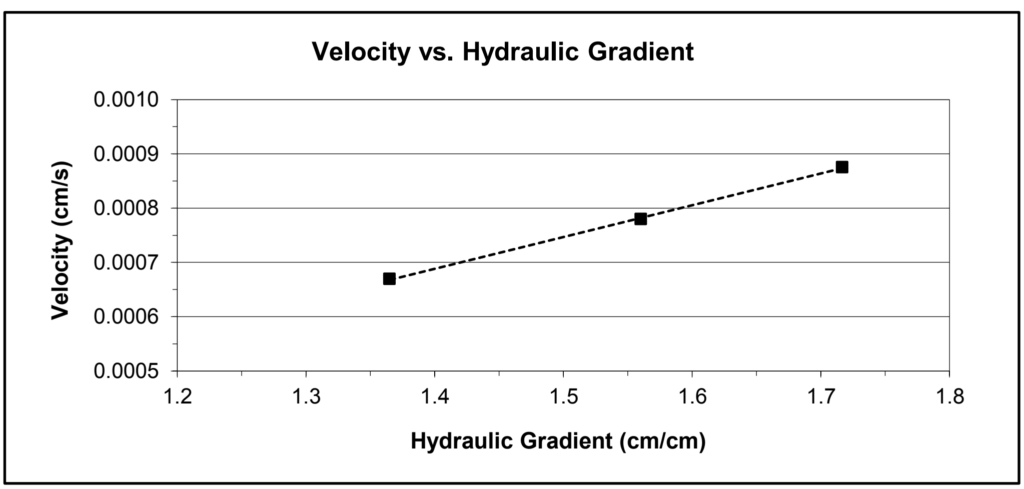
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:57:45	22.0	6.4	15.86	4.8	187	5.3E-04	5.0E-04
2-Sep-14	13:00:52							
Test # 2:								
2-Sep-14	13:17:36	22.0	5.8	15.77	4.7	206	5.2E-04	4.9E-04
2-Sep-14	13:21:02							
Test # 3:								
2-Sep-14	13:30:43	22.0	5.05	15.71	4.7	237	5.1E-04	4.9E-04
2-Sep-14	13:34:40							

***Average Ksat* (cm/sec): 4.9E-04**

***Oversize Corrected Ksat* (cm/sec): 3.7E-04**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2 (85%, 1.48)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 44.2

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	24.42	75.58	100.00
Bulk Density (g/cm^3):	2.65	1.48	1.66
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Mass Fraction (%):	24.42	75.58	100.00
Ksat (cm/sec):	NM	4.9E-04	3.7E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Hydrometrics, Inc.	*Type of water used:*	TAP
Job Number:	LB14.0168.00	*Collection vessel tare* (g)*:*	10.94
Sample Number:	Topsoil-1 (85%, 1.10)	*Sample length* (cm)*:*	7.60
Project Name:	VVL Composite Samples	*Sample diameter* (cm)*:*	6.13
PO Number:	12015	*Sample x-sectional area* (cm^2)*:*	29.50

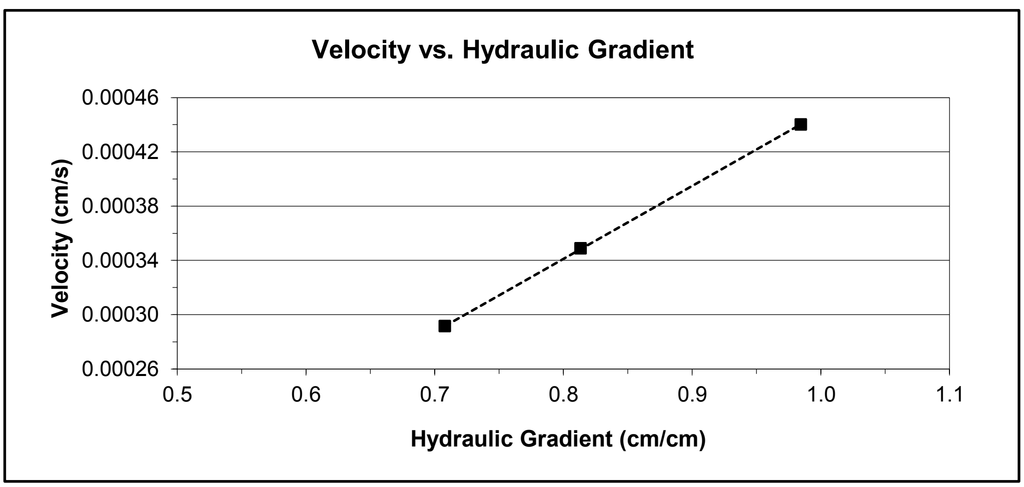
Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
2-Sep-14	12:57:11	22.0	7.1	13.29	2.4	181	4.7E-04	4.5E-04
2-Sep-14	13:00:12							
Test # 2:								
2-Sep-14	13:16:44	22.0	5.8	13.08	2.1	208	4.6E-04	4.4E-04
2-Sep-14	13:20:12							
Test # 3:								
2-Sep-14	13:30:24	22.0	5	12.66	1.7	200	4.4E-04	4.2E-04
2-Sep-14	13:33:44							

Average Ksat* (cm/sec)*: **4.4E-04**

Oversize Corrected Ksat* (cm/sec)*: **---**

Comments:

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite 0-10 (85%, 1.46)	0	44.8
	13	44.7
	35	43.5
	105	38.7
	337	34.7
	17235	11.3
	70060	8.0
	215994	6.3
	851293	4.6
VVL Composite 11-15 (85%, 1.50)	0	42.7
	8	42.7
	24	41.7
	77	34.1
	337	27.2 ‡‡
	15093	7.0 ‡‡
	52010	5.4 ‡‡
	460950	3.1 ‡‡
	851293	3.0 ‡‡
VVL Composite 16-20 (85%, 1.45)	0	47.2
	13	47.0
	35	44.1
	108	38.9
	337	34.7
	18968	11.1
	60066	8.8
	285136	6.1
	851293	4.3

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite 21-30 (85%, 1.38)	0	48.7
	12	48.7
	31	46.9
	104	41.3
	337	36.0
	9076	14.5
	41506	10.3
	164596	7.3
	851293	4.7
VVL Composite 31+ (85%, 1.22)	0	57.2
	12	57.2
	32	56.6
	93	51.8
	337	46.6
	19070	20.3
	52112	16.8
	449630	10.7
	851293	8.8
VVL Composite TP-10 (85%, 1.51)	0	43.3
	8	43.0
	21	41.7
	73	33.2 ‡‡
	337	24.1 ‡‡
	13971	8.4 ‡‡
	54559	5.9 ‡‡
	146545	4.8 ‡‡
	851293	3.6 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
VVL Composite TP-12 (85%, 1.40)	0	46.7
	12	46.6
	32	46.2
	105	41.6
	337	36.9 ‡‡
	5303	17.7 ‡‡
	22742	14.1 ‡‡
	185502	9.4 ‡‡
	851293	6.2 ‡‡
VVL Composite TP-13 (85%, 1.37)	0	49.8
	13	49.3 ‡‡
	34	47.3 ‡‡
	103	42.1 ‡‡
	337	38.1 ‡‡
	20090	13.5 ‡‡
	82196	10.1 ‡‡
	148381	8.7 ‡‡
	851293	5.7 ‡‡
WB Borrow-1 (85%, 1.42)	0	46.7
	7	46.2
	29	45.8
	102	37.7
	337	26.4
	23251	11.8
	67307	8.8
	220379	5.7
	851293	3.5

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
WB Stockpile-1 (85%, 1.52)	0	43.6
	8	43.6
	27	43.2
	91	38.5
	337	28.2
	32430	10.2
	164494	6.5
	510308	4.8
	851293	3.9
WB Stockpile-2 (85%, 1.48)	0	46.2
	8	46.1
	29	45.6
	91	37.2
	337	25.7
	24883	9.5
	64961	7.8
	285646	5.1
	851293	3.5
Topsoil-1 (85%, 1.10)	0	58.8
	9	58.2
	30	58.0
	103	46.4
	337	32.9
	12646	12.6
	78729	8.5
	412101	5.6
	851293	4.3

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
VVL Composite 0-10 (85%, 1.46)	0.0061	1.3021	1.12	44.60	0.97	38.39
VVL Composite 11-15 (85%, 1.50)	0.0140	1.3170	0.27	42.99	0.23	37.96
VVL Composite 16-20 (85%, 1.45)	0.0094	1.2646	0.00	46.90	0.00	42.92
VVL Composite 21-30 (85%, 1.38)	0.0089	1.2641	0.00	48.73	0.00	42.94
VVL Composite 31+ (85%, 1.22)	0.0065	1.2130	0.00	57.37	0.00	53.98
VVL Composite TP-10 (85%, 1.51)	0.0231	1.3099	1.43	43.91	1.23	37.97
VVL Composite TP-12 (85%, 1.40)	0.0059	1.3005	3.43	46.81	3.02	41.45
VVL Composite TP-13 (85%, 1.37)	0.0083	1.2450	0.00	49.39	0.00	45.81
WB Borrow-1 (85%, 1.42)	0.0179	1.2868	1.94	47.42	1.80	44.09
WB Stockpile-1 (85%, 1.52)	0.0118	1.2869	1.45	44.26	1.38	41.97
WB Stockpile-2 (85%, 1.48)	0.0153	1.3648	3.35	47.09	2.83	39.90
Topsoil-1 (85%, 1.10)	0.0137	1.3859	3.92	59.68	---	---

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3181.06
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	265.08
Sample Number:	VVL Composite 0-10 (85%, 1.46)	*Tare wt., screen & clamp* (g):	48.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2175.34
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.46
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	44.82

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	8-Sep-14	14:00	4468.60	0	44.78
	15-Sep-14	10:00	4466.20	13.0	44.67
	22-Sep-14	15:33	4440.30	35.0	43.48
	29-Sep-14	16:20	4337.12	104.5	38.74
Pressure plate:	8-Oct-14	13:05	4248.60	337	34.67

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	13.0	---	---	---	---
	35.0	---	---	---	---
	104.5	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite 0-10 (85%, 1.46)

Initial sample bulk density (g/cm^3): 1.46
Fraction of test sample used (<2.00mm fraction) (%): 52.36

Dry weight of dew point potentiometer sample* (g): 164.36
Tare weight, jar (g): 110.60

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	13:06	172.28	17235	11.28
	10-Sep-14	9:30	170.01	70060	8.05
	9-Sep-14	14:42	168.75	215994	6.25

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	17235	---	---	---	---
	70060	---	---	---	---
	215994	---	---	---	---

Dry weight of relative humidity box sample* (g): 72.21
Tare weight (g): 40.97

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	74.08	851293	4.59

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

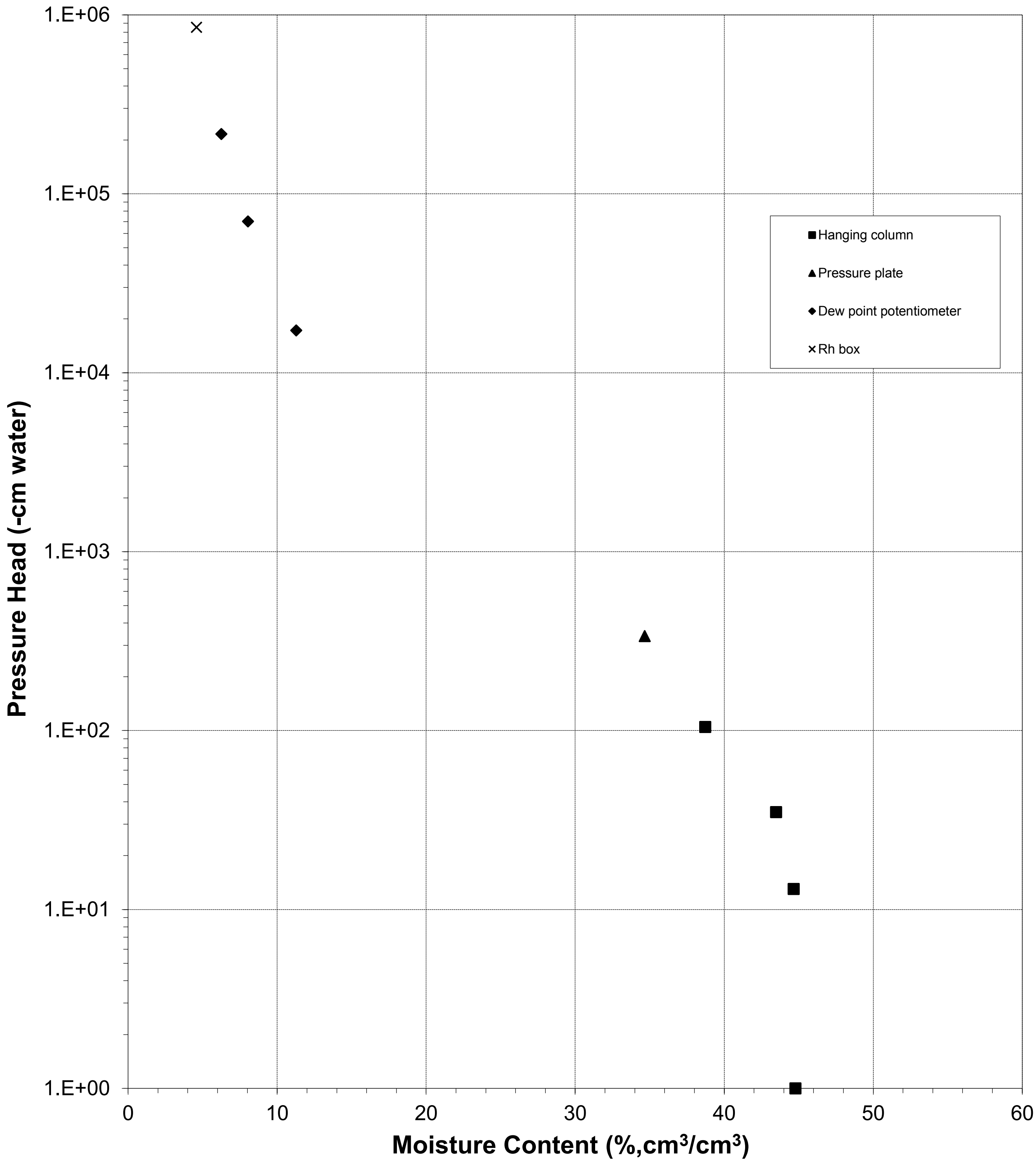
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

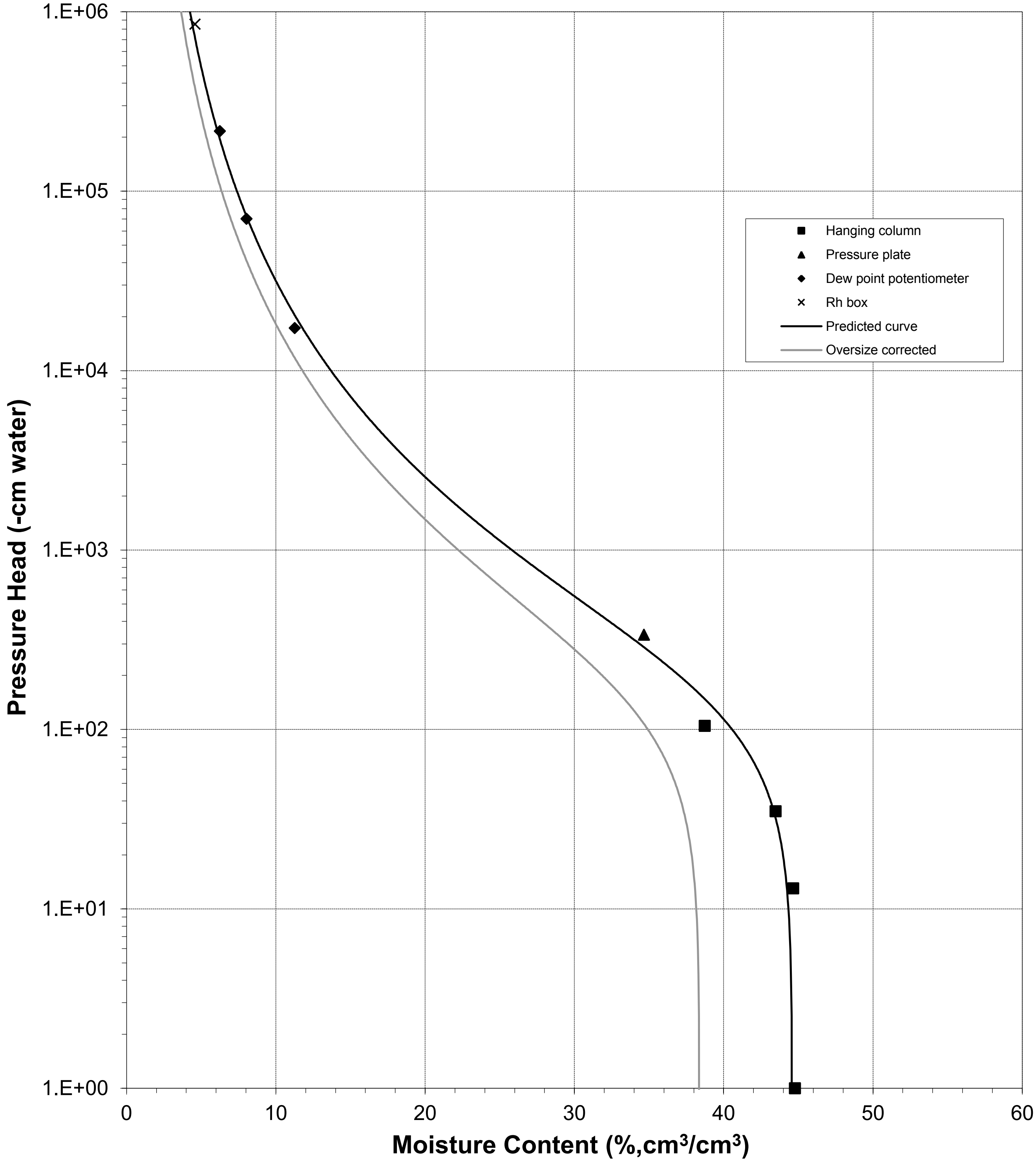
Water Retention Data Points

Sample Number: VVL Composite 0-10 (85%, 1.46)



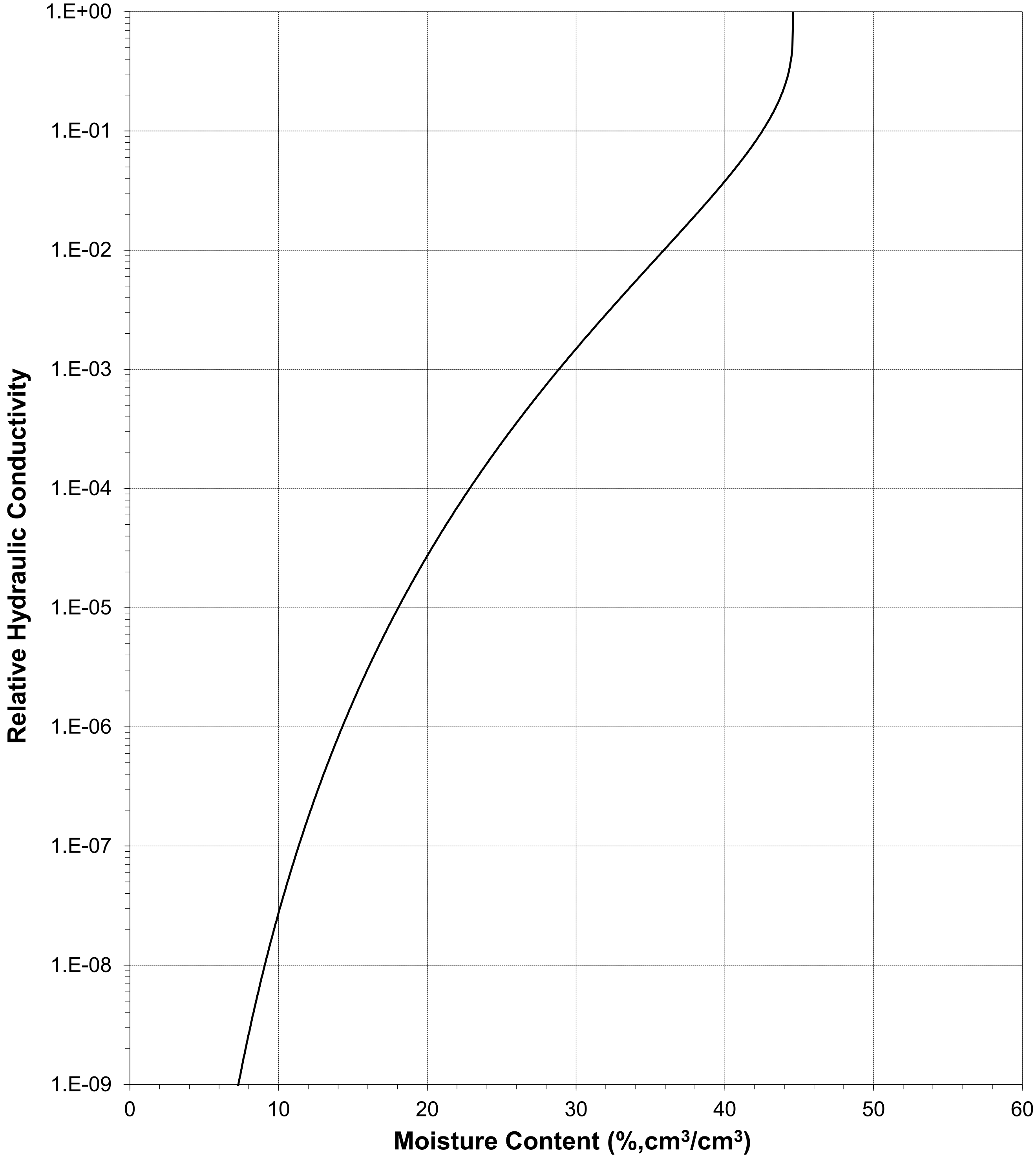
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite 0-10 (85%, 1.46)



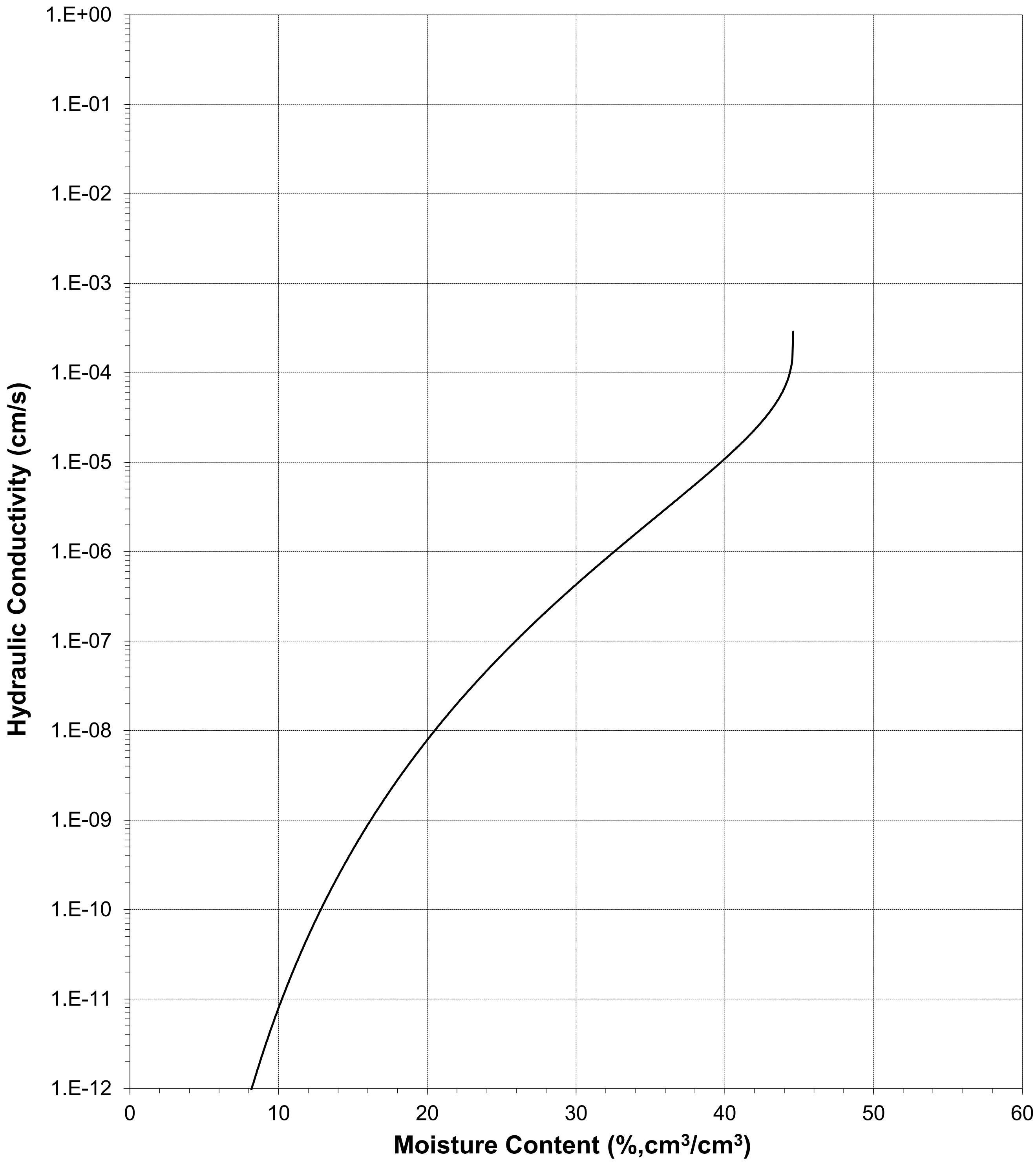
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 0-10 (85%, 1.46)



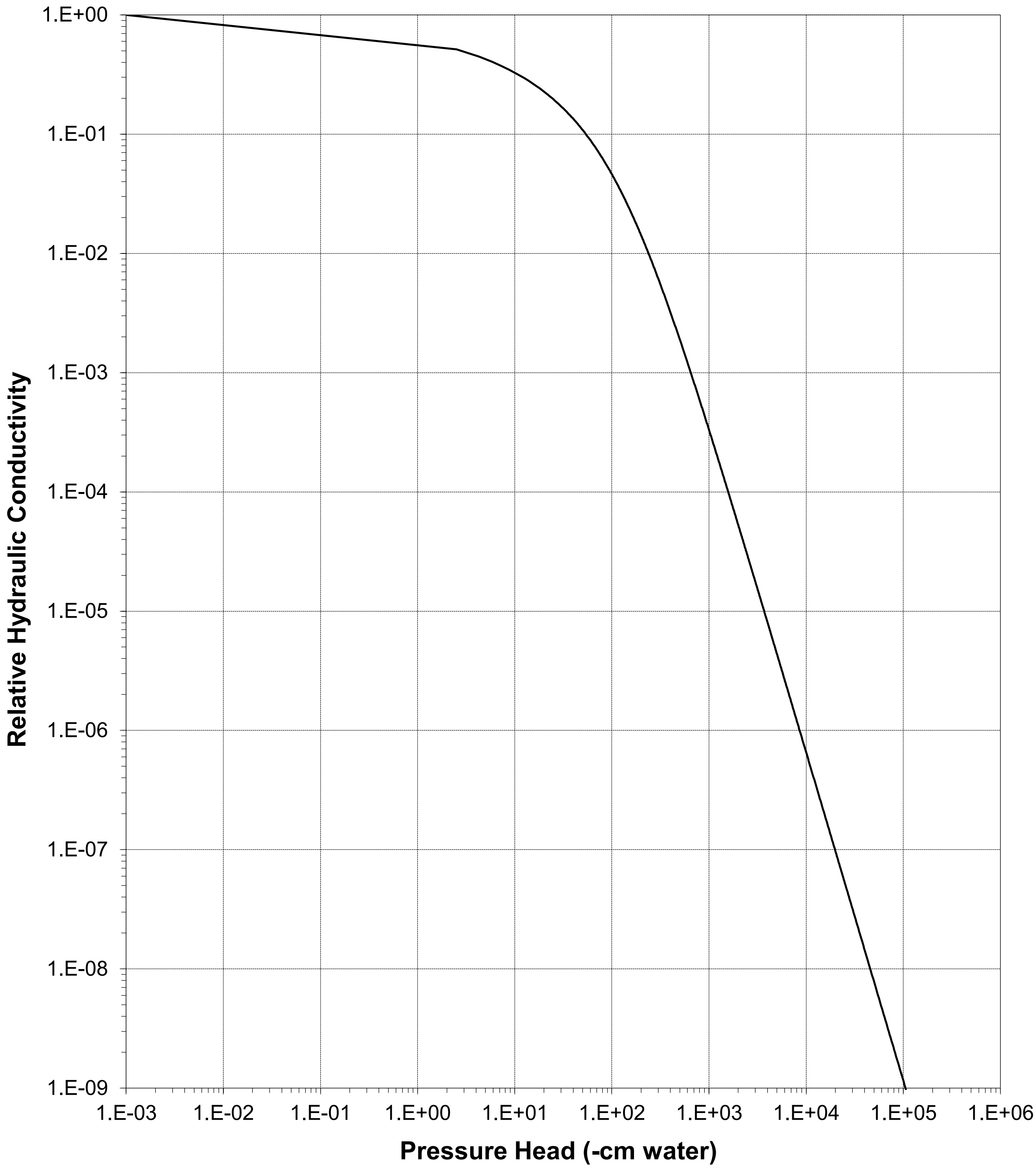
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 0-10 (85%, 1.46)



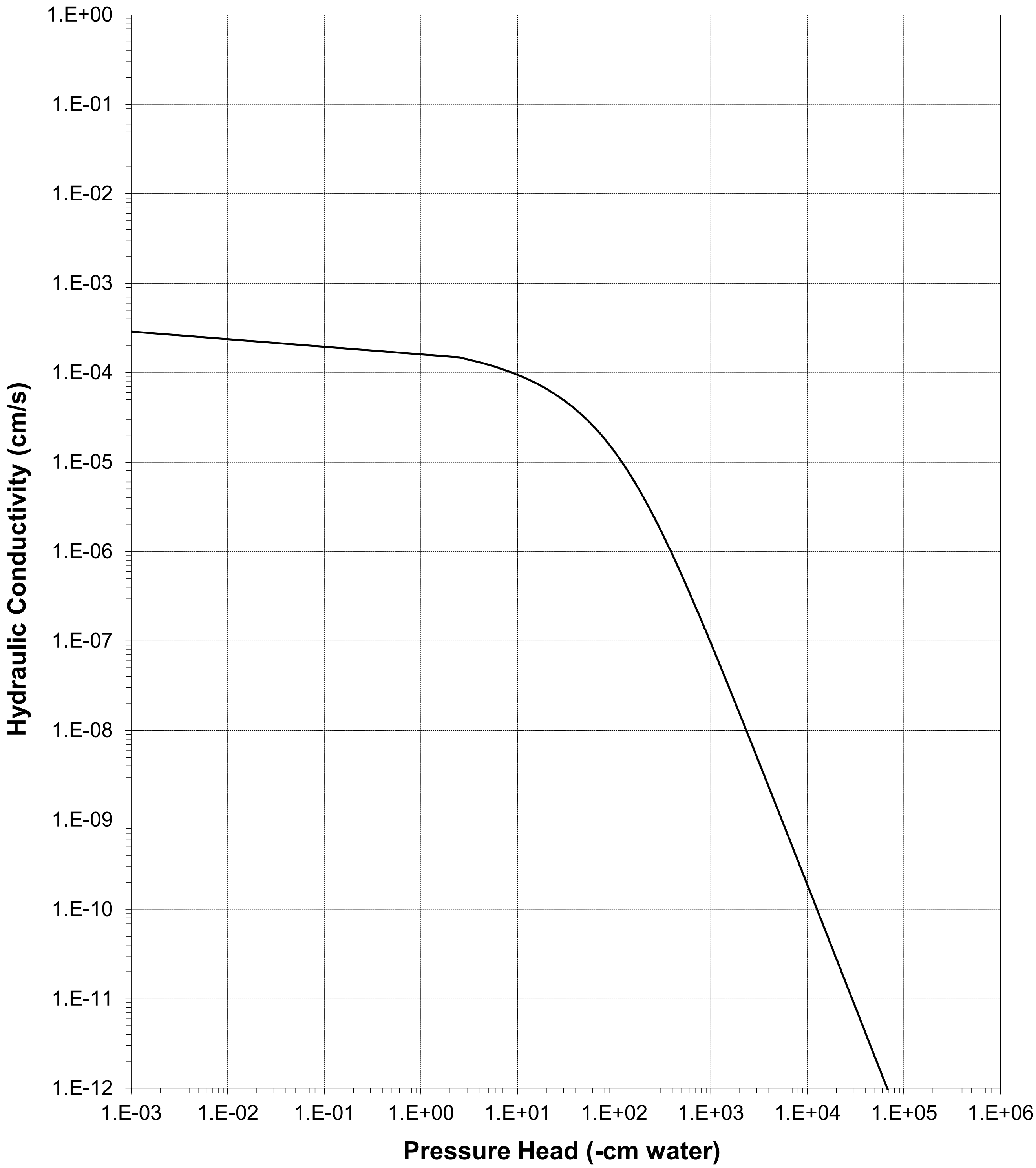
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 0-10 (85%, 1.46)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 0-10 (85%, 1.46)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10 (85%, 1.46)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	22.66	77.34	100.00
Mass Fraction (%):	22.66	77.34	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	38.58
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Initial Moisture Content (% vol):	0.00	24.10	20.75
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	38.58
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Saturated Moisture Content (% vol):	0.00	44.60	38.39
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	38.58
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Residual Moisture Content (% vol):	0.00	1.12	0.97
Ksat (cm/sec):	NM	2.9E-04	2.2E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3332.92
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	270.65
Sample Number:	VVL Composite 11-15 (85%, 1.50)	*Tare wt., screen & clamp* (g):	57.66
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2220.20
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.50
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	43.35

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Hanging column:	8-Sep-14	14:00	4609.50	0	42.71	
	15-Sep-14	9:30	4610.06	7.5	42.74	
	22-Sep-14	15:20	4586.50	24.0	41.68	
	29-Sep-14	16:00	4419.38	76.5	34.15	
Pressure plate:	9-Oct-14	7:40	4259.00	337	27.24	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	7.5	---	---	---	---
	24.0	---	---	---	---
	76.5	---	---	---	---
Pressure plate:	337	2194.13	-1.17%	1.52	42.68

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite 11-15 (85%, 1.50)

Initial sample bulk density (g/cm^3)*:* 1.50

Fraction of test sample used (<2.00mm fraction) (%): 56.44

Dry weight of dew point potentiometer sample* (g)*:* 178.32

Tare weight, jar (g)*:* 117.95

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	10-Sep-14	12:40	183.27	15093	7.03	‡‡
	10-Sep-14	8:41	182.10	52010	5.37	‡‡
	9-Sep-14	14:10	180.49	460950	3.08	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	15093	2194.13	-1.17%	1.52	42.68
	52010	2194.13	-1.17%	1.52	42.68
	460950	2194.13	-1.17%	1.52	42.68

Dry weight of relative humidity box sample* (g)*:* 73.44

Tare weight (g)*:* 41.63

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Relative humidity box:	9-Sep-14	11:00	74.55	851293	2.98	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	2194.13	-1.17%	1.52	42.68

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

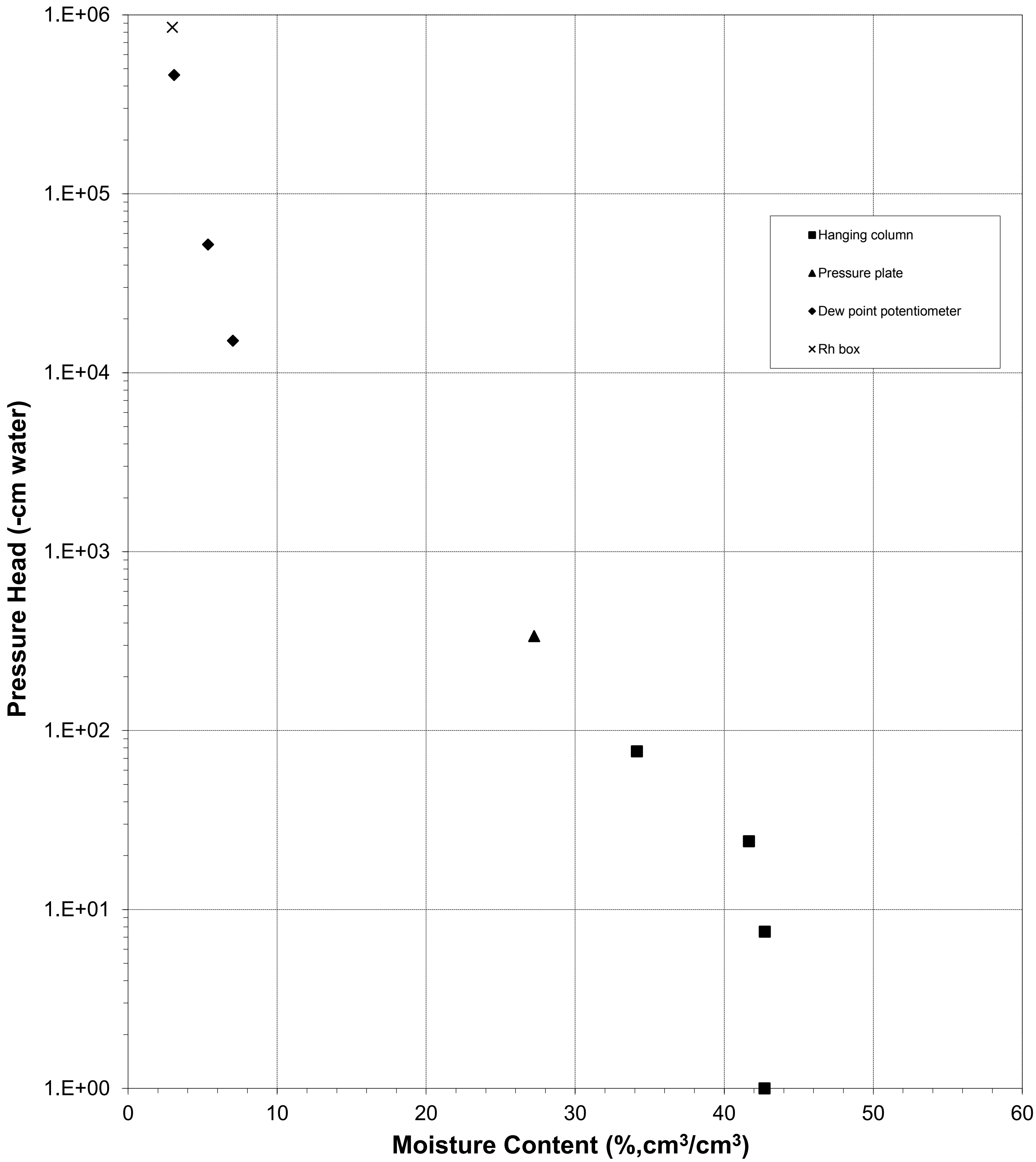
Laboratory analysis by: D. O' Dowd/D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

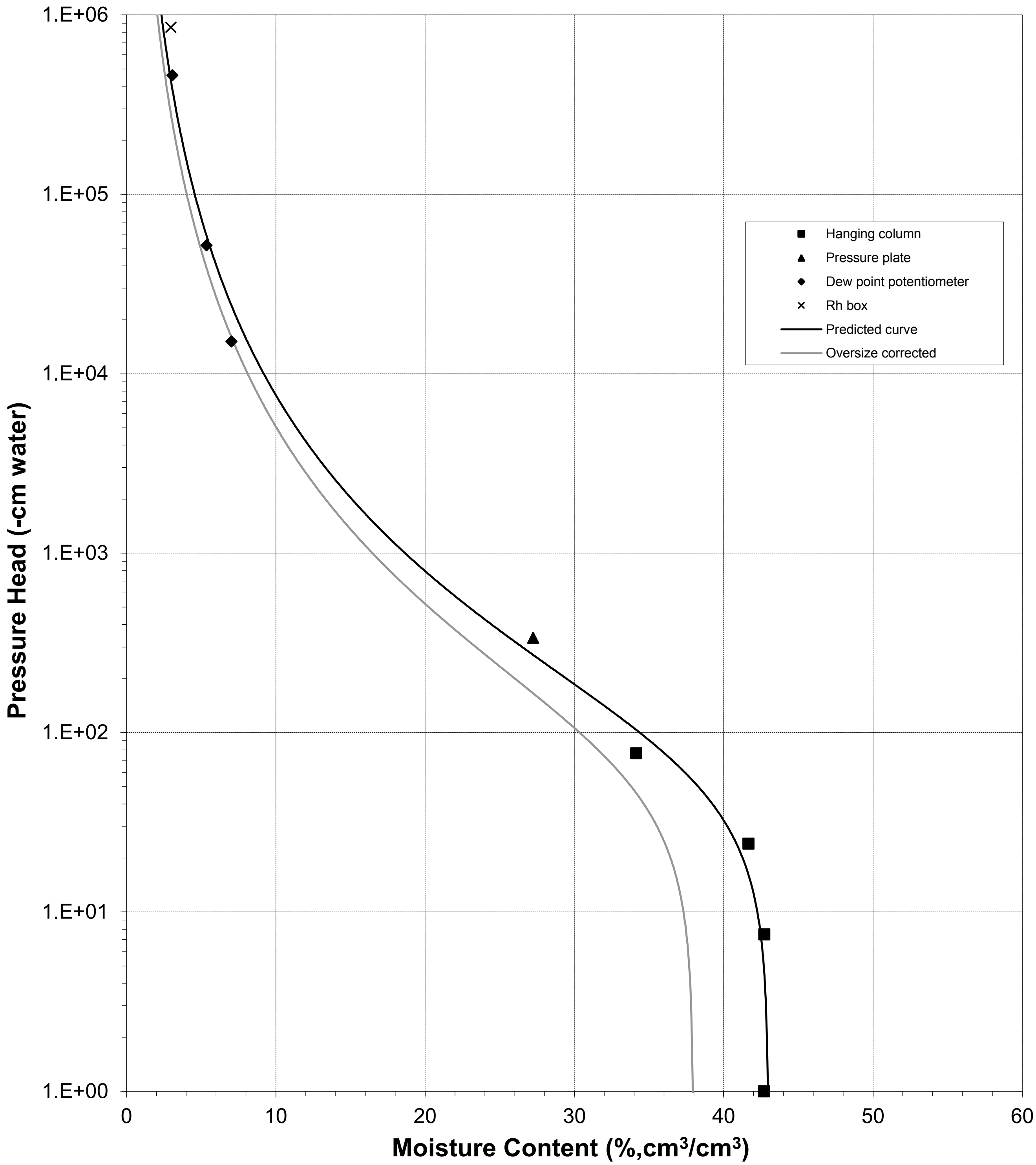
Water Retention Data Points

Sample Number: VVL Composite 11-15 (85%, 1.50)



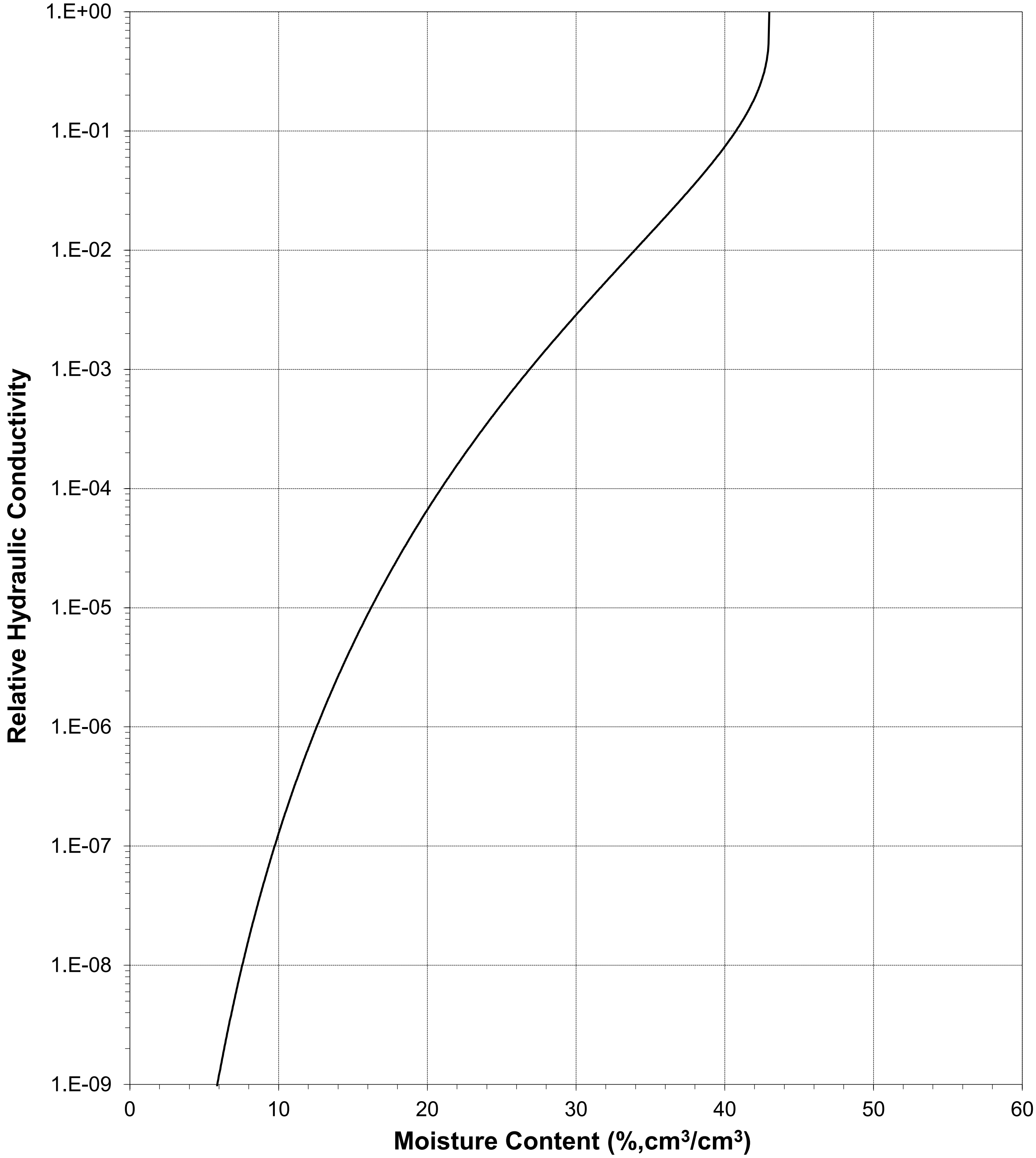
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite 11-15 (85%, 1.50)



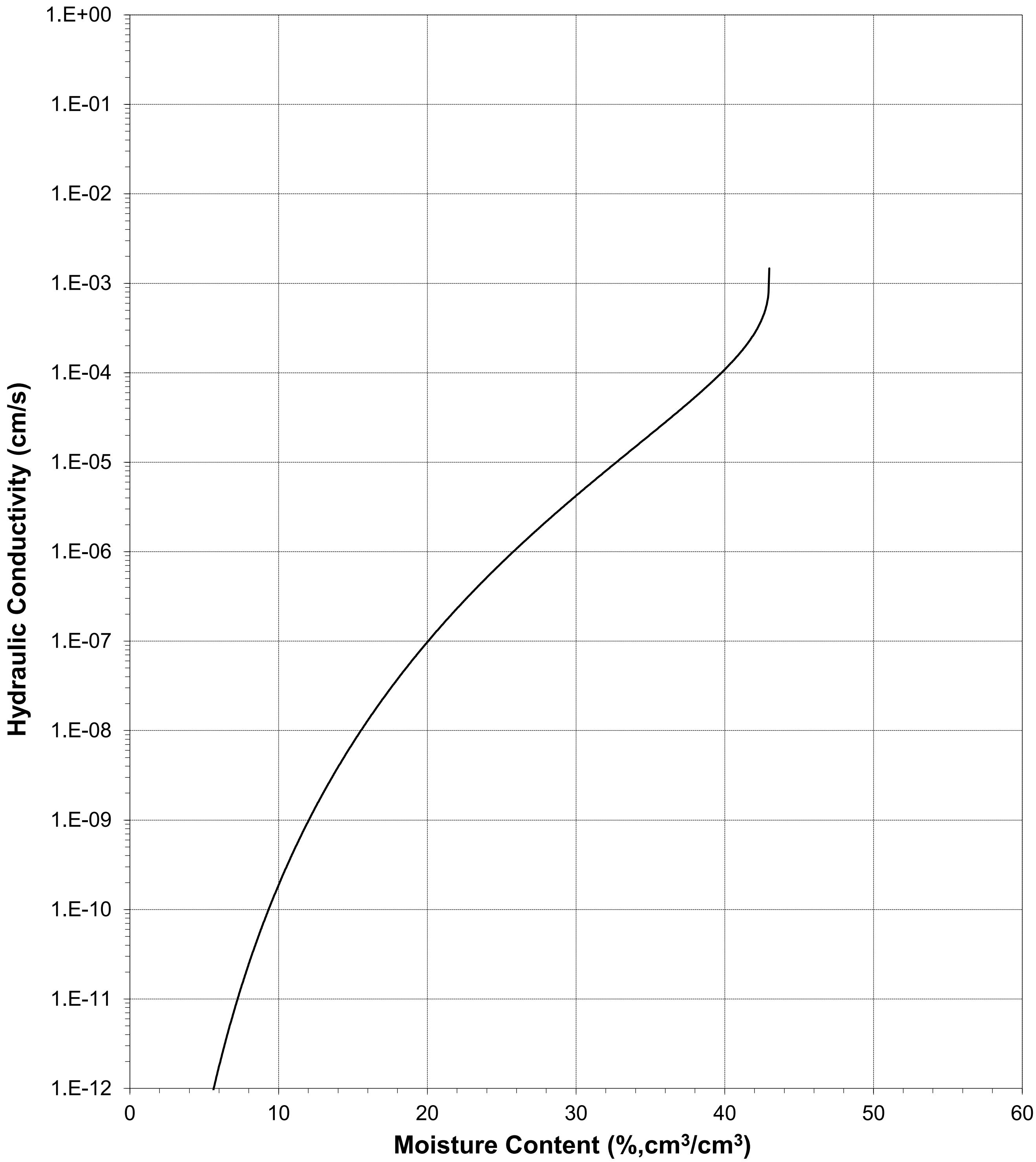
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 11-15 (85%, 1.50)



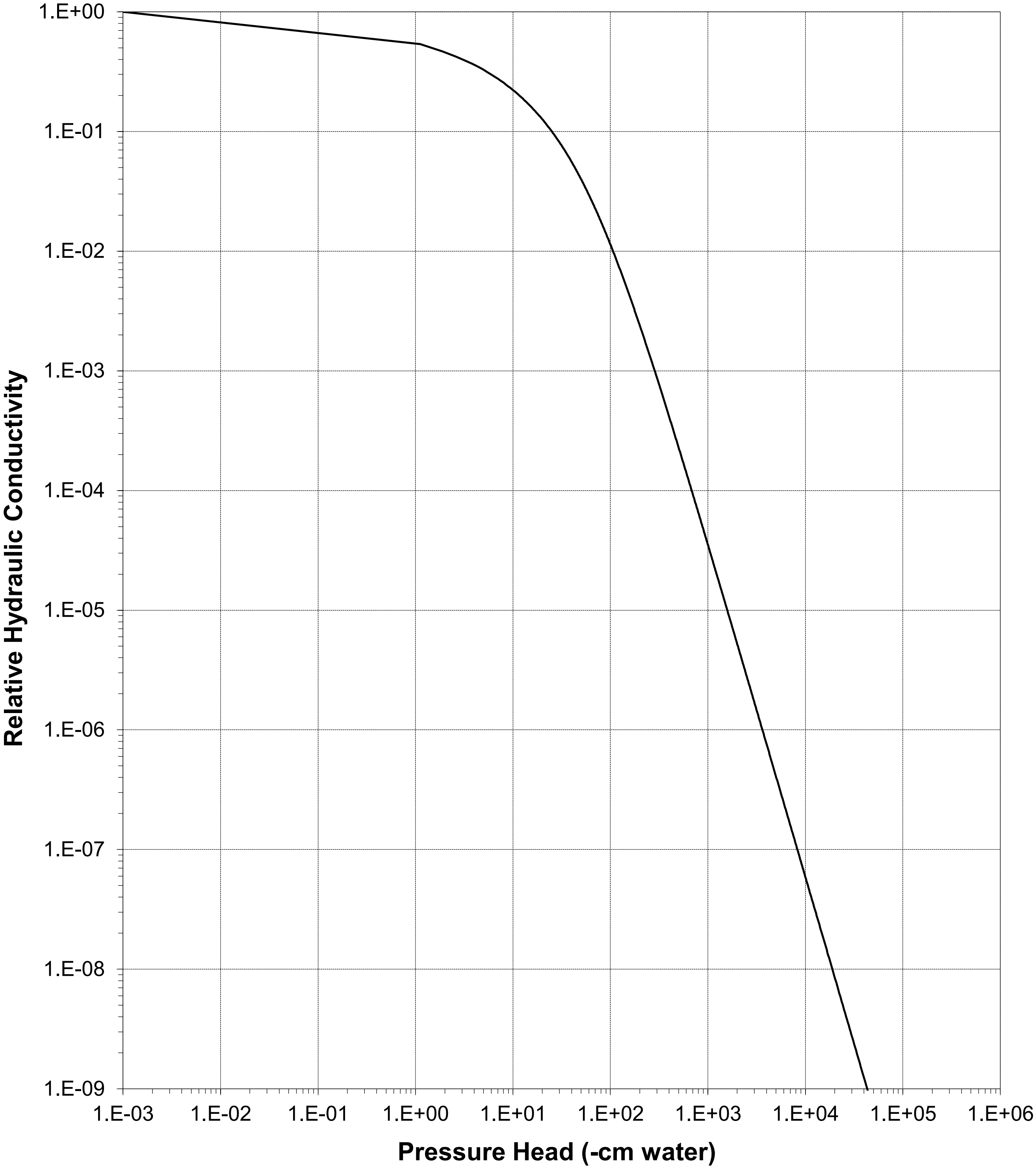
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 11-15 (85%, 1.50)



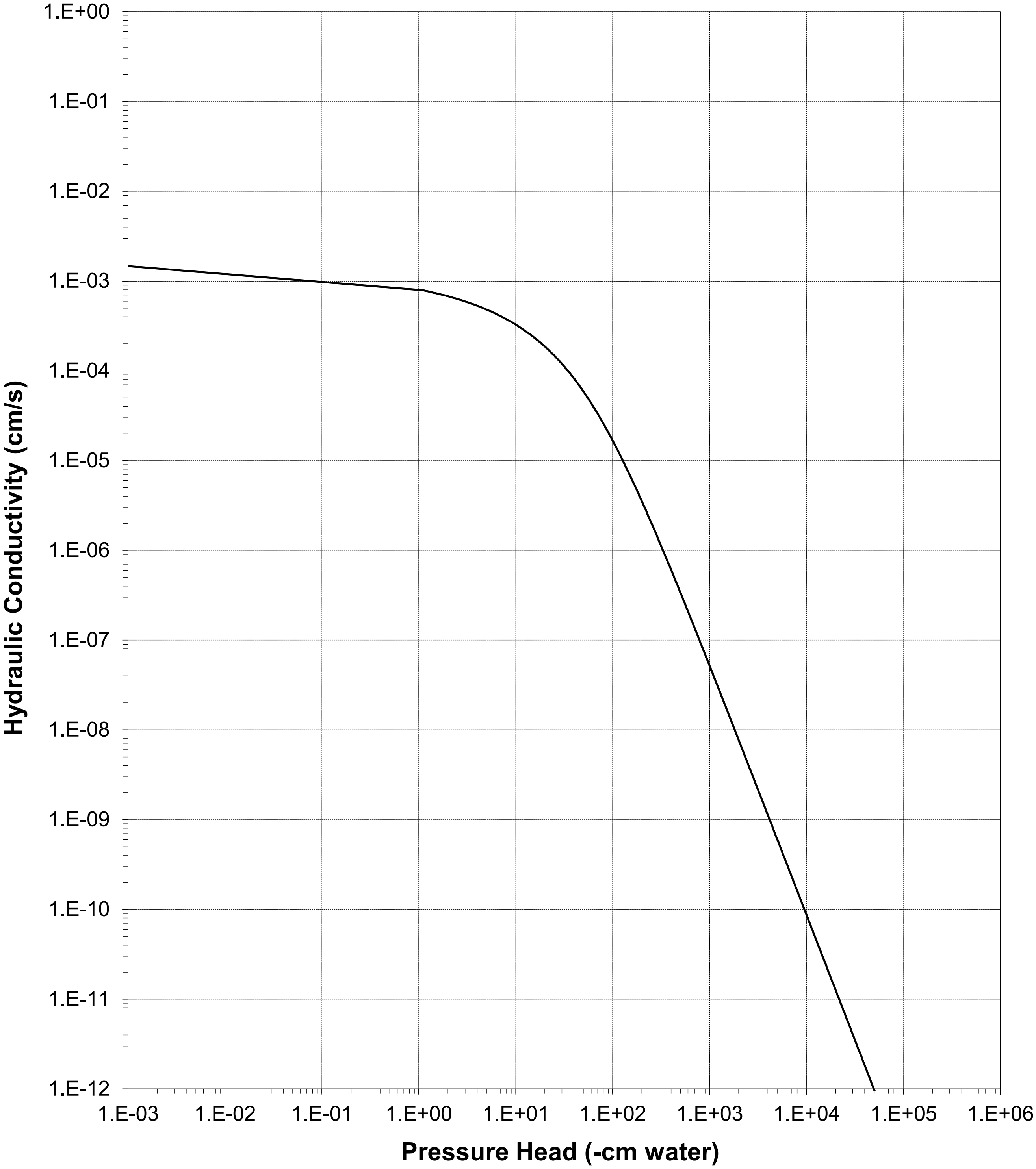
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 11-15 (85%, 1.50)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 11-15 (85%, 1.50)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15 (85%, 1.50)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	18.97	81.03	100.00
Mass Fraction (%):	18.97	81.03	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.50	1.64
Calculated Porosity (% vol):	0.00	43.35	38.28
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	23.40	23.40
Total Volume (cm^3):	7.16	53.98	61.14
Volumetric Fraction (%):	11.71	88.29	100.00
Initial Moisture Content (% vol):	0.00	20.94	18.49
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.50	1.64
Calculated Porosity (% vol):	0.00	43.35	38.28
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	23.40	23.40
Total Volume (cm^3):	7.16	53.98	61.14
Volumetric Fraction (%):	11.71	88.29	100.00
Saturated Moisture Content (% vol):	0.00	42.99	37.96
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.52	1.65
Calculated Porosity (% vol):	0.00	42.68	37.63
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	22.77	22.77
Total Volume (cm^3):	7.16	53.34	60.50
Volumetric Fraction (%):	11.83	88.17	100.00
Residual Moisture Content (% vol):	0.00	0.27	0.23
Ksat (cm/sec):	NM	1.5E-03	1.2E-03

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3186.29
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	269.93
Sample Number:	VVL Composite 16-20 (85%, 1.45)	*Tare wt., screen & clamp* (g):	47.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2194.77
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.45
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	45.22

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	8-Sep-14	14:00	4539.10	0	47.19
	15-Sep-14	10:00	4534.19	12.5	46.96
	22-Sep-14	15:30	4472.40	34.5	44.15
	29-Sep-14	16:15	4356.73	107.5	38.88
Pressure plate:	8-Oct-14	13:00	4264.80	337	34.69

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	12.5	---	---	---	---
	34.5	---	---	---	---
	107.5	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite 16-20 (85%, 1.45)

Initial sample bulk density (g/cm³)*:* 1.45
Fraction of test sample used (<2.00mm fraction) (%): 57.04

Dry weight of dew point potentiometer sample* (g)*:* 169.95
Tare weight, jar (g)*:* 118.36

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	13:20	176.88	18968	11.12
	10-Sep-14	10:50	175.41	60066	8.76
	9-Sep-14	15:30	173.75	285136	6.10

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	18968	---	---	---	---
	60066	---	---	---	---
	285136	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 75.66
Tare weight (g)*:* 40.73

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	77.46	851293	4.28

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

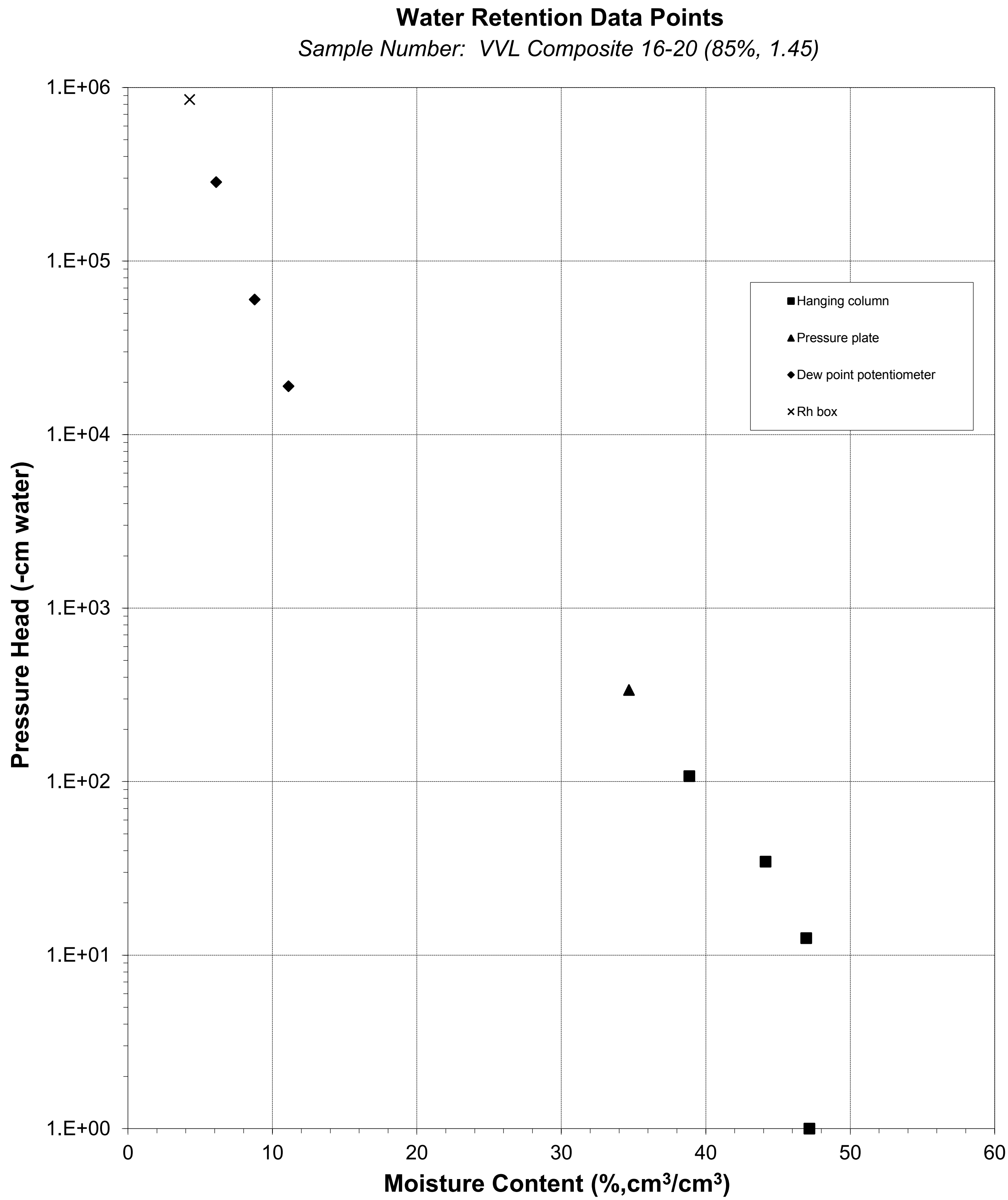
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

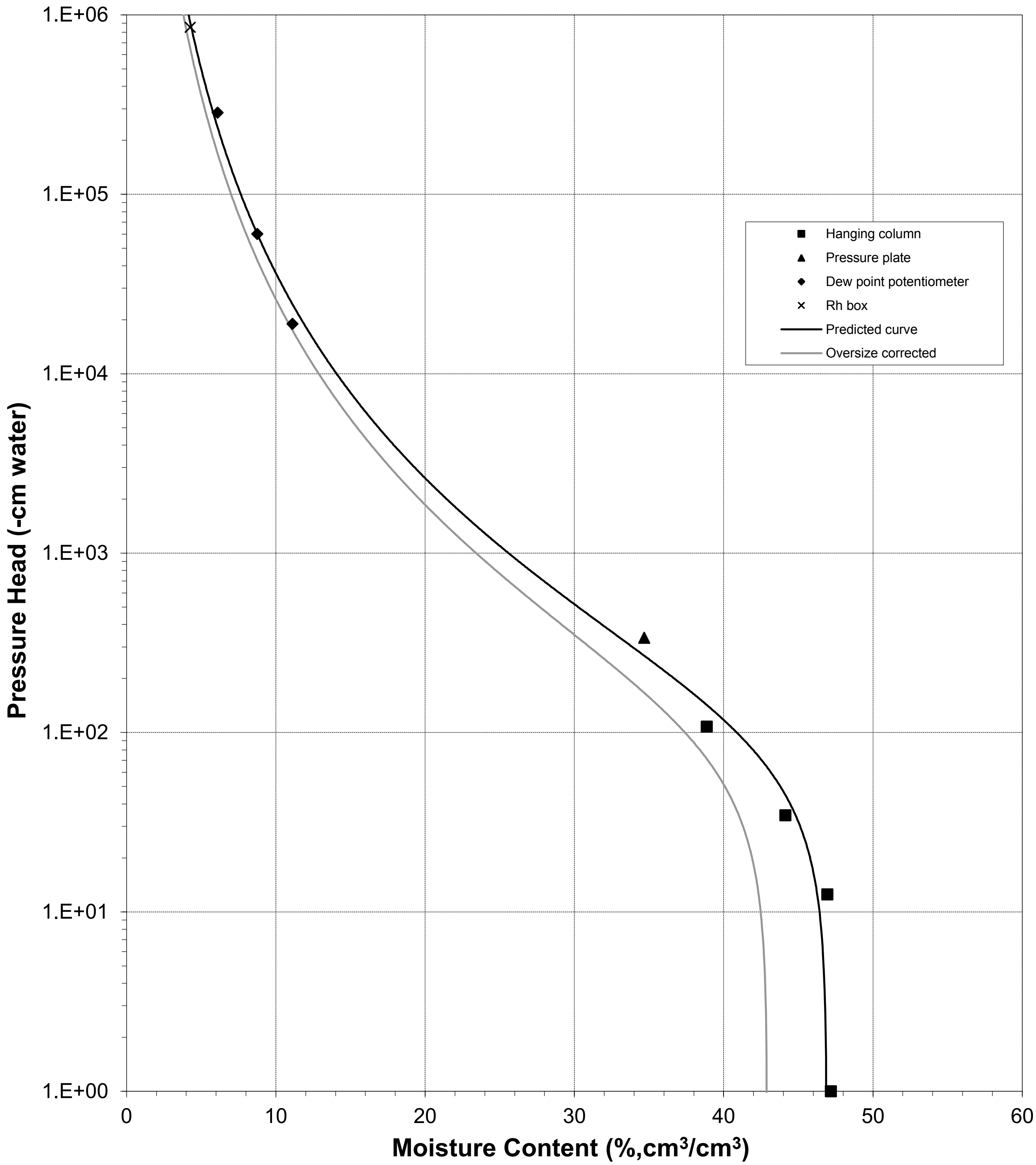
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines


Water Retention Data Points
Sample Number: VVL Composite 16-20 (85%, 1.45)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)
Hanging column
Pressure plate
Dew point potentiometer
Rh box

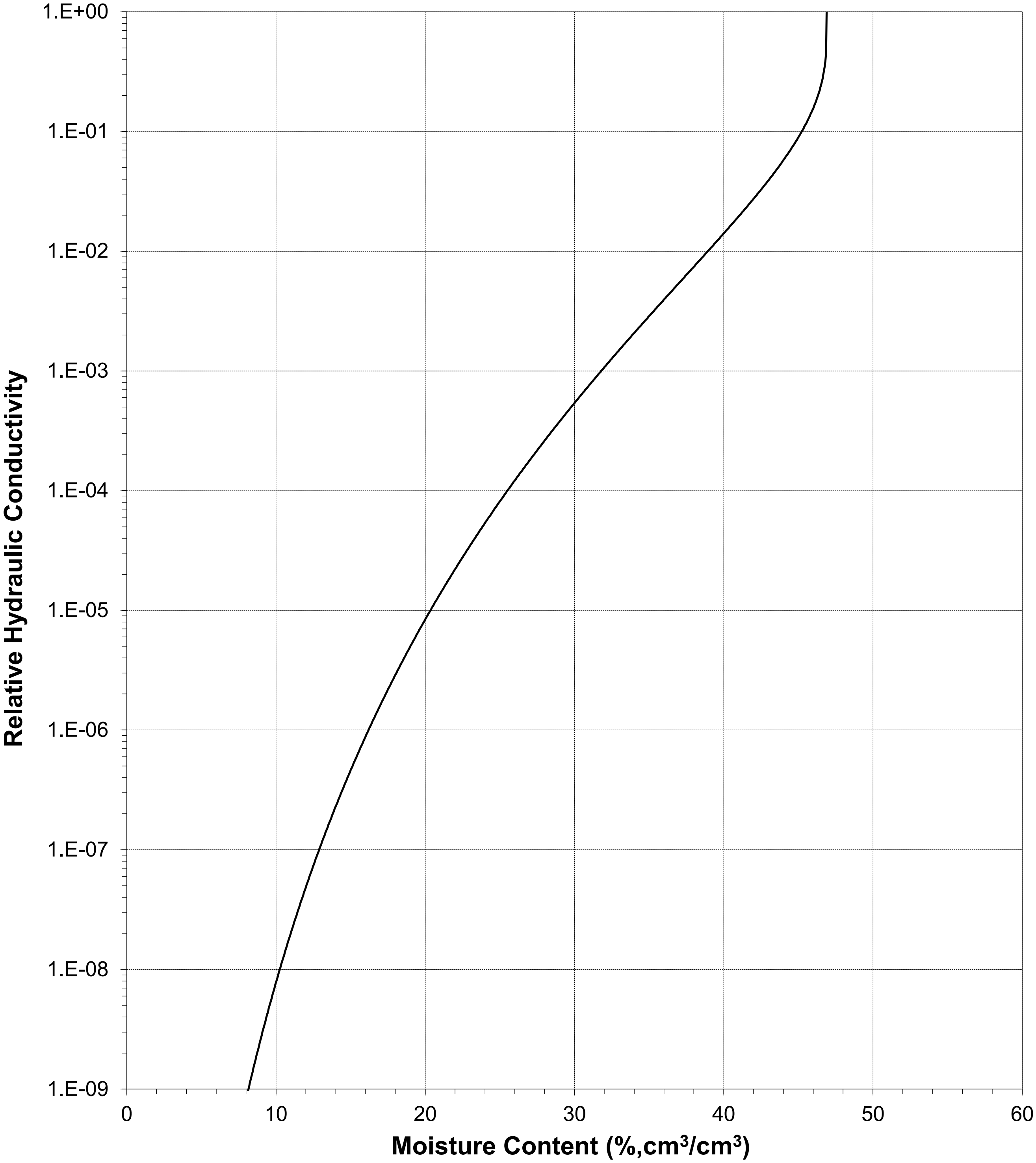
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite 16-20 (85%, 1.45)



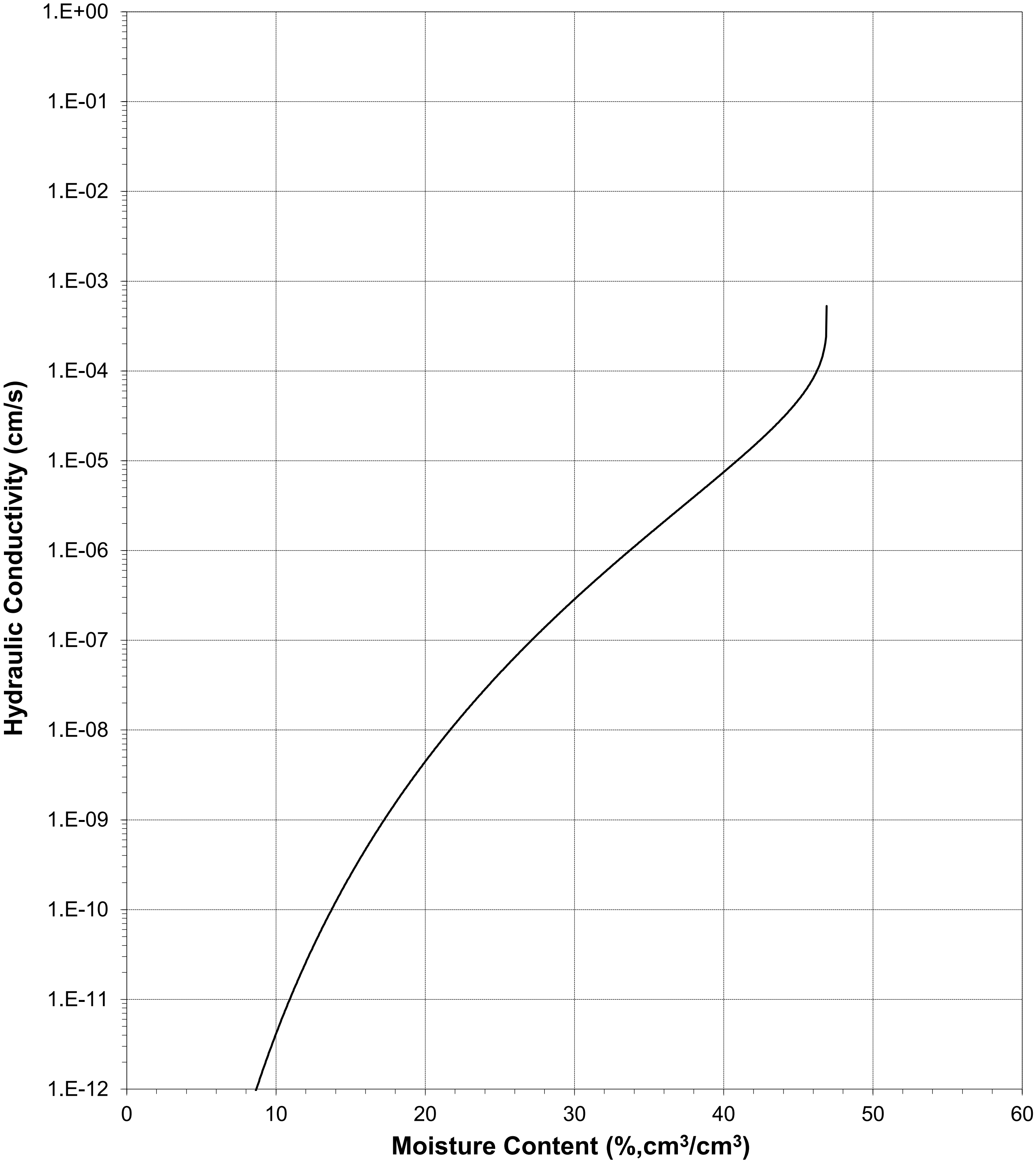
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 16-20 (85%, 1.45)



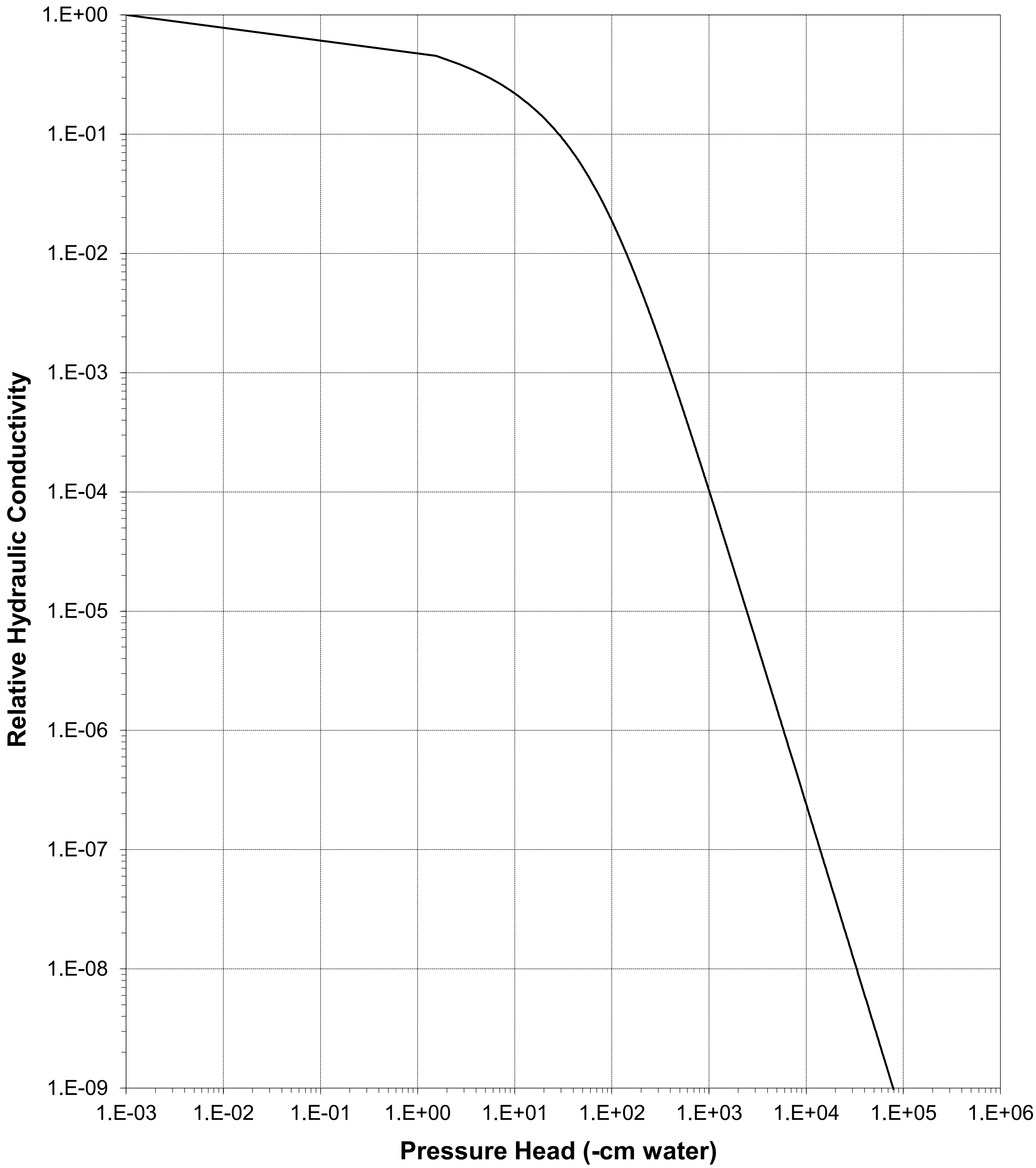
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 16-20 (85%, 1.45)



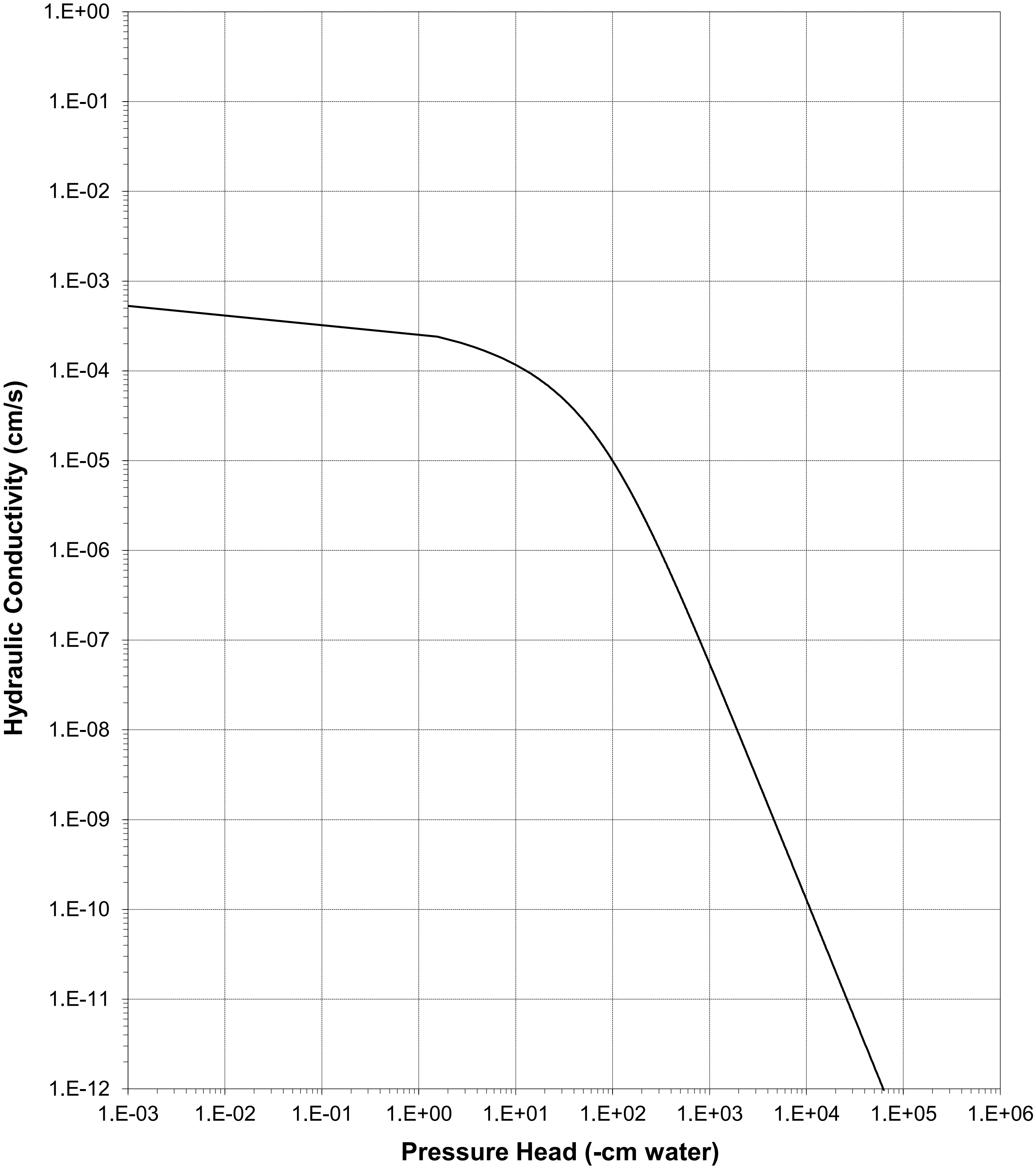
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 16-20 (85%, 1.45)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 16-20 (85%, 1.45)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20 (85%, 1.45)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	14.48	85.52	100.00
Mass Fraction (%):	14.48	85.52	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	41.38
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Initial Moisture Content (% vol):	0.00	24.76	22.66
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	41.38
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Saturated Moisture Content (% vol):	0.00	46.90	42.92
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	41.38
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	5.3E-04	4.5E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

Dry wt. of sample (g): 3048.84
Tare wt., ring (g): 271.14
Tare wt., screen & clamp (g): 60.30
Initial sample volume (cm^3): 2201.91
Initial dry bulk density (g/cm^3): 1.38
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 47.75

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	8-Sep-14	14:00	4452.60	0	48.70
	15-Sep-14	9:30	4451.85	12.0	48.67
	22-Sep-14	15:15	4413.50	30.5	46.92
	29-Sep-14	13:45	4288.78	103.5	41.26
Pressure plate:	8-Oct-14	12:40	4172.90	337	36.00

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	12.0	---	---	---	---
	30.5	---	---	---	---
	103.5	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer / Relative Humidity Box
(Soil-Water Characteristic Curve)

Sample Number: VVL Composite 21-30 (85%, 1.38)

Initial sample bulk density (g/cm³)*:* 1.38
Fraction of test sample used (<2.00mm fraction) (%): 56.28

Dry weight of dew point potentiometer sample* (g)*:* 161.19
Tare weight, jar (g)*:* 114.40

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	13:17	169.92	9076	14.54
	10-Sep-14	12:15	167.40	41506	10.34
	9-Sep-14	16:00	165.59	164596	7.33

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	9076	---	---	---	---
	41506	---	---	---	---
	164596	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 69.86
Tare weight (g)*:* 42.29

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	71.51	851293	4.66

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

1 Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

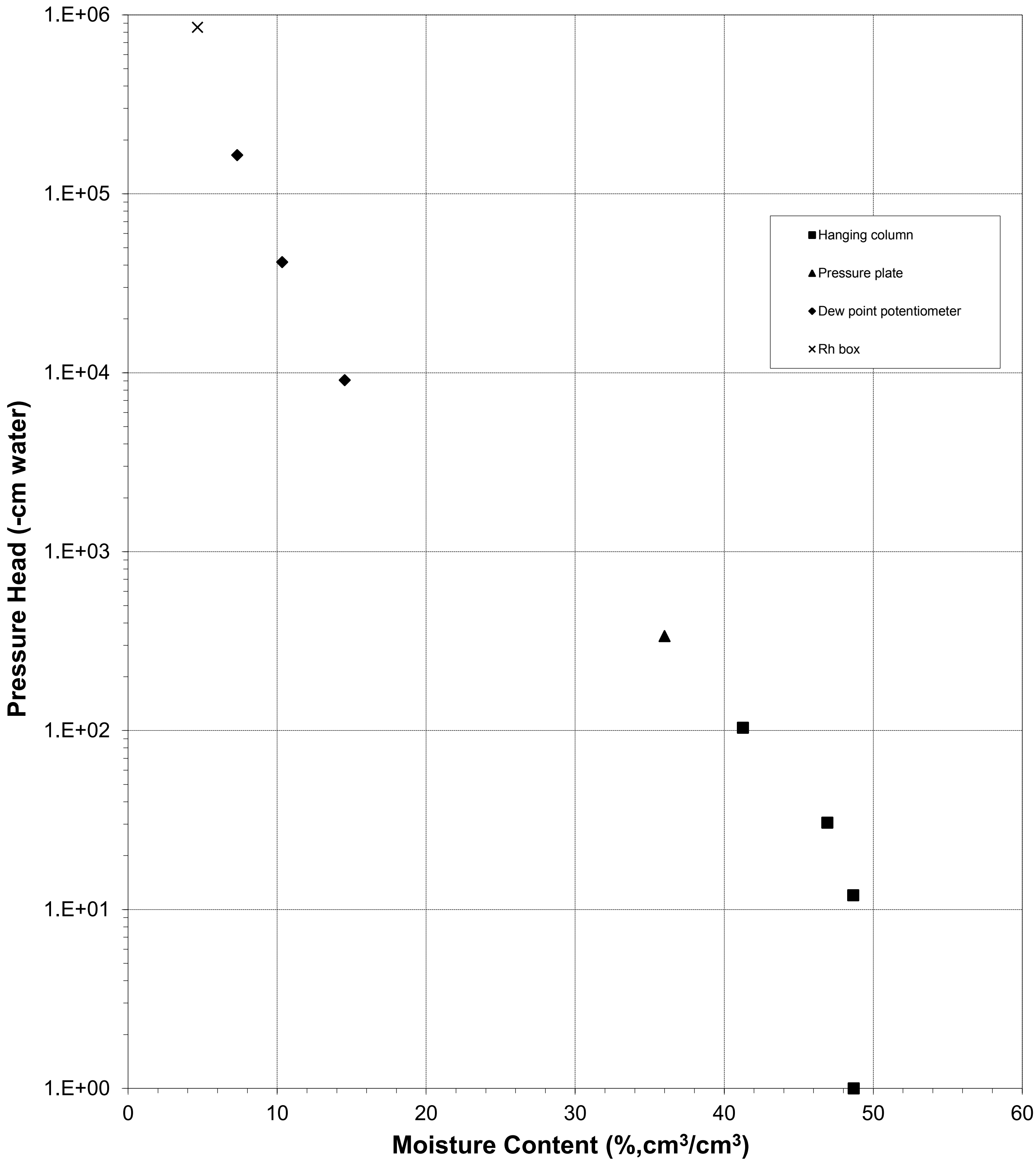
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

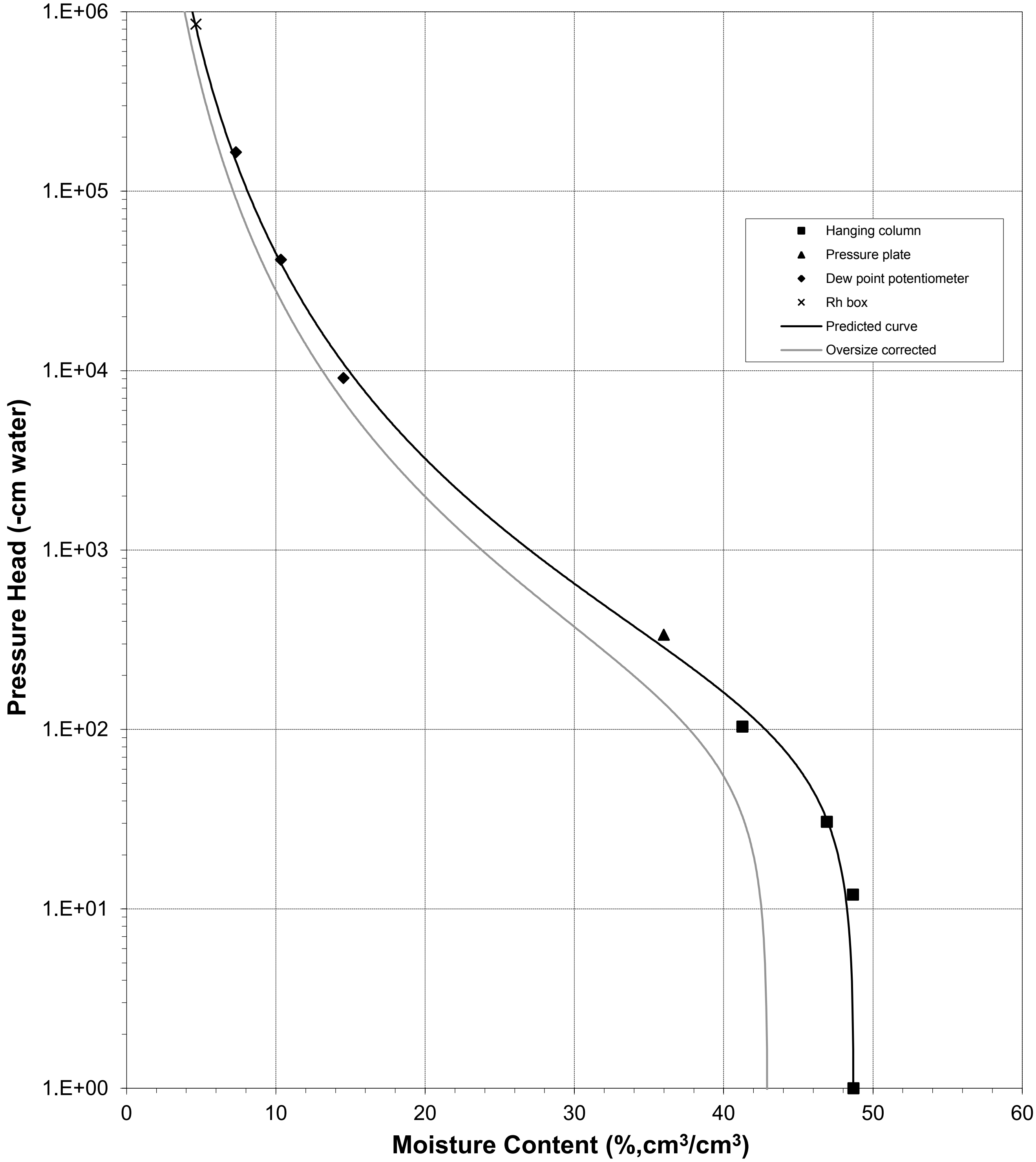
Water Retention Data Points

Sample Number: VVL Composite 21-30 (85%, 1.38)



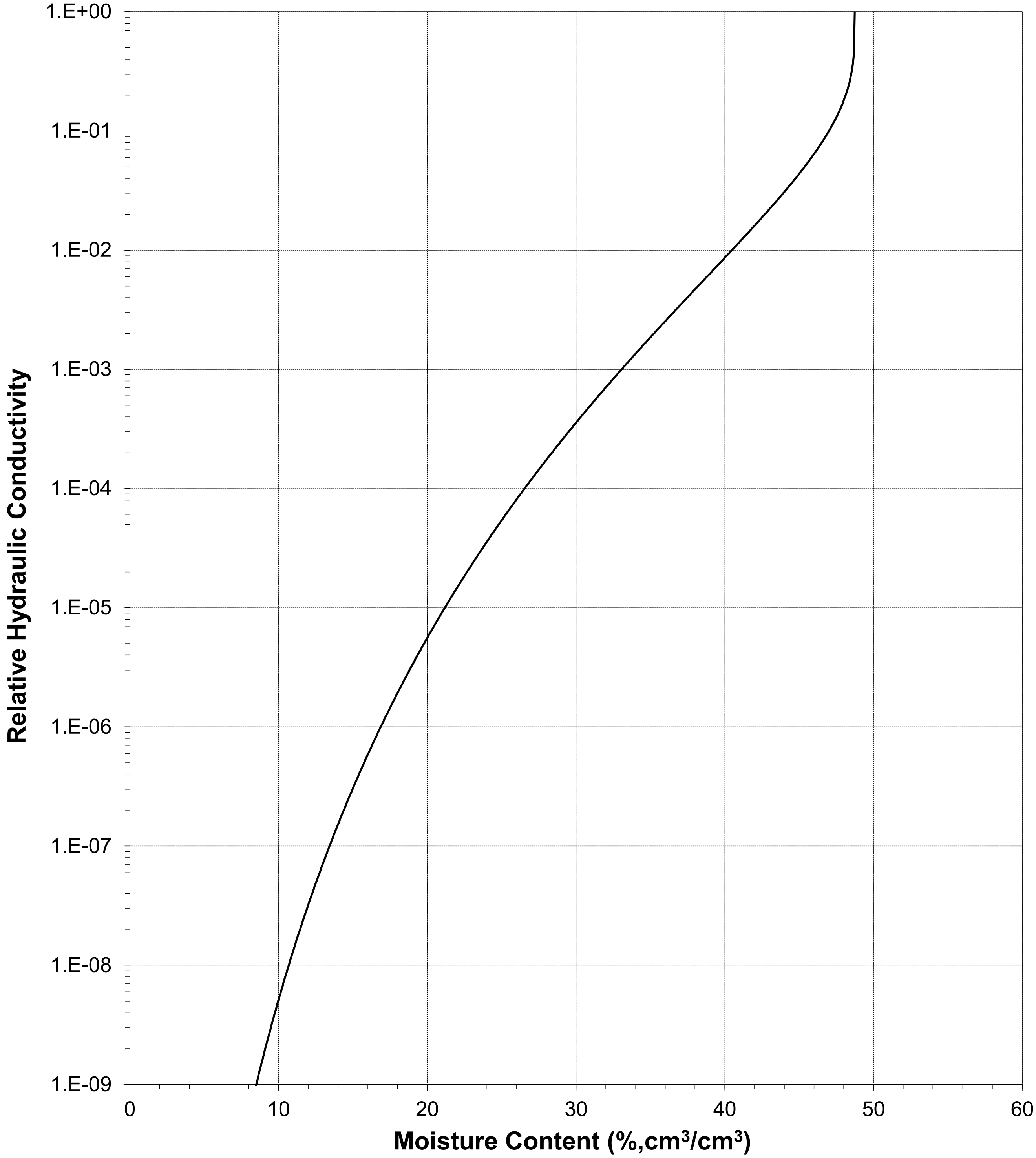
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite 21-30 (85%, 1.38)



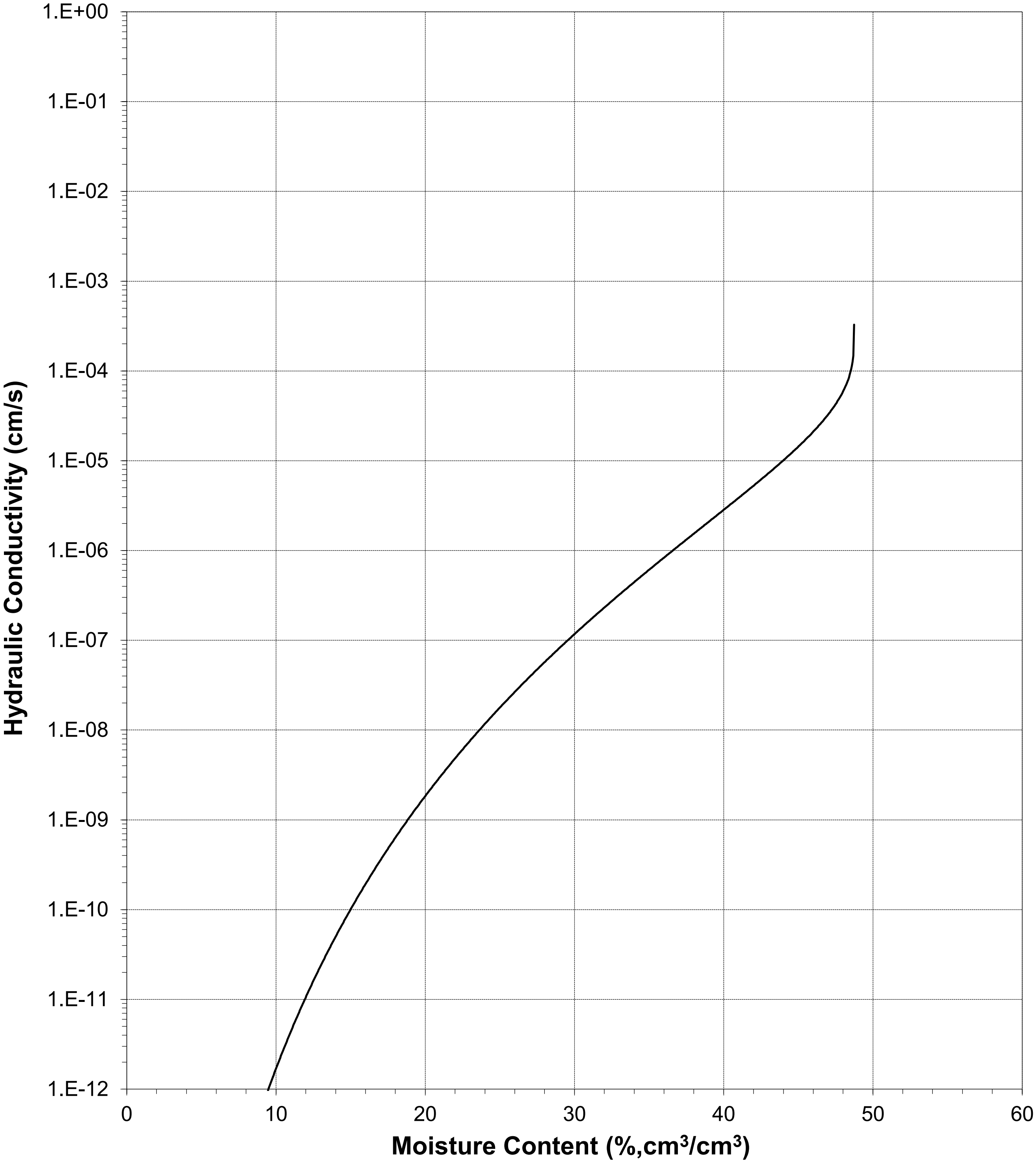
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 21-30 (85%, 1.38)



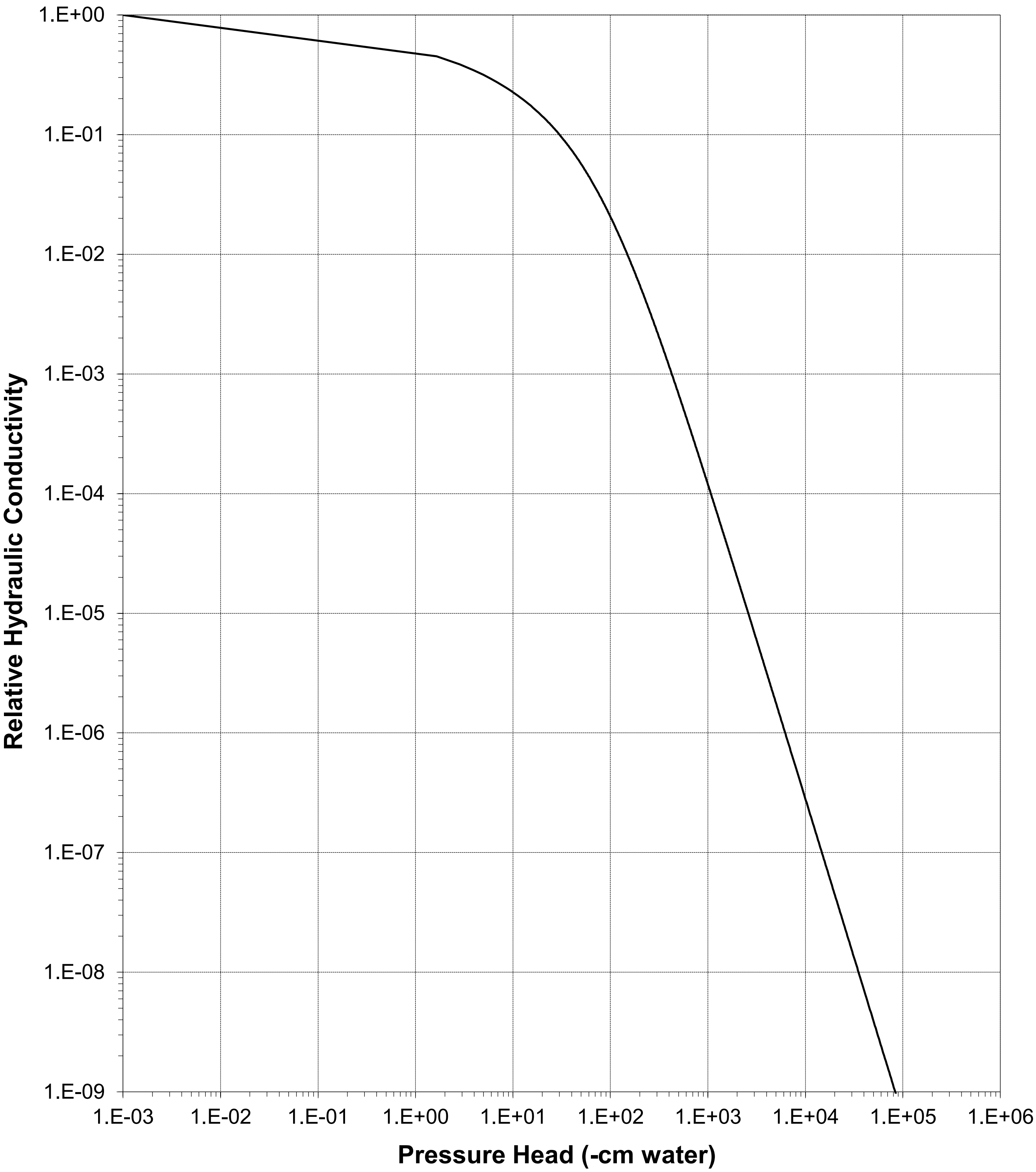
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite 21-30 (85%, 1.38)



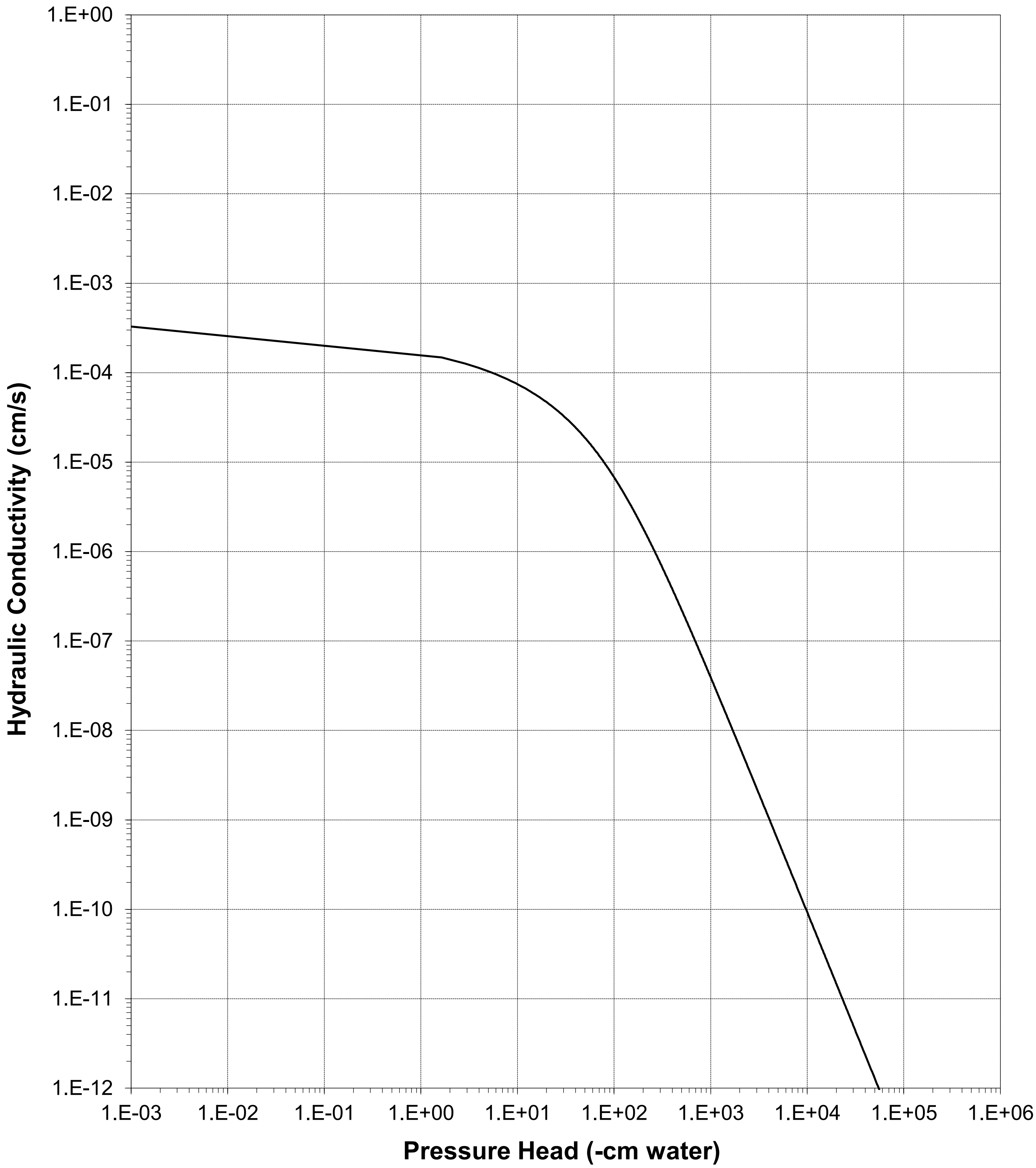
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 21-30 (85%, 1.38)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 21-30 (85%, 1.38)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	20.52	79.48	100.00
Mass Fraction (%):	20.52	79.48	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	42.07
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Initial Moisture Content (% vol):	0.00	25.09	22.11
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	42.07
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Saturated Moisture Content (% vol):	0.00	48.73	42.94
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	42.07
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	3.3E-04	2.6E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	2700.23
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	272.82
Sample Number:	VVL Composite 31+ (85%, 1.22)	*Tare wt., screen & clamp* (g):	67.12
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2217.25
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.22
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	54.04

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	3-Sep-14	10:55	4309.20	0	57.23
	10-Sep-14	13:35	4308.96	12.0	57.22
	17-Sep-14	10:45	4295.60	32.0	56.62
	24-Sep-14	15:30	4188.20	93.0	51.78
Pressure plate:	4-Oct-14	10:45	4072.50	337	46.56

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	12.0	---	---	---	---
	32.0	---	---	---	---
	93.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite 31+ (85%, 1.22)

Initial sample bulk density (g/cm^3)*:* 1.22

Fraction of test sample used (<2.00mm fraction) (%): 78.45

Dry weight of dew point potentiometer sample* (g)*:* 147.15

Tare weight, jar (g)*:* 116.43

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	13:00	153.68	19070	20.31
	10-Sep-14	9:00	152.54	52112	16.76
	9-Sep-14	14:30	150.60	449630	10.73

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	19070	---	---	---	---
	52112	---	---	---	---
	449630	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 59.09

Tare weight (g)*:* 40.70

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	60.78	851293	8.81

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

1 Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

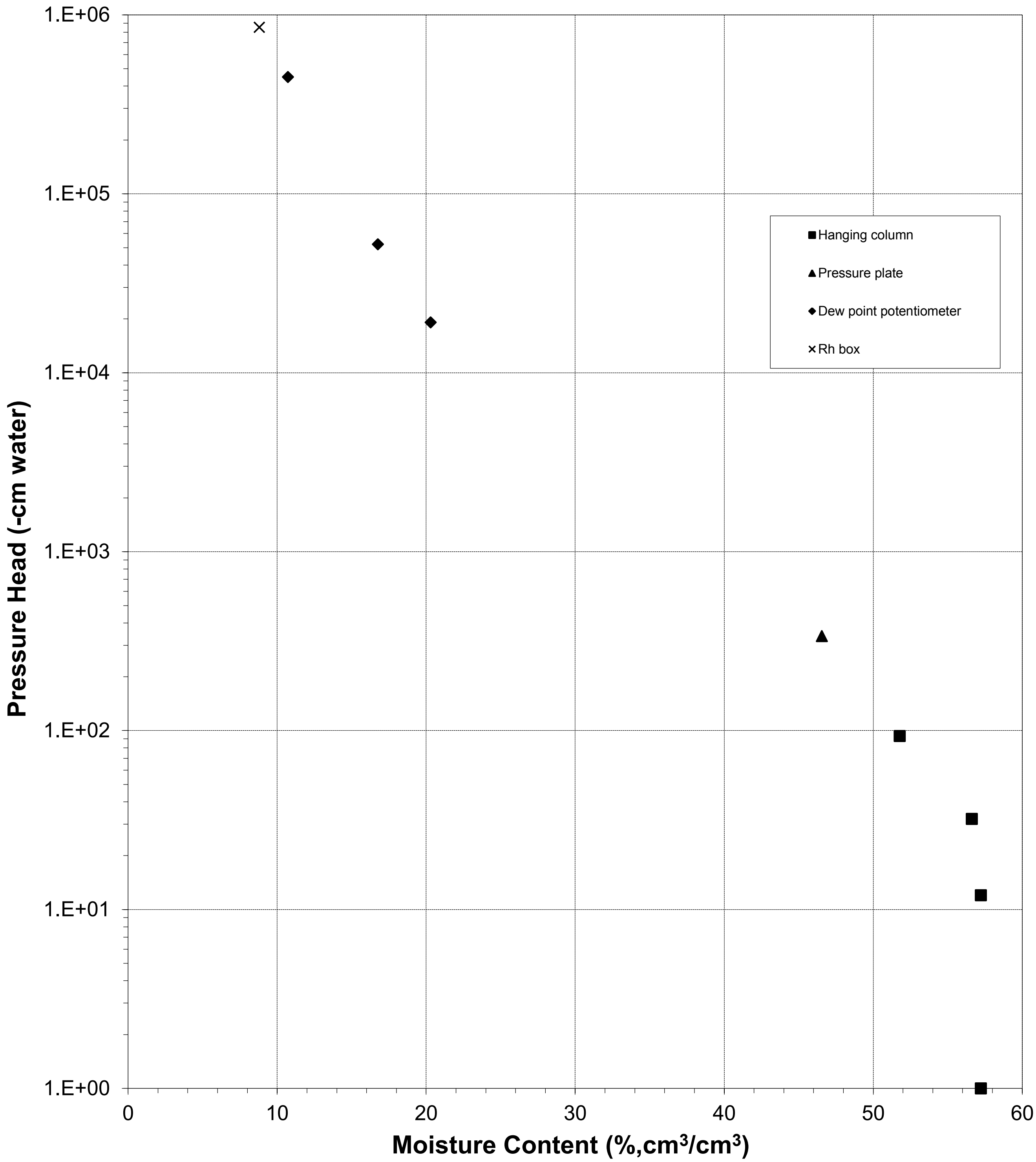
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

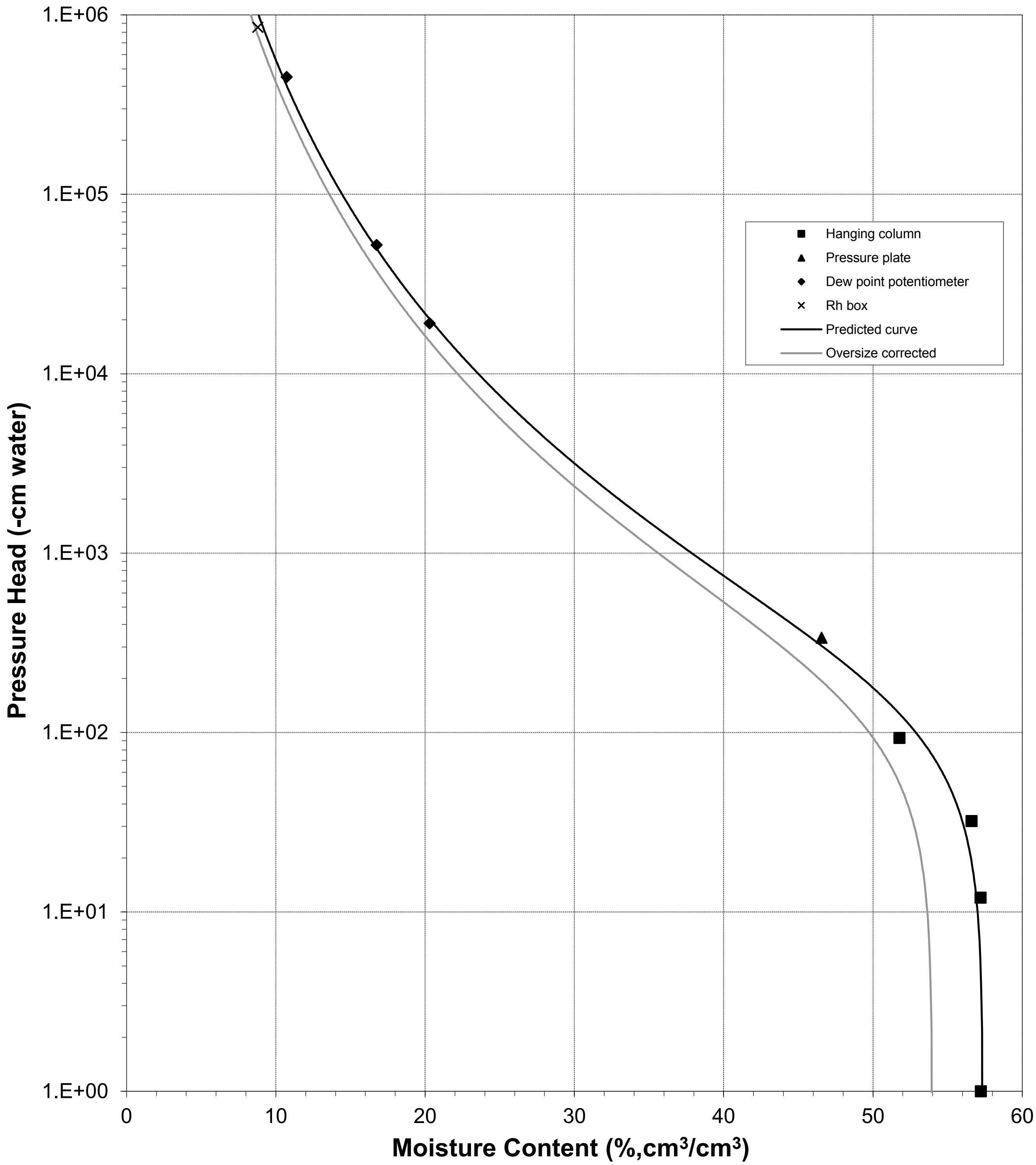
Water Retention Data Points

Sample Number: VVL Composite 31+ (85%, 1.22)



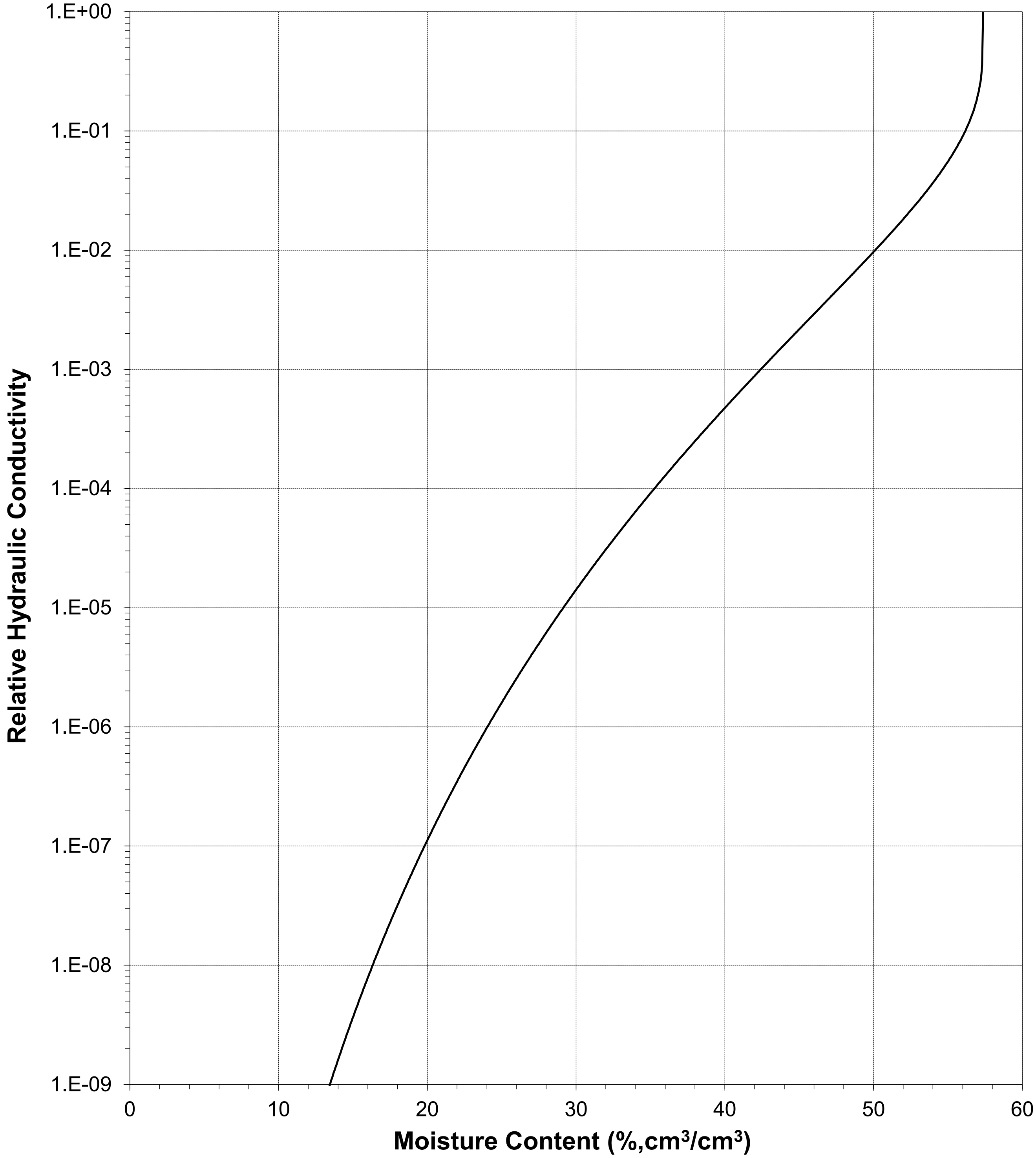
Predicted Water Retention Curve and Data Points

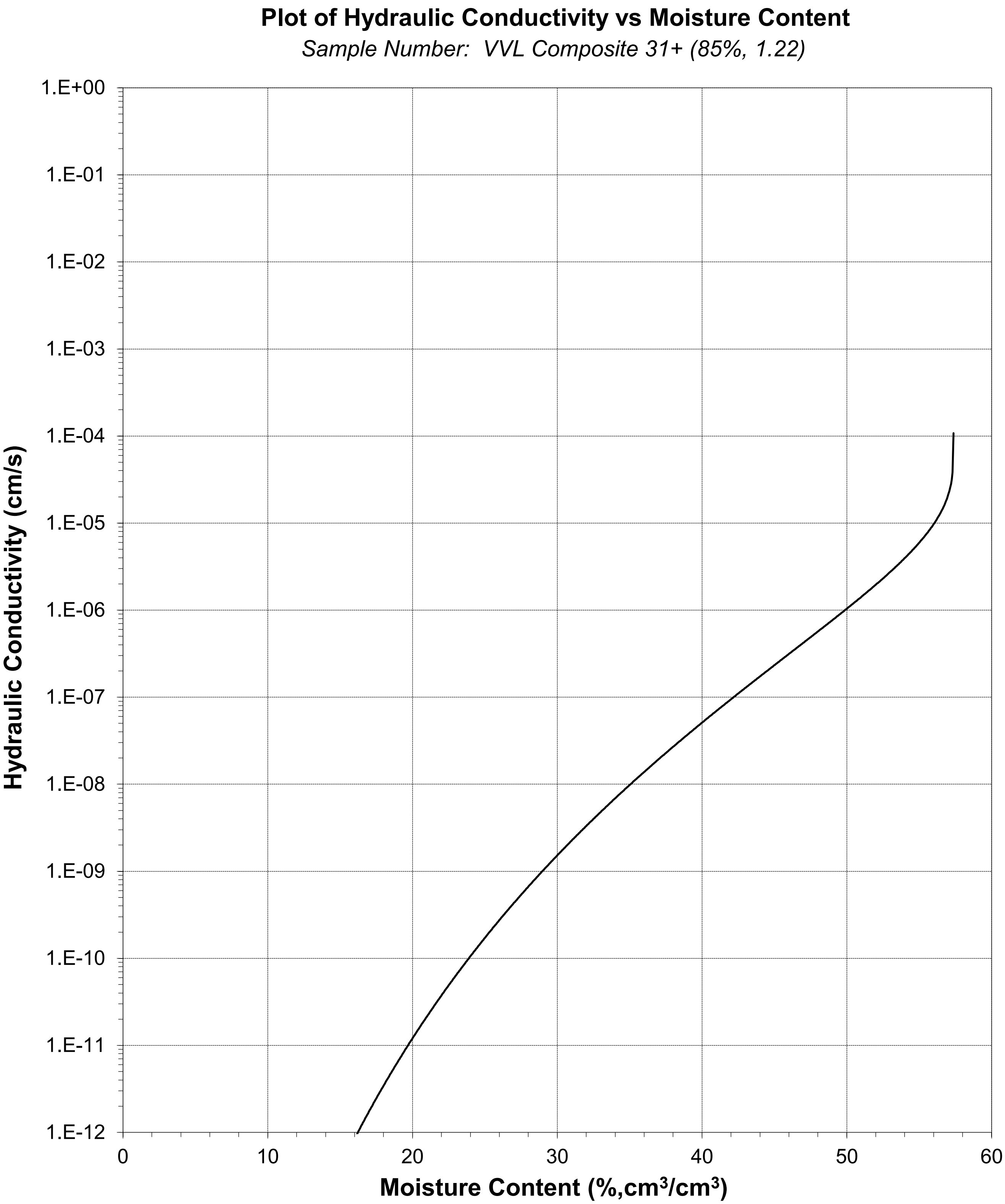
Sample Number: VVL Composite 31+ (85%, 1.22)



Plot of Relative Hydraulic Conductivity vs Moisture Content

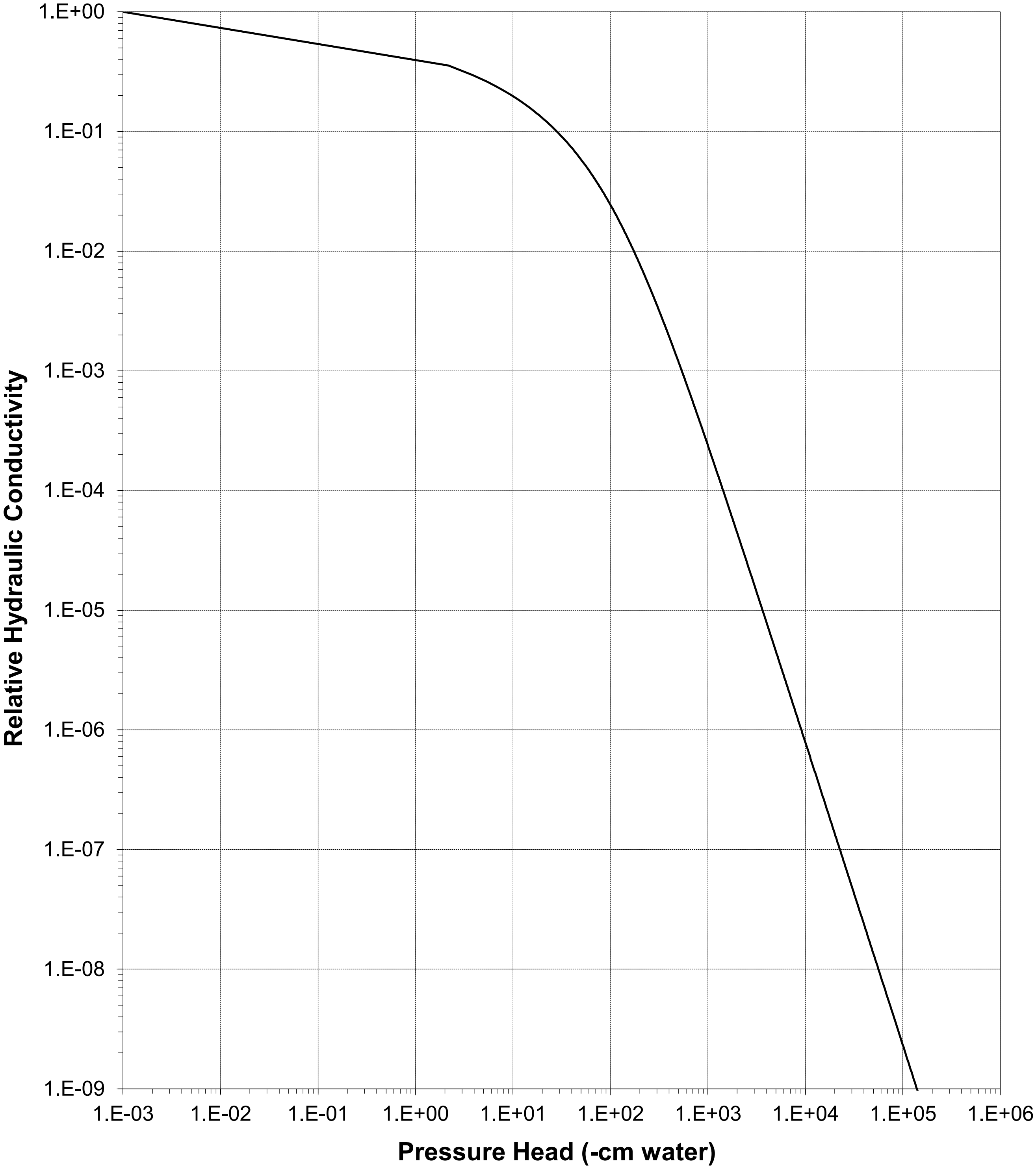
Sample Number: VVL Composite 31+ (85%, 1.22)




Plot of Hydraulic Conductivity vs Moisture Content
Sample Number: VVL Composite 31+ (85%, 1.22)
Hydraulic Conductivity (cm/s)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)

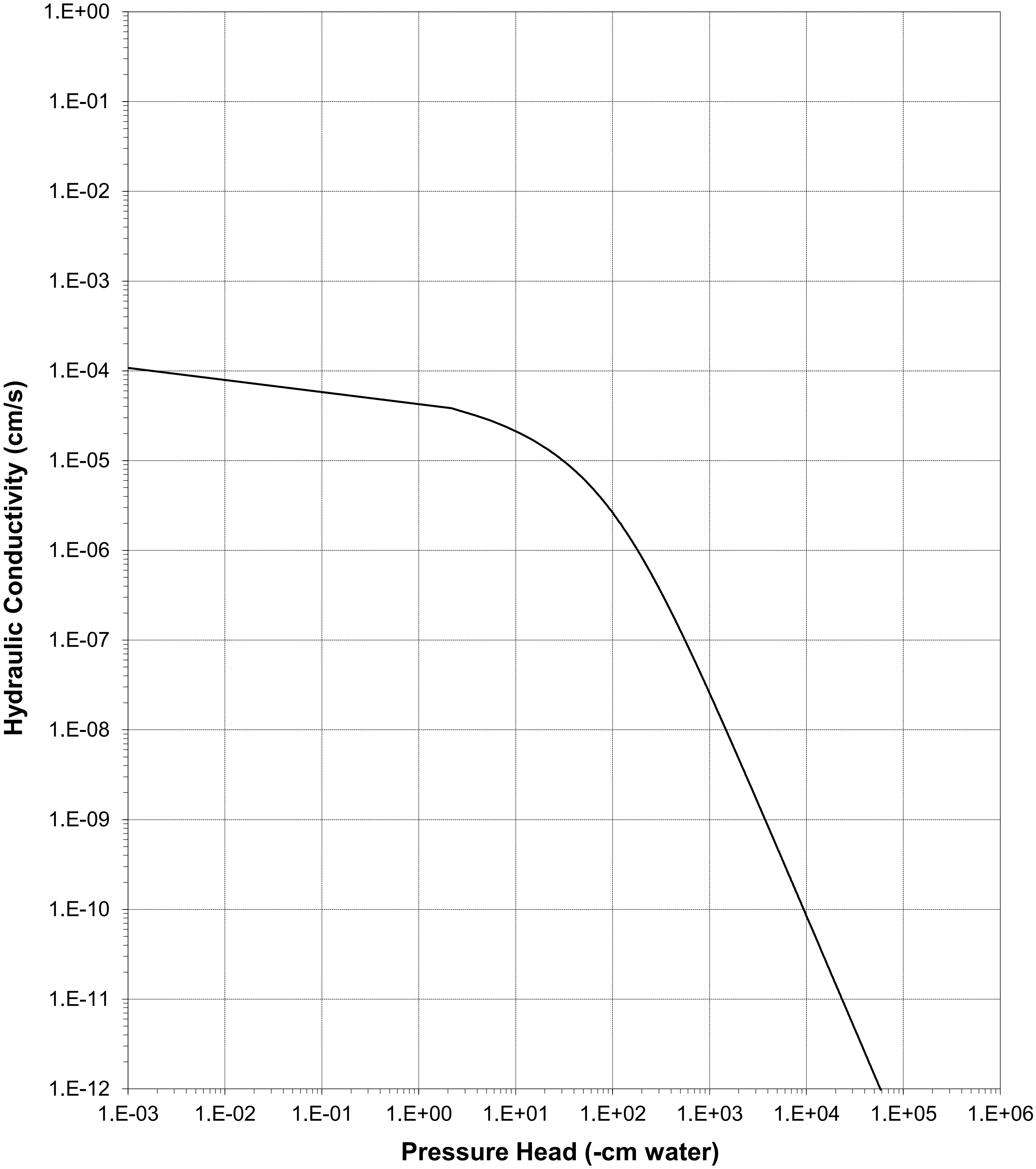
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 31+ (85%, 1.22)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite 31+ (85%, 1.22)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+ (85%, 1.22)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	12.02	87.98	100.00
Mass Fraction (%):	12.02	87.98	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	50.85
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Initial Moisture Content (% vol):	0.00	33.05	31.10
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	50.85
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Saturated Moisture Content (% vol):	0.00	57.37	53.98
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	50.85
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	1.1E-04	9.5E-05

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-10 (85%, 1.51)
Project Name:	VVL Composite Samples
PO Number:	12015

Dry wt. of sample (g):	3342.18
Tare wt., ring (g):	272.60
Tare wt., screen & clamp (g):	53.78
Initial sample volume (cm^3):	2220.60
Initial dry bulk density (g/cm^3):	1.51
Assumed particle density (g/cm^3):	2.65
Initial calculated total porosity (%):	43.20

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	3-Sep-14	1:20	4630.70	0	43.33	
	10-Sep-14	13:25	4624.48	8.0	43.05	
	17-Sep-14	10:35	4595.60	20.5	41.75	
	24-Sep-14	15:15	4399.65	73.0	33.21	‡‡
Pressure plate:	4-Oct-14	10:30	4174.90	337	24.15	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	20.5	---	---	---	---
	73.0	2201.16	-0.88%	1.52	42.70
Pressure plate:	337	2096.96	-5.57%	1.59	39.86

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite TP-10 (85%, 1.51)

Initial sample bulk density (g/cm³)*:* 1.51

Fraction of test sample used (<2.00mm fraction) (%): 63.04

Dry weight of dew point potentiometer sample* (g)*:* 169.09

Tare weight, jar (g)*:* 112.27

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	10-Sep-14	14:10	173.84	13971	8.40	‡‡
	10-Sep-14	12:35	172.45	54559	5.94	‡‡
	10-Sep-14	11:55	171.81	146545	4.81	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	13971	2096.96	-5.57%	1.59	39.86
	54559	2096.96	-5.57%	1.59	39.86
	146545	2096.96	-5.57%	1.59	39.86

Dry weight of relative humidity box sample* (g)*:* 72.86

Tare weight (g)*:* 47.61

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Relative humidity box:	9-Sep-14	11:00	73.75	851293	3.57	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	2096.96	-5.57%	1.59	39.86

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

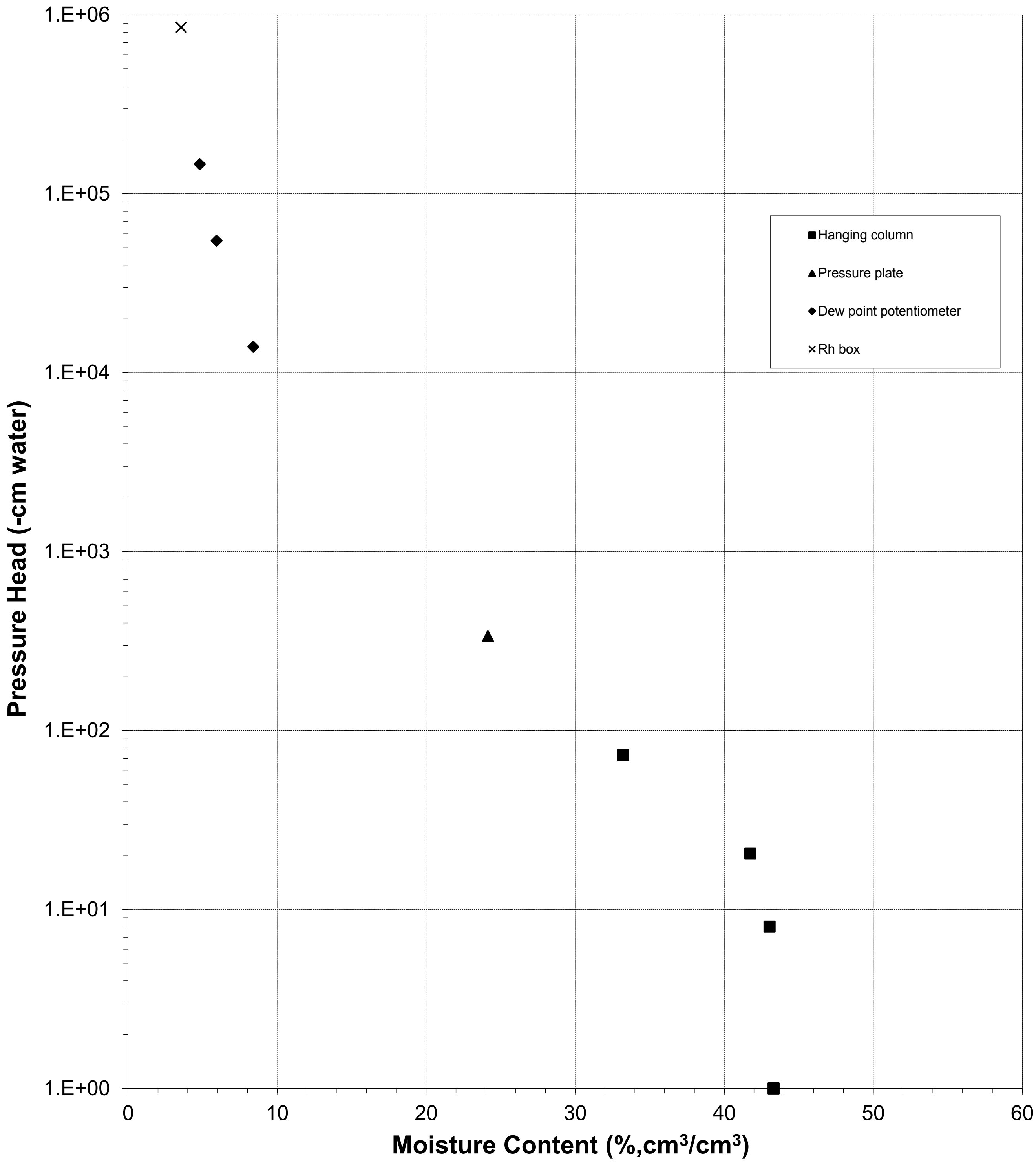
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

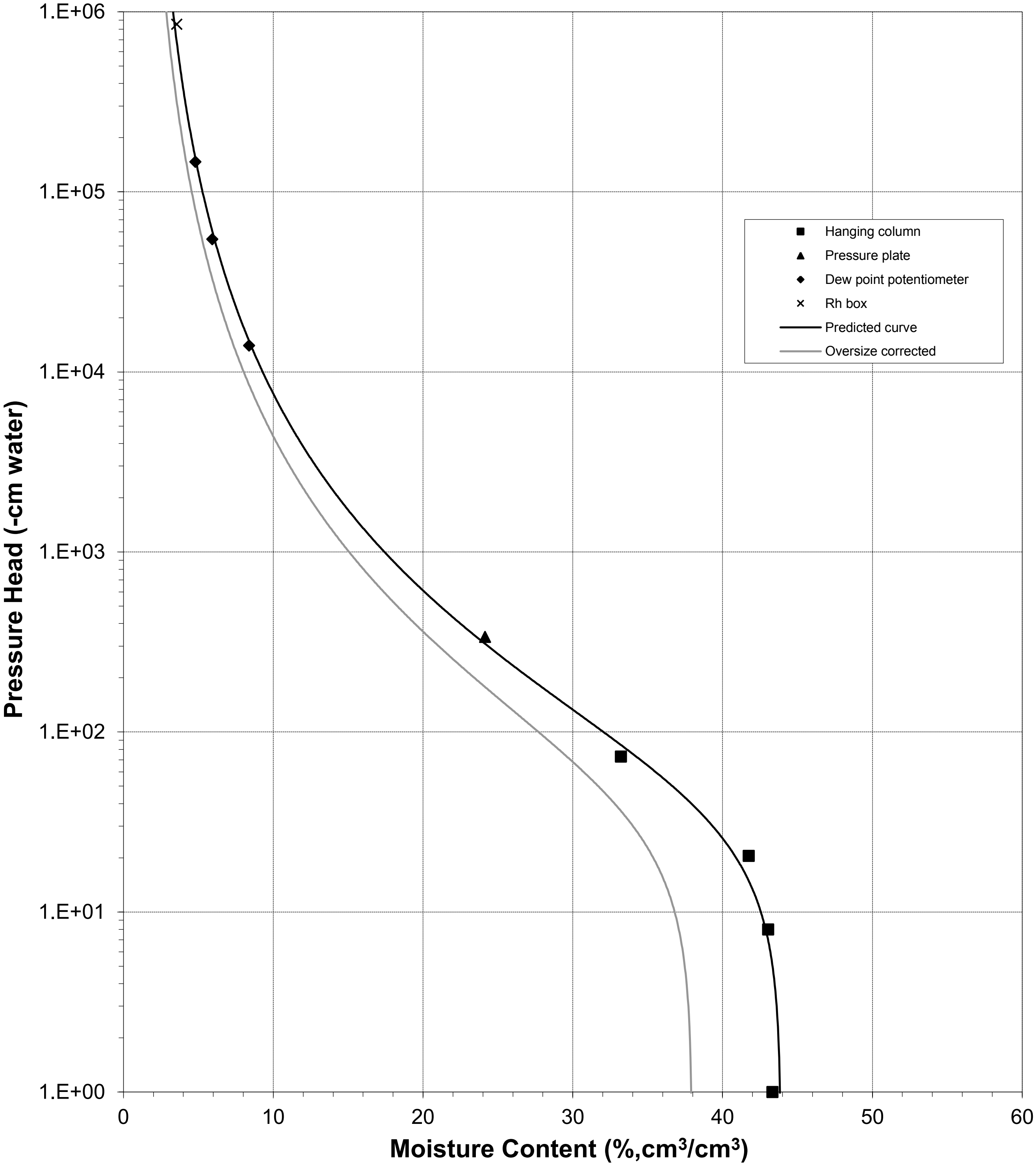
Water Retention Data Points

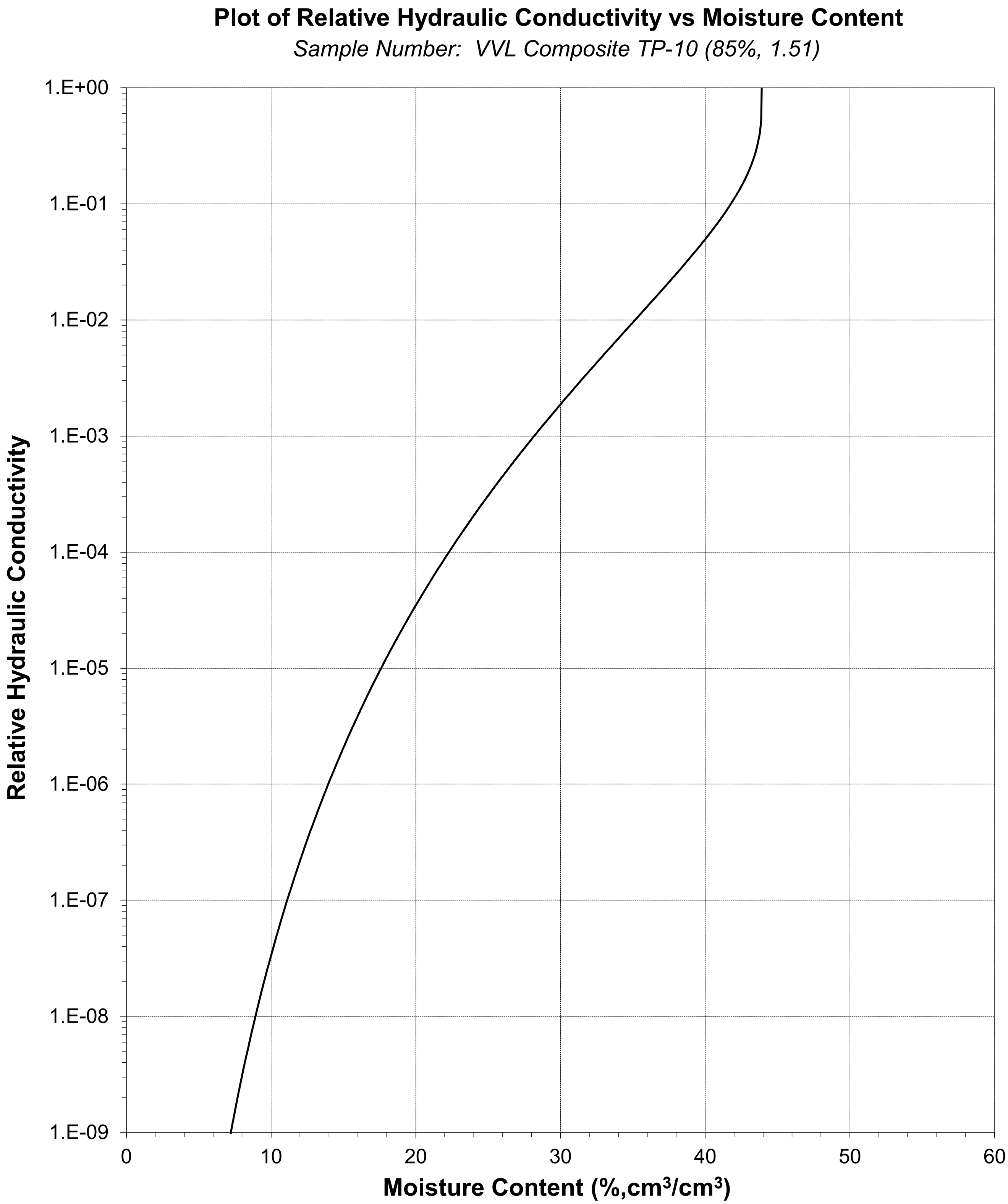
Sample Number: VVL Composite TP-10 (85%, 1.51)



Predicted Water Retention Curve and Data Points

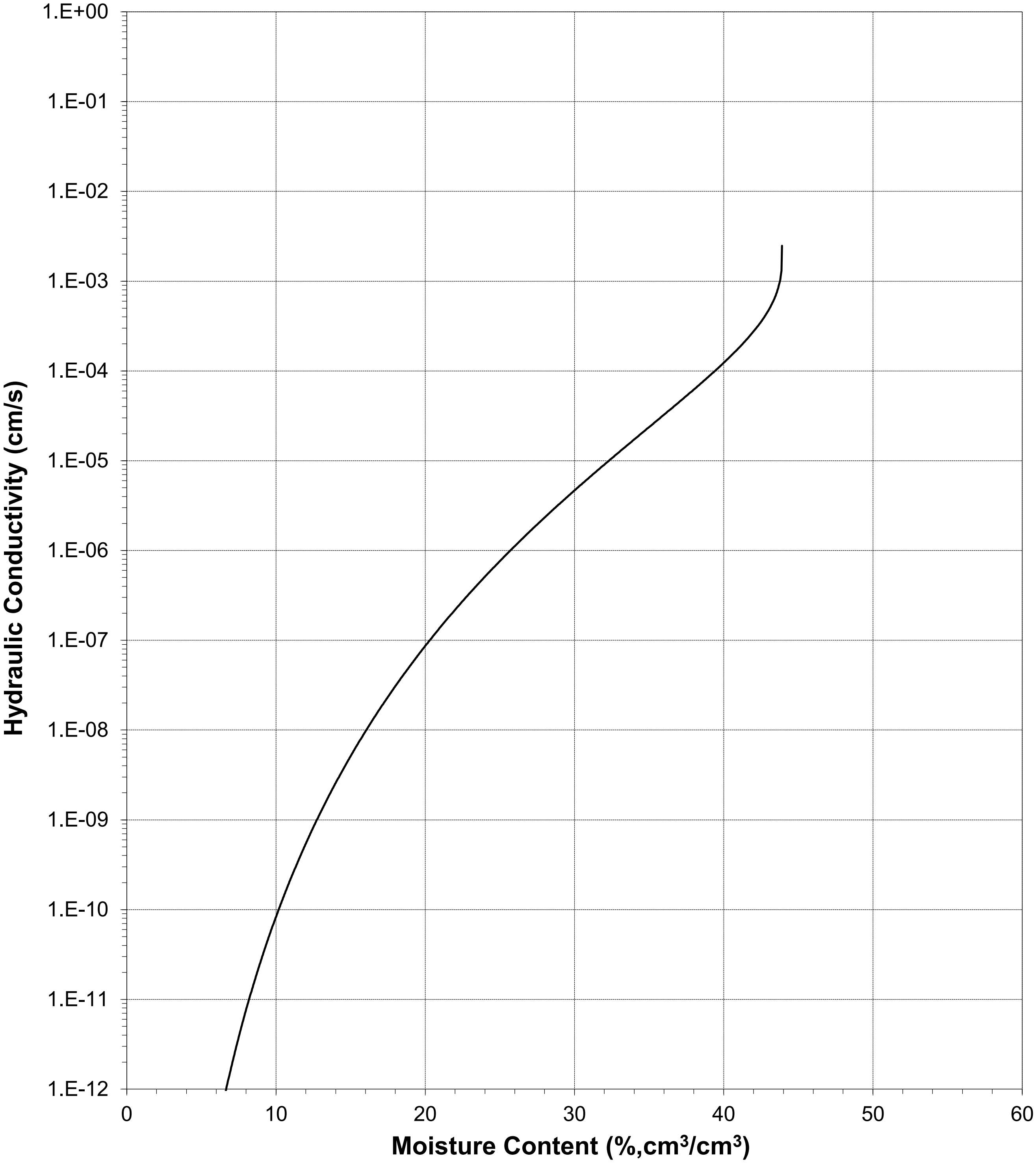
Sample Number: VVL Composite TP-10 (85%, 1.51)




Plot of Relative Hydraulic Conductivity vs Moisture Content
Sample Number: VVL Composite TP-10 (85%, 1.51)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
Relative Hydraulic Conductivity
0
10
20
30
40
50
60
Moisture Content (%,cm³/cm³)

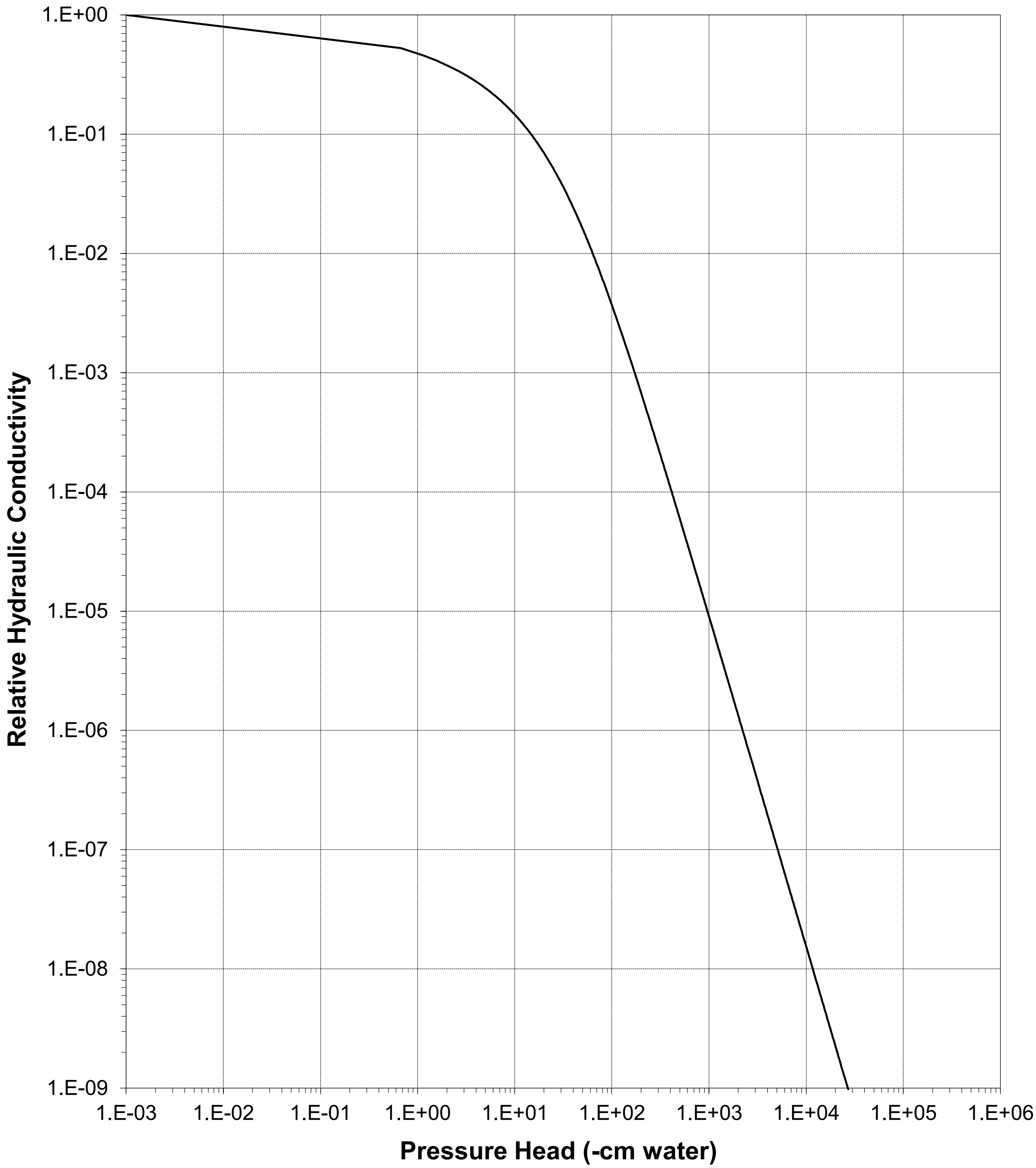
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite TP-10 (85%, 1.51)



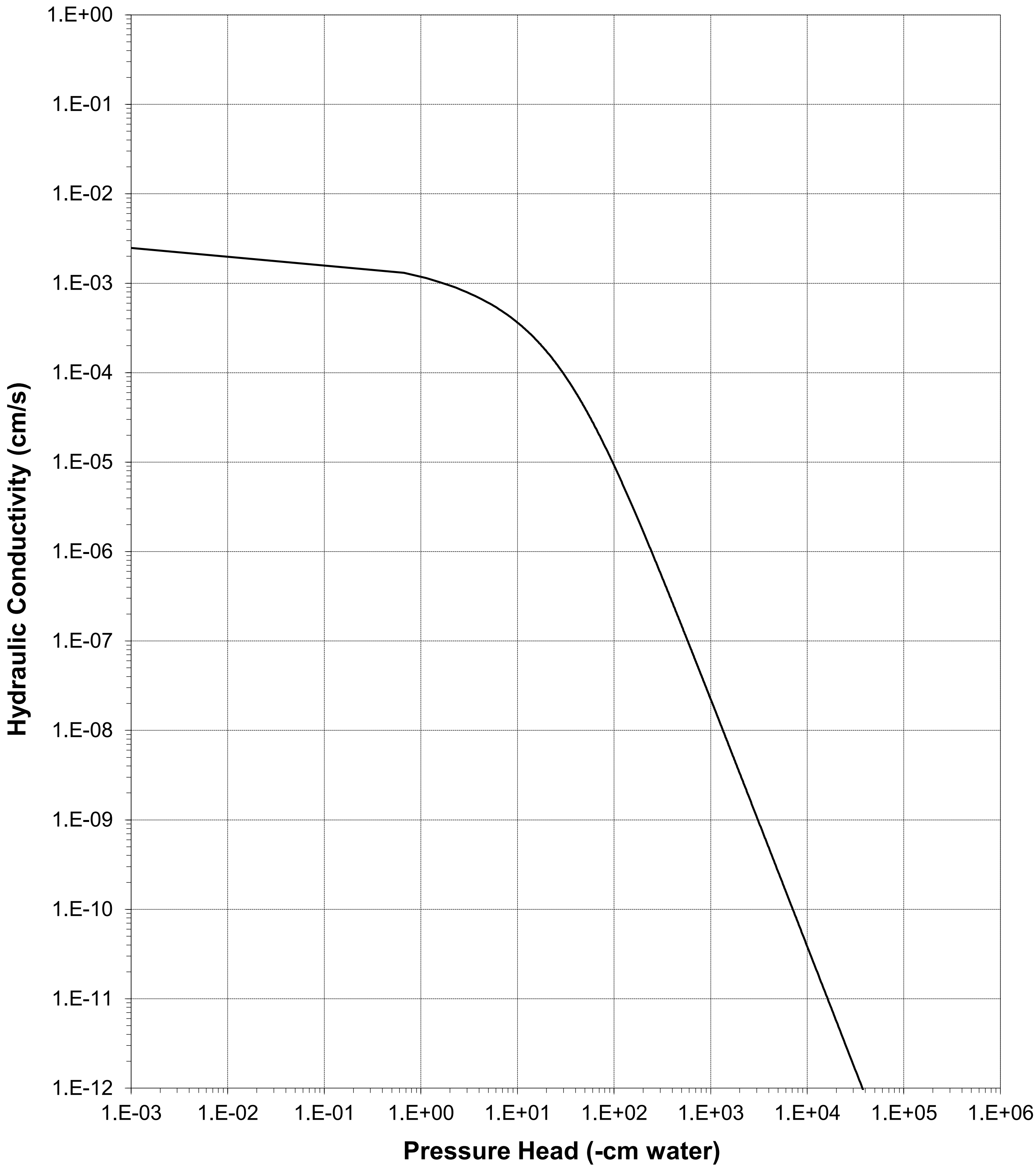
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-10 (85%, 1.51)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-10 (85%, 1.51)



Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10 (85%, 1.51)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	21.58	78.42	100.00
Mass Fraction (%):	21.58	78.42	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.51	1.66
Calculated Porosity (% vol):	0.00	43.20	37.36
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	22.51	22.51
Total Volume (cm^3):	8.14	52.10	60.25
Volumetric Fraction (%):	13.52	86.48	100.00
Initial Moisture Content (% vol):	0.00	23.65	20.46
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.51	1.66
Calculated Porosity (% vol):	0.00	43.20	37.36
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	22.51	22.51
Total Volume (cm^3):	8.14	52.10	60.25
Volumetric Fraction (%):	13.52	86.48	100.00
Saturated Moisture Content (% vol):	0.00	43.91	37.97
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.59	1.74
Calculated Porosity (% vol):	0.00	39.86	34.19
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	19.61	19.61
Total Volume (cm^3):	8.14	49.20	57.34
Volumetric Fraction (%):	14.20	85.80	100.00
Residual Moisture Content (% vol):	0.00	1.43	1.23
Ksat (cm/sec):	NM	2.5E-03	2.0E-03

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3091.19
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	270.01
Sample Number:	VVL Composite TP-12 (85%, 1.40)	*Tare wt., screen & clamp* (g):	56.79
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2203.81
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.40
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	47.07

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	3-Sep-14	10:40	4446.30	0	46.66	
	10-Sep-14	13:30	4445.90	12.0	46.64	
	17-Sep-14	10:40	4437.06	32.0	46.24	
	24-Sep-14	15:20	4334.46	105.0	41.59	
Pressure plate:	4-Oct-14	10:37	4184.50	337	36.86	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	12.0	---	---	---	---
	32.0	---	---	---	---
	105.0	---	---	---	---
Pressure plate:	337	2079.65	-5.63%	1.49	43.91

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite TP-12 (85%, 1.40)

Initial sample bulk density (g/cm^3)*:* 1.40
Fraction of test sample used (<2.00mm fraction) (%): 60.23

Dry weight of dew point potentiometer sample* (g)*:* 136.31
Tare weight, jar (g)*:* 111.86

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	10-Sep-14	12:45	141.14	5303	17.69	‡‡
	10-Sep-14	8:46	140.15	22742	14.06	‡‡
	9-Sep-14	14:30	138.87	185502	9.37	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	5303	2079.65	-5.63%	1.49	43.91
	22742	2079.65	-5.63%	1.49	43.91
	185502	2079.65	-5.63%	1.49	43.91

Dry weight of relative humidity box sample* (g)*:* 60.11
Tare weight (g)*:* 38.03

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Relative humidity box:	9-Sep-14	11:00	61.63	851293	6.18	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	2079.65	-5.63%	1.49	43.91

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

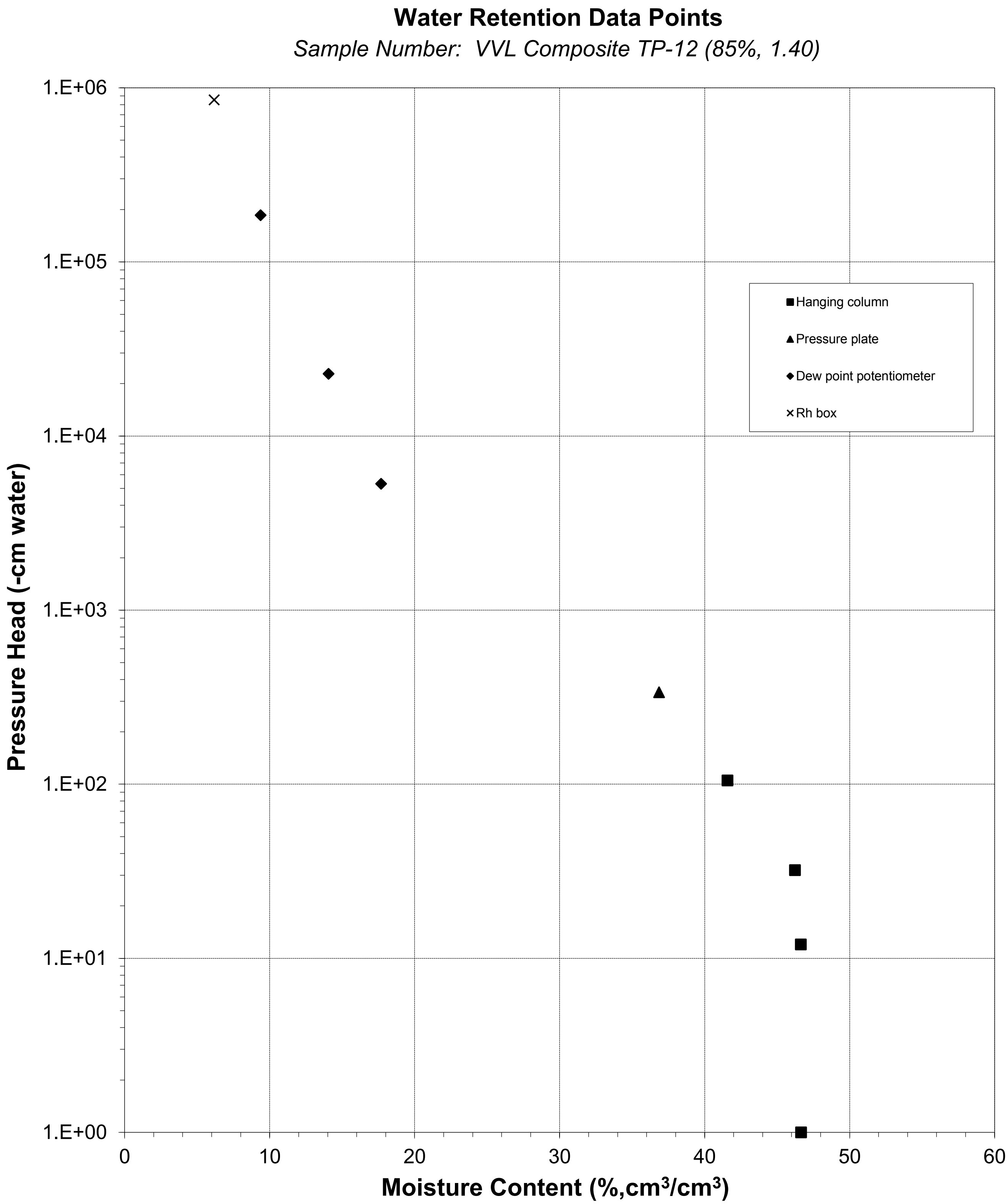
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

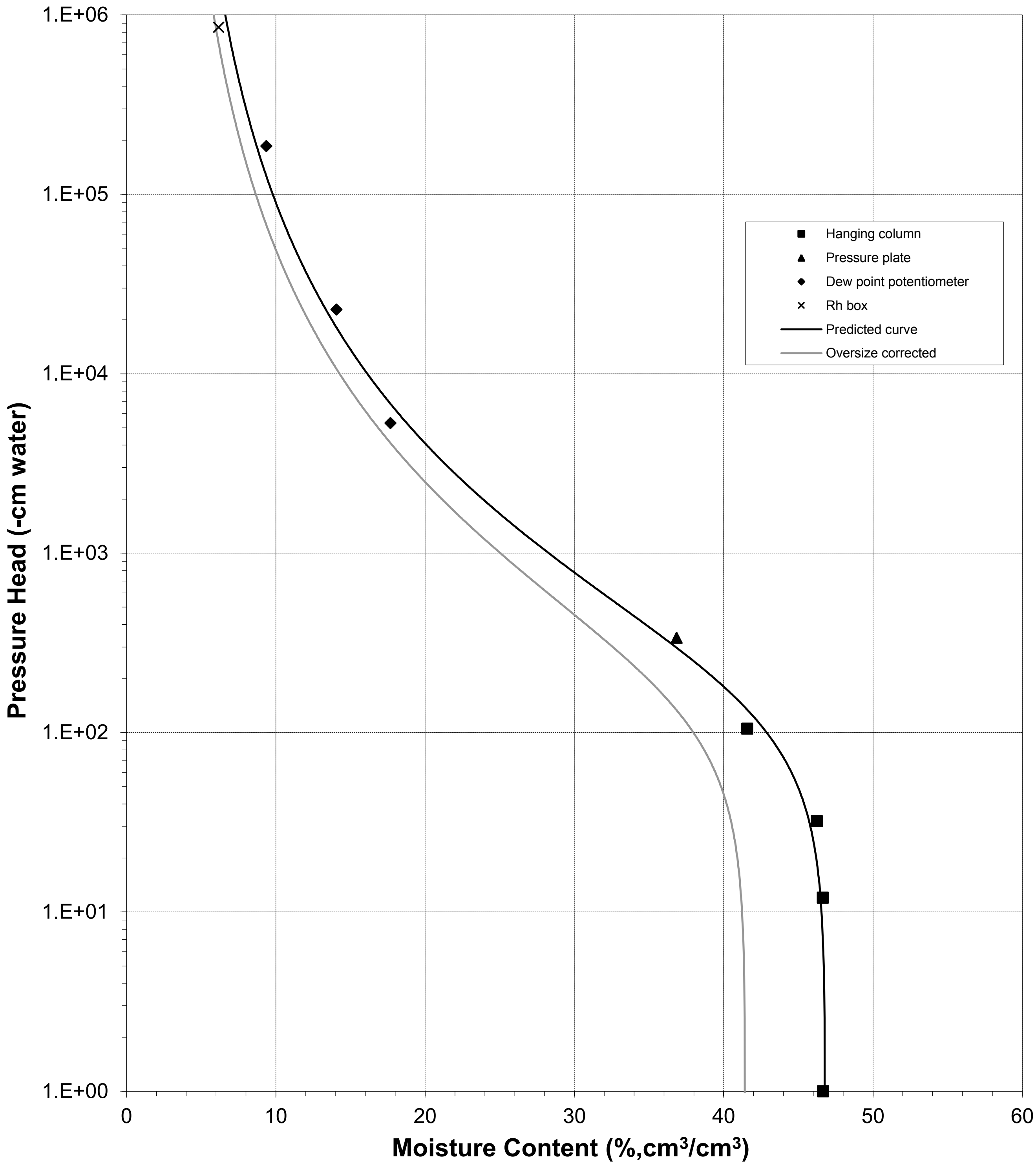
Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines



Water Retention Data Points
Sample Number: VVL Composite TP-12 (85%, 1.40)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)
Hanging column
Pressure plate
Dew point potentiometer
Rh box

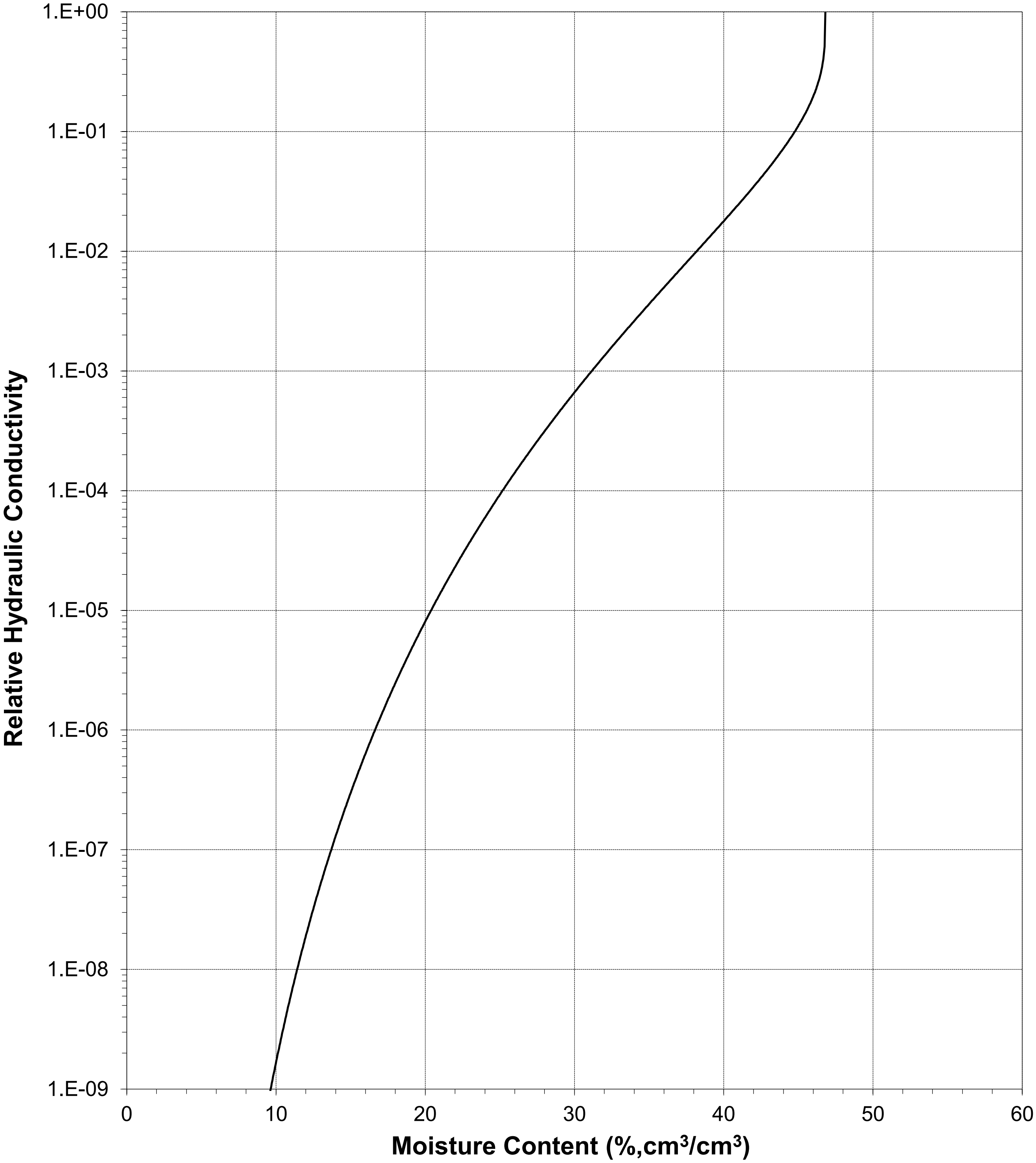
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite TP-12 (85%, 1.40)



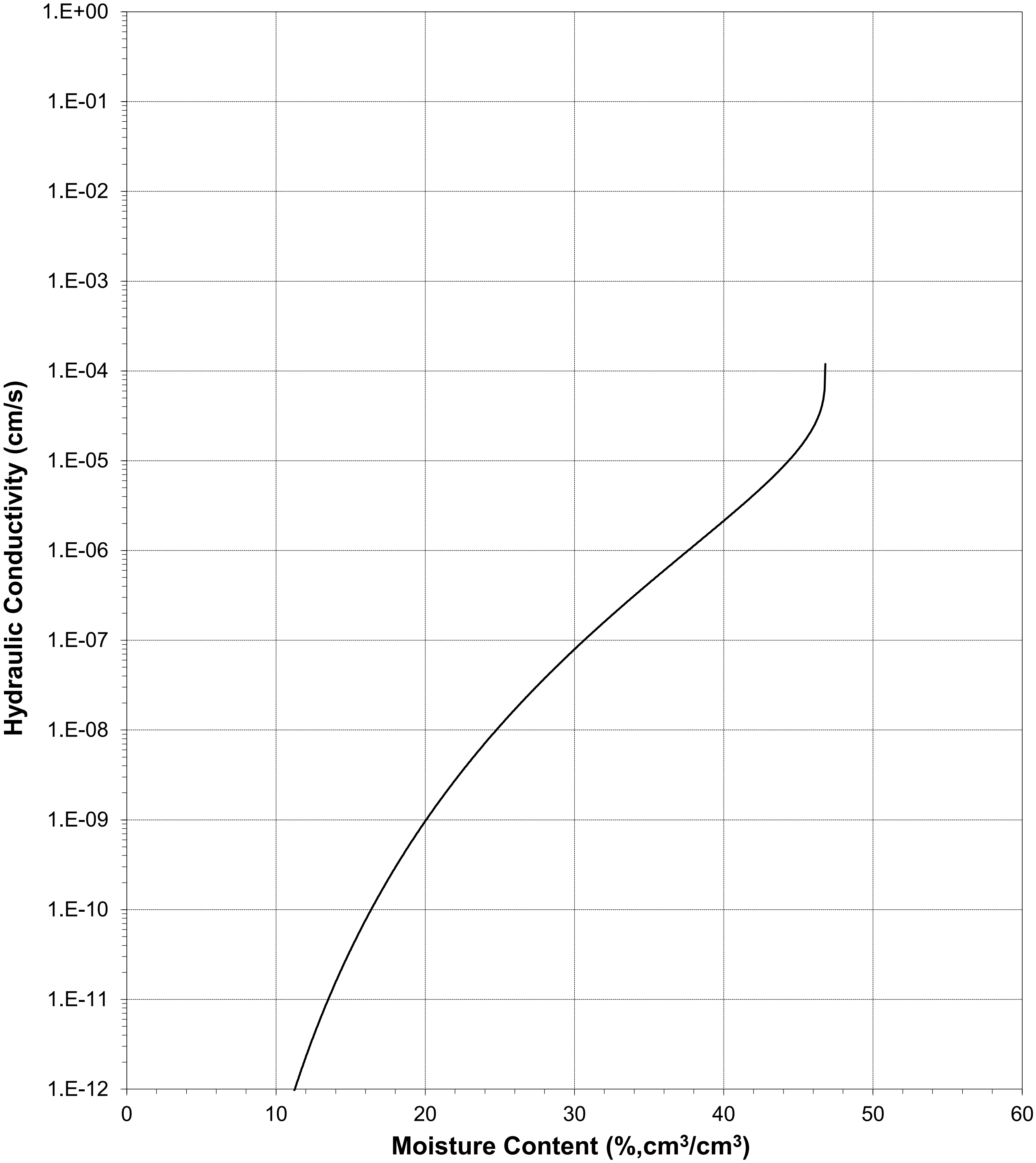
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite TP-12 (85%, 1.40)



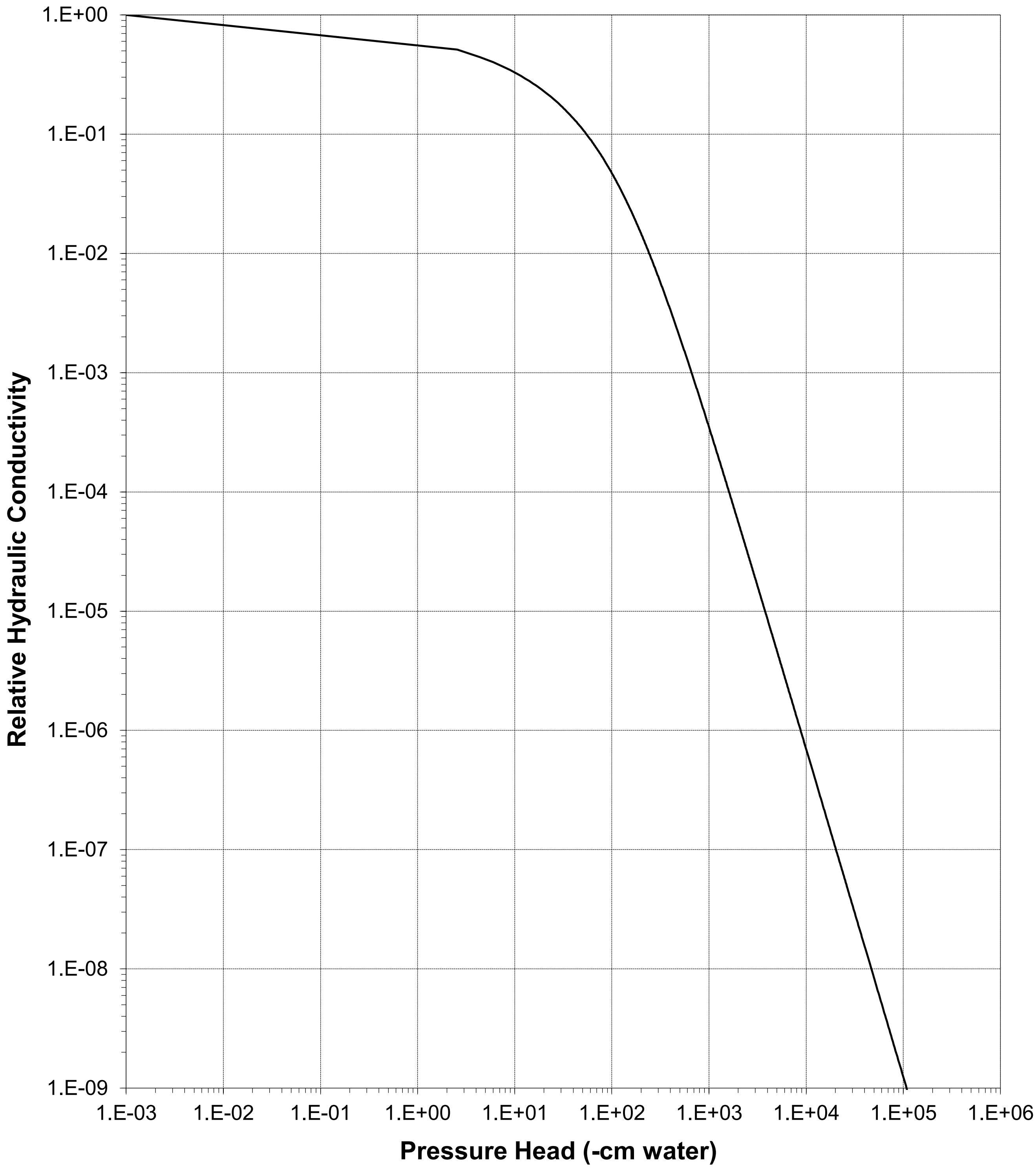
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite TP-12 (85%, 1.40)



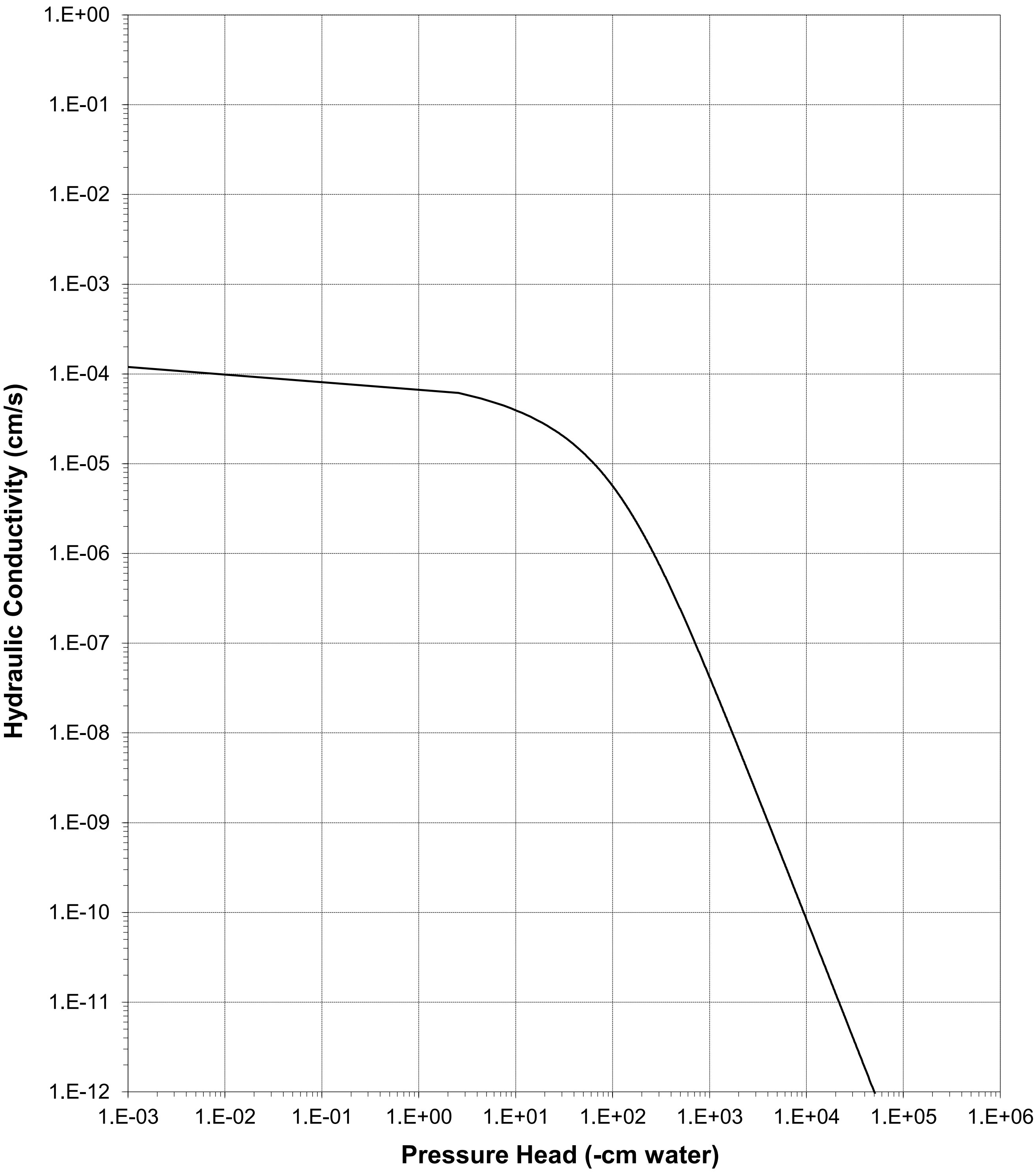
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-12 (85%, 1.40)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-12 (85%, 1.40)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12 (85%, 1.40)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	19.61	80.39	100.00
Mass Fraction (%):	19.61	80.39	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.40	1.55
Calculated Porosity (% vol):	0.00	47.07	41.69
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	26.98	26.98
Total Volume (cm^3):	7.40	57.31	64.71
Volumetric Fraction (%):	11.44	88.56	100.00
Initial Moisture Content (% vol):	0.00	26.07	23.09
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.40	1.55
Calculated Porosity (% vol):	0.00	47.07	41.69
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	26.98	26.98
Total Volume (cm^3):	7.40	57.31	64.71
Volumetric Fraction (%):	11.44	88.56	100.00
Saturated Moisture Content (% vol):	0.00	46.81	41.45
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.49	1.63
Calculated Porosity (% vol):	0.00	43.91	38.62
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	23.75	23.75
Total Volume (cm^3):	7.40	54.08	61.48
Volumetric Fraction (%):	12.04	87.96	100.00
Residual Moisture Content (% vol):	0.00	3.43	3.02
Ksat (cm/sec):	NM	1.2E-04	9.6E-05

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3086.05
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	275.53
Sample Number:	VVL Composite TP-13 (85%, 1.37)	*Tare wt., screen & clamp* (g):	55.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2250.16
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.37
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	48.25

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	8-Sep-14	14:00	4536.42	0	49.76	
	15-Sep-14	9:33	4547.12	13.0	49.33	‡‡
	22-Sep-14	15:25	4501.30	34.0	47.33	‡‡
	29-Sep-14	16:05	4381.16	103.0	42.09	‡‡
Pressure plate:	8-Oct-14	12:48	4289.80	337	38.10	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	13.0	2291.03	+1.82%	1.35	49.17
	34.0	2291.03	+1.82%	1.35	49.17
	103.0	2291.03	+1.82%	1.35	49.17
Pressure plate:	337	2291.03	+1.82%	1.35	49.17

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: VVL Composite TP-13 (85%, 1.37)

Initial sample bulk density (g/cm^3)*:* 1.37
Fraction of test sample used (<2.00mm fraction) (%): 65.88

Dry weight of dew point potentiometer sample* (g)*:* 160.83
Tare weight, jar (g)*:* 114.94

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	10-Sep-14	9:55	167.82	20090	13.52	‡‡
	9-Sep-14	15:30	166.04	82196	10.07	‡‡
	9-Sep-14	14:32	165.31	148381	8.66	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	20090	2291.03	+1.82%	1.35	49.17
	82196	2291.03	+1.82%	1.35	49.17
	148381	2291.03	+1.82%	1.35	49.17

Dry weight of relative humidity box sample* (g)*:* 83.17
Tare weight (g)*:* 44.10

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Relative humidity box:	9-Sep-14	11:00	85.66	851293	5.66	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	2291.03	+1.82%	1.35	49.17

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

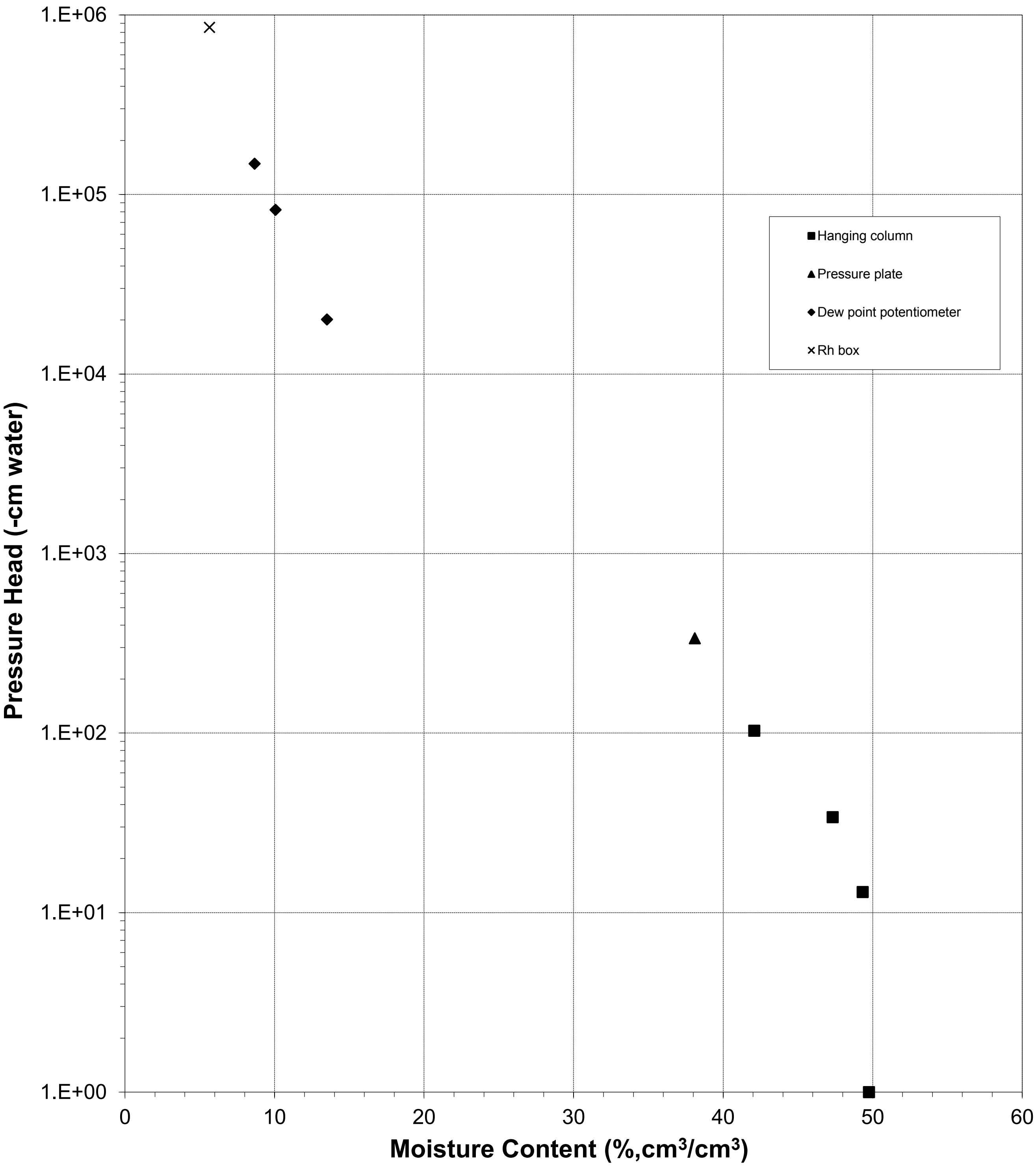
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

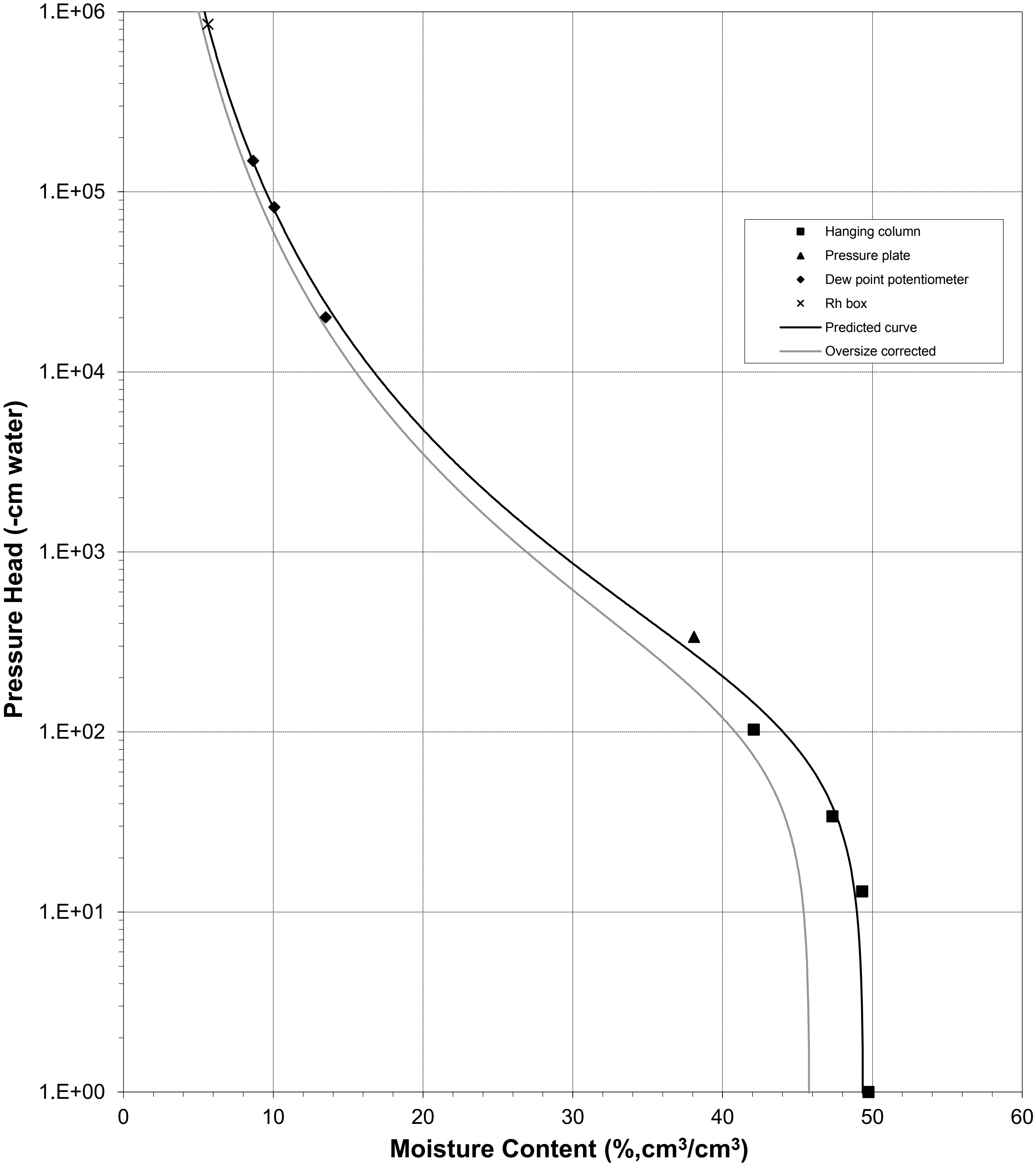
Water Retention Data Points

Sample Number: VVL Composite TP-13 (85%, 1.37)



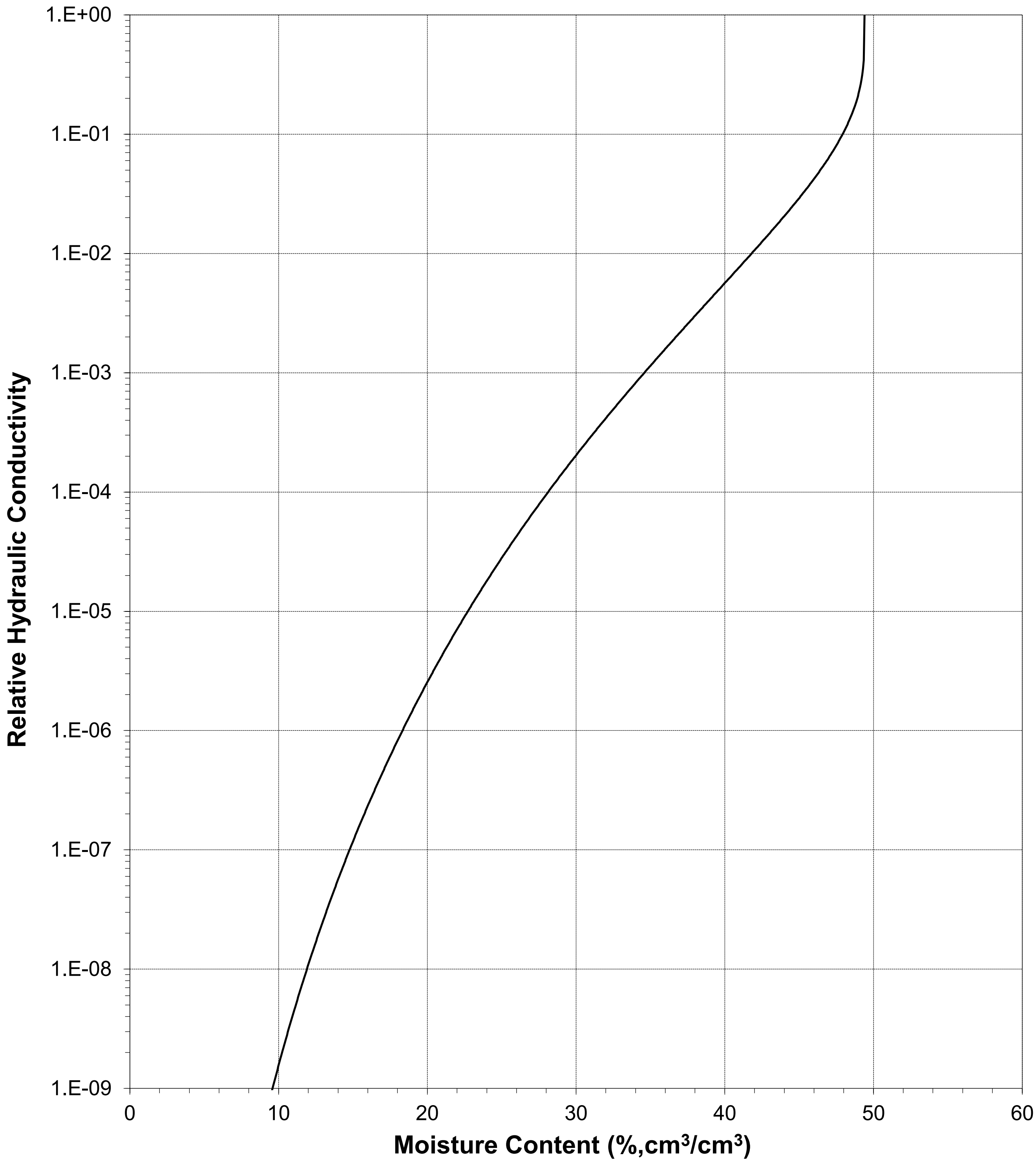
Predicted Water Retention Curve and Data Points

Sample Number: VVL Composite TP-13 (85%, 1.37)



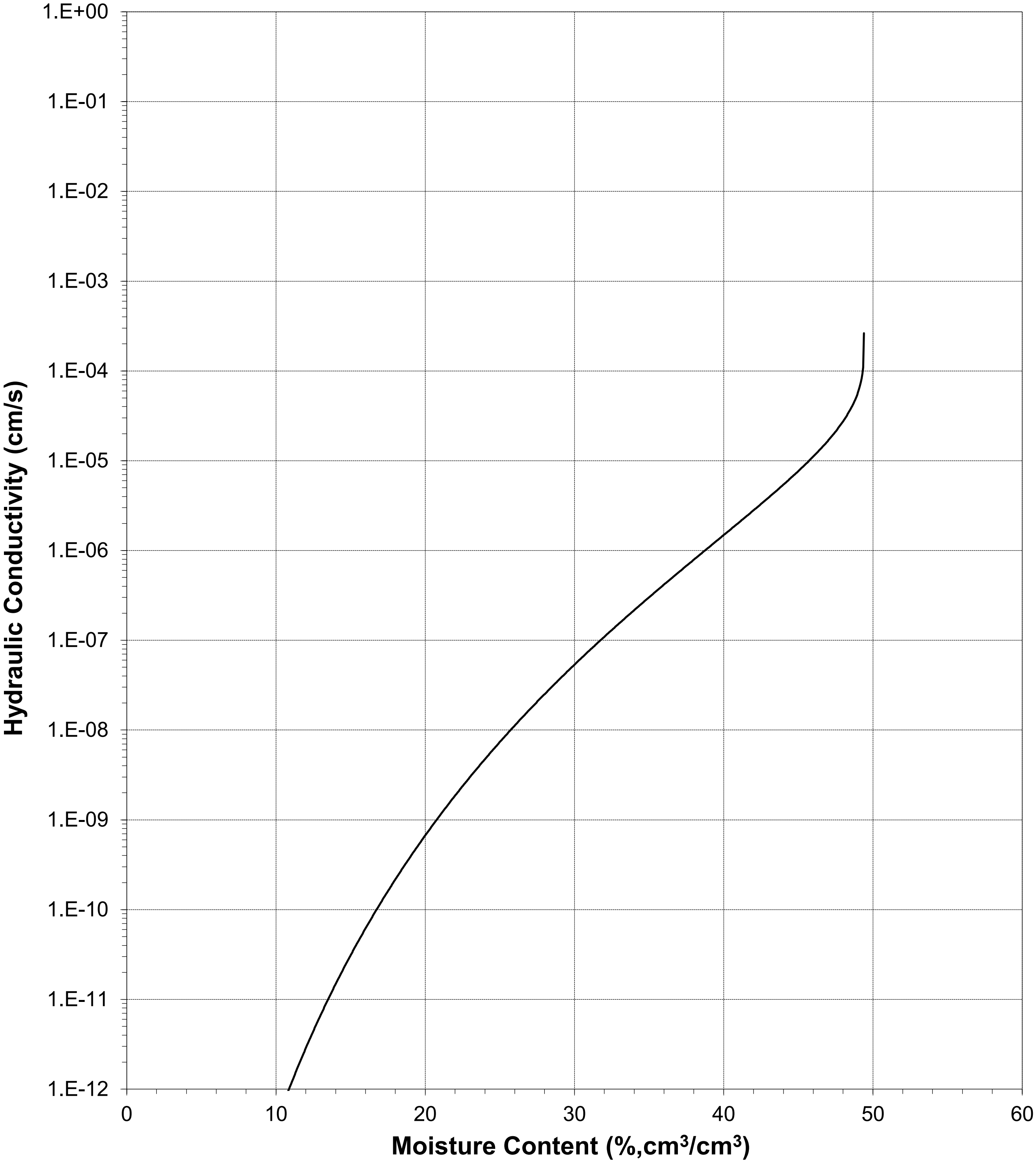
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite TP-13 (85%, 1.37)



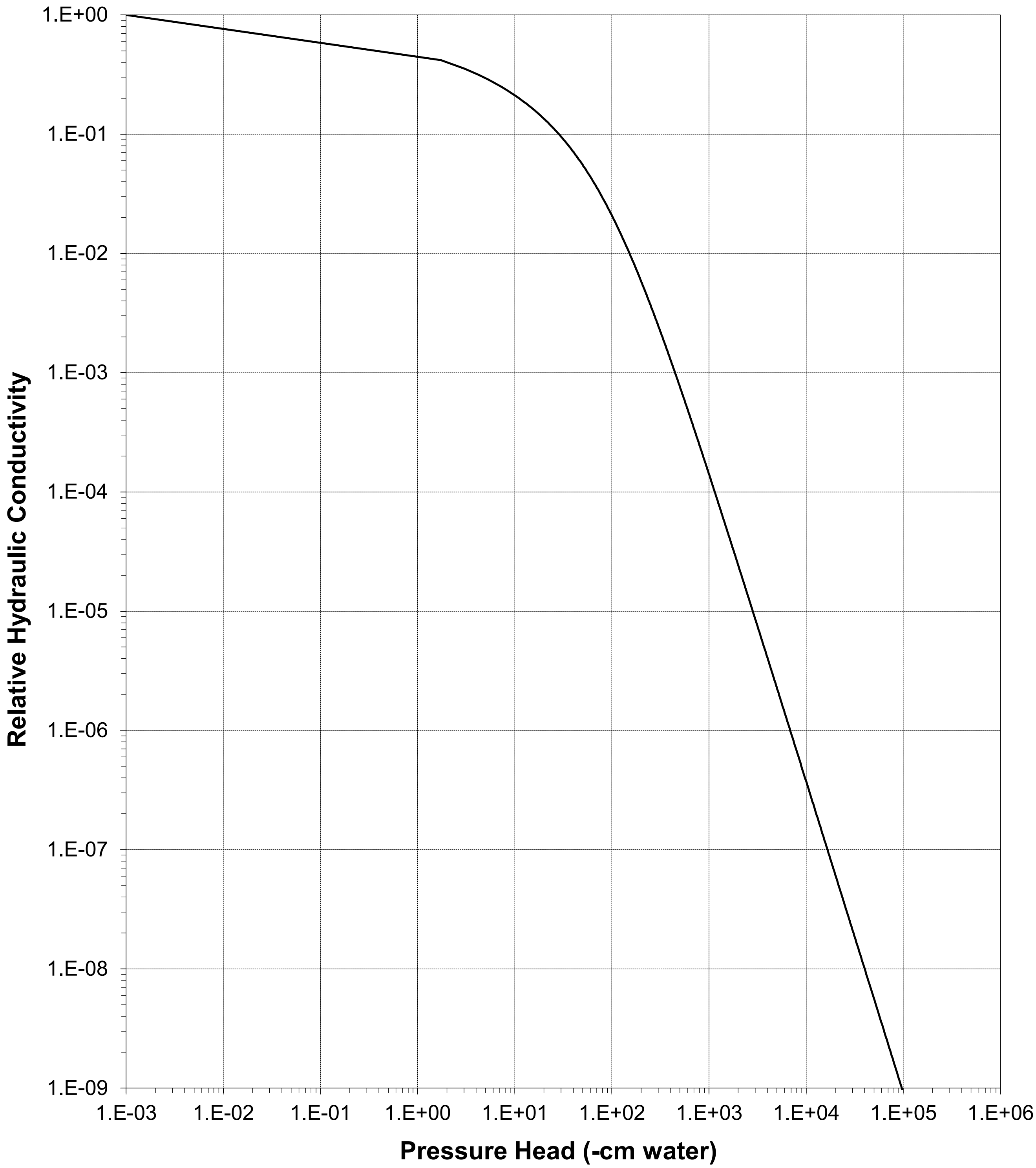
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: VVL Composite TP-13 (85%, 1.37)



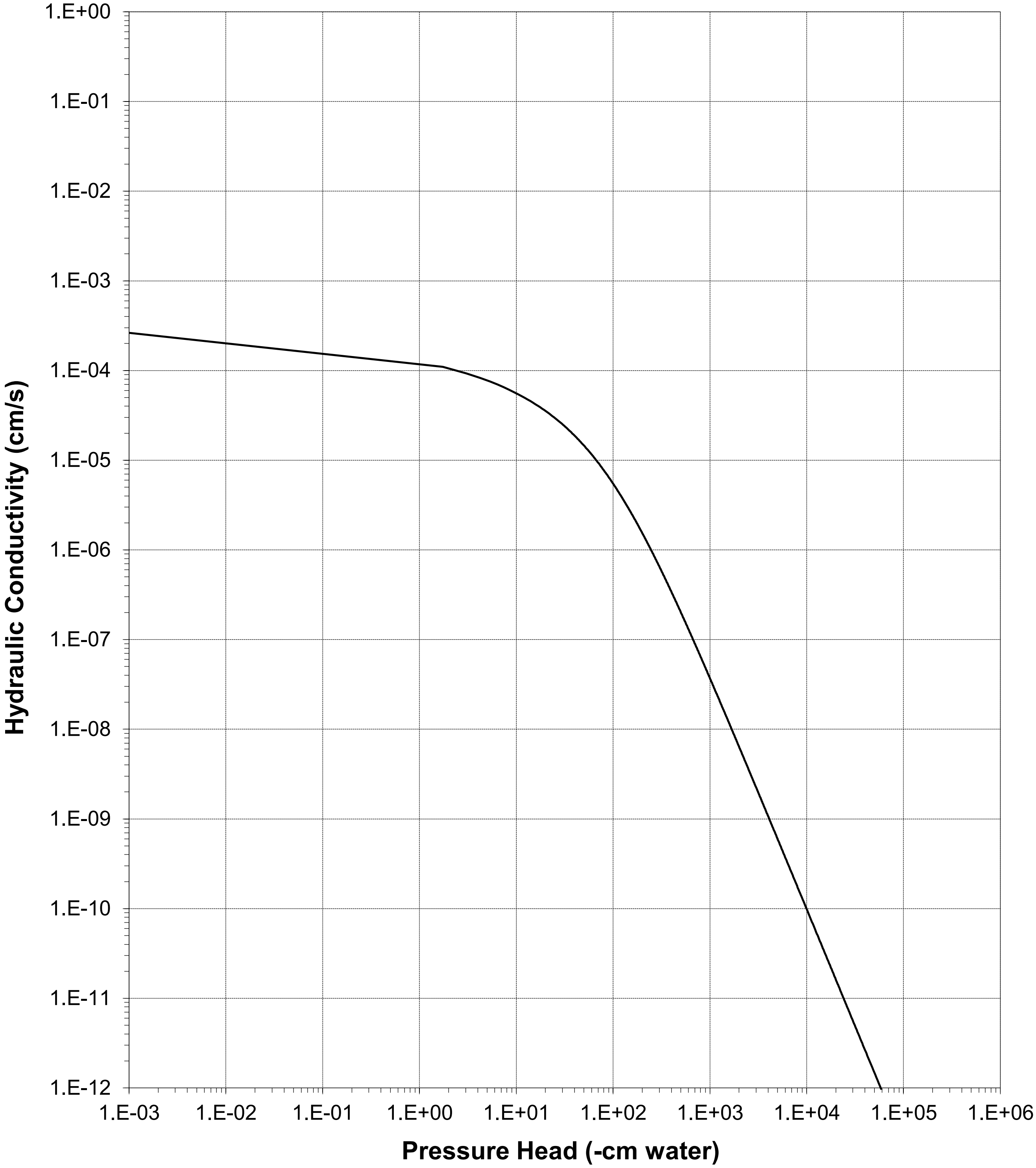
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-13 (85%, 1.37)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: VVL Composite TP-13 (85%, 1.37)



Oversize Correction Data Sheet

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-13 (85%, 1.37)
Project Name:	VVL Composite Samples
PO Number:	12015
Split (3/4", 3/8", #4):	3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	13.14	86.86	100.00
Mass Fraction (%):	13.14	86.86	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.37	1.46
Calculated Porosity (% vol):	0.00	48.25	44.74
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	30.56	30.56
Total Volume (cm^3):	4.96	63.33	68.29
Volumetric Fraction (%):	7.26	92.74	100.00
Initial Moisture Content (% vol):	0.00	28.91	26.81
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.37	1.46
Calculated Porosity (% vol):	0.00	48.25	44.74
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	30.56	30.56
Total Volume (cm^3):	4.96	63.33	68.29
Volumetric Fraction (%):	7.26	92.74	100.00
Saturated Moisture Content (% vol):	0.00	49.39	45.81
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.35	1.44
Calculated Porosity (% vol):	0.00	49.17	45.66
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	31.71	31.71
Total Volume (cm^3):	4.96	64.49	69.44
Volumetric Fraction (%):	7.14	92.86	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	2.6E-04	2.3E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	164.29
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	53.27
Sample Number:	WB Borrow-1 (85%, 1.42)	*Tare wt., screen & clamp* (g):	25.51
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	115.77
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.42
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	46.45

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	3-Sep-14	11:45	297.09	0	46.66
	10-Sep-14	13:30	296.54	7.0	46.19
	17-Sep-14	10:30	296.15	29.0	45.85
	24-Sep-14	15:22	286.73	102.0	37.71
Pressure plate:	3-Oct-14	16:25	273.63	337	26.40

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	7.0	---	---	---	---
	29.0	---	---	---	---
	102.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: WB Borrow-1 (85%, 1.42)

Initial sample bulk density (g/cm^3)*:* 1.42

Fraction of test sample used (<2.00mm fraction) (%): 82.87

Dry weight of dew point potentiometer sample* (g)*:* 156.79

Tare weight, jar (g)*:* 117.49

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)
Dew point potentiometer:	10-Sep-14	9:00	160.72	23251	11.76
	9-Sep-14	16:00	159.74	67307	8.83
	9-Sep-14	14:08	158.69	220379	5.69

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	23251	---	---	---	---
	67307	---	---	---	---
	220379	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 59.40

Tare weight (g)*:* 36.82

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	9-Sep-14	11:00	60.07	851293	3.49

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

1 Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

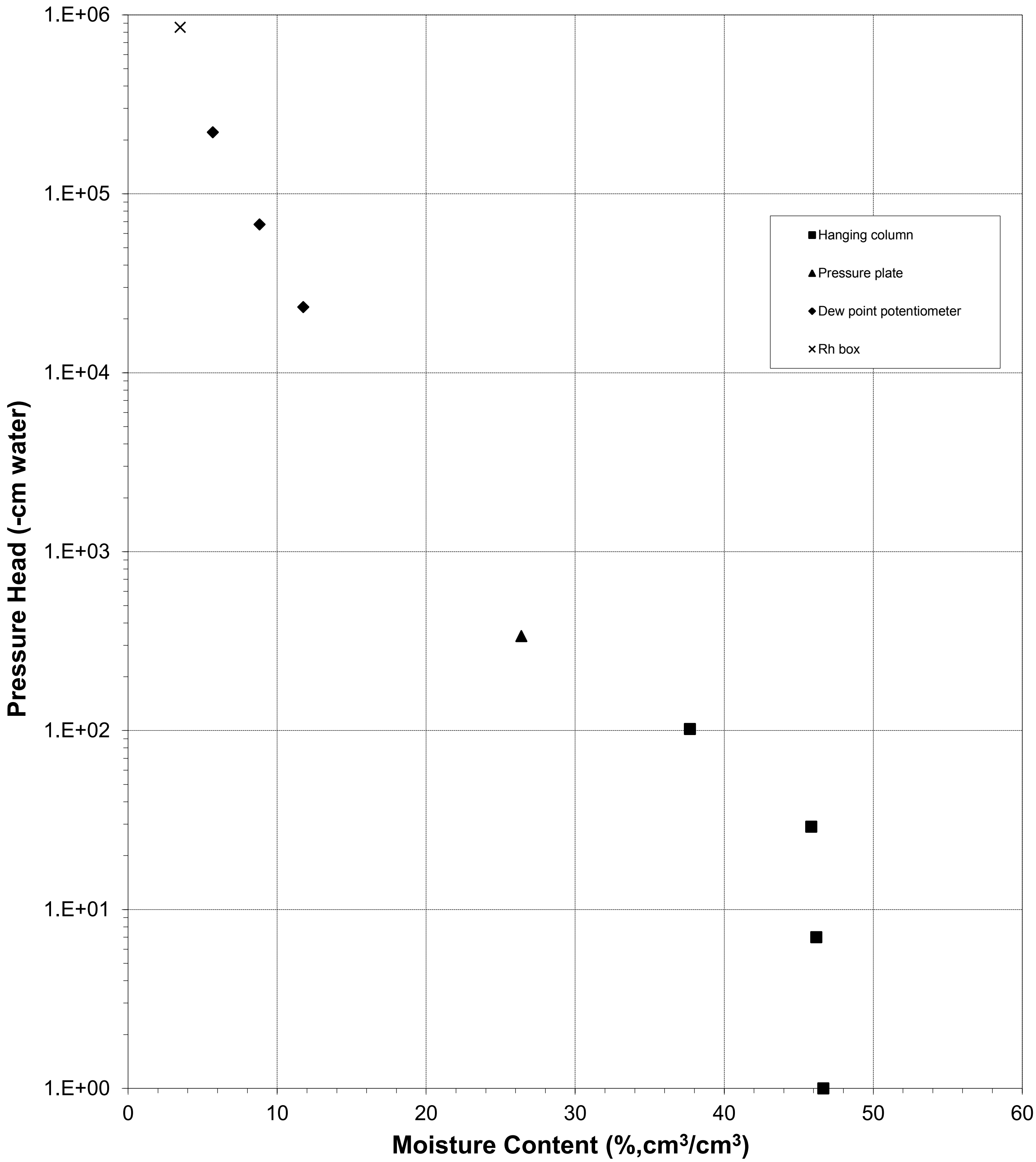
Laboratory analysis by: D. O' Dowd/D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

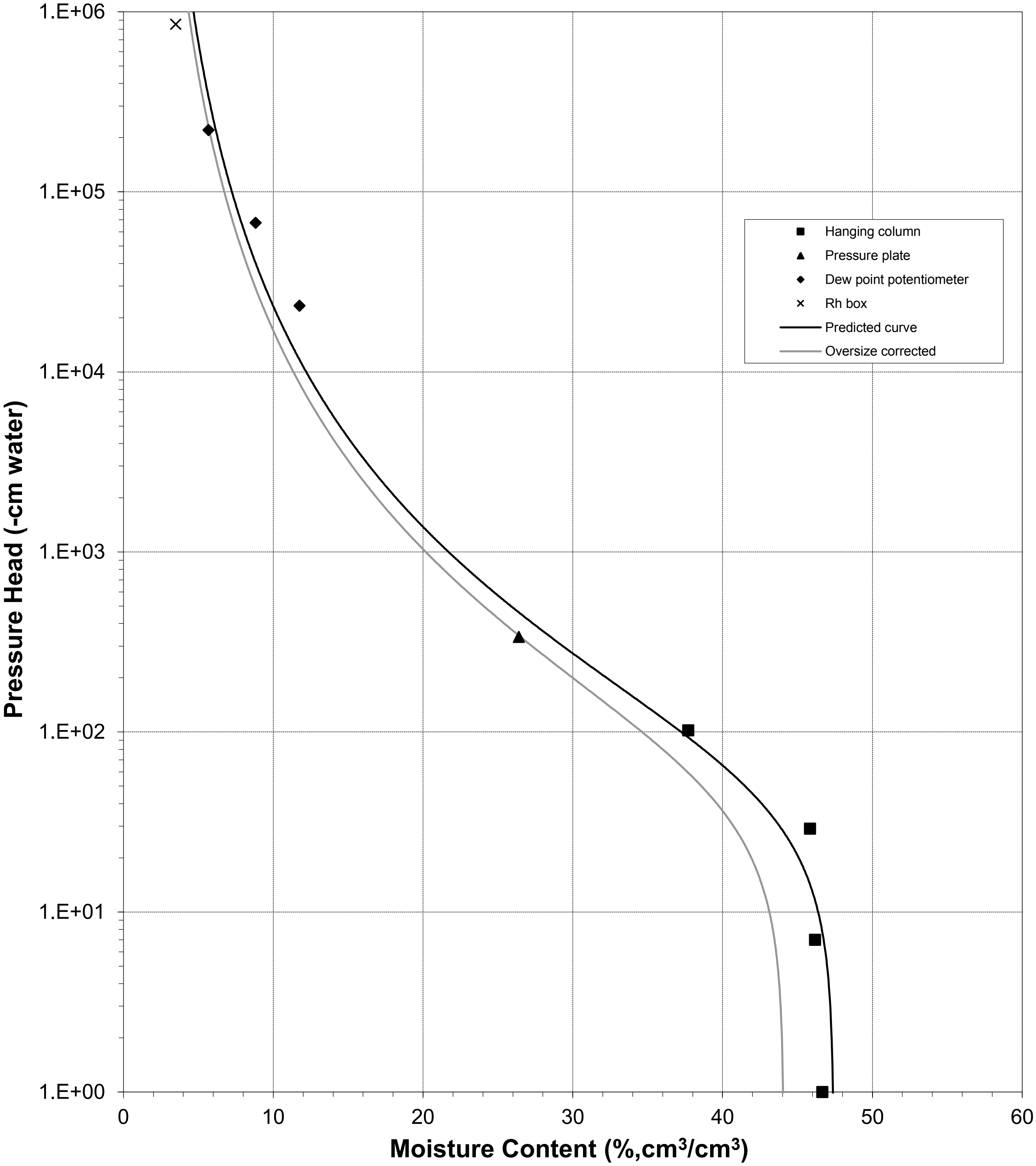
Water Retention Data Points

Sample Number: WB Borrow-1 (85%, 1.42)



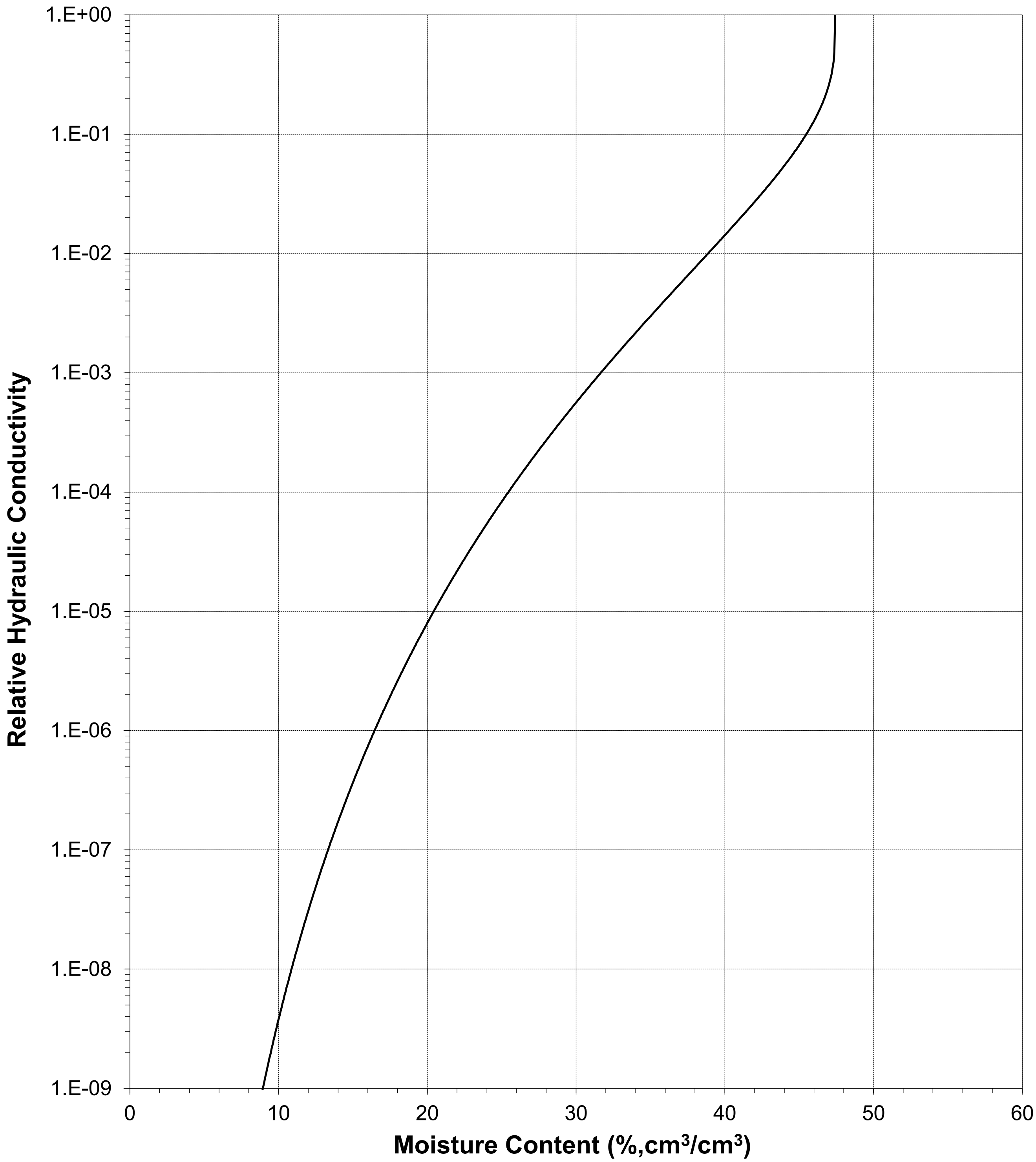
Predicted Water Retention Curve and Data Points

Sample Number: WB Borrow-1 (85%, 1.42)



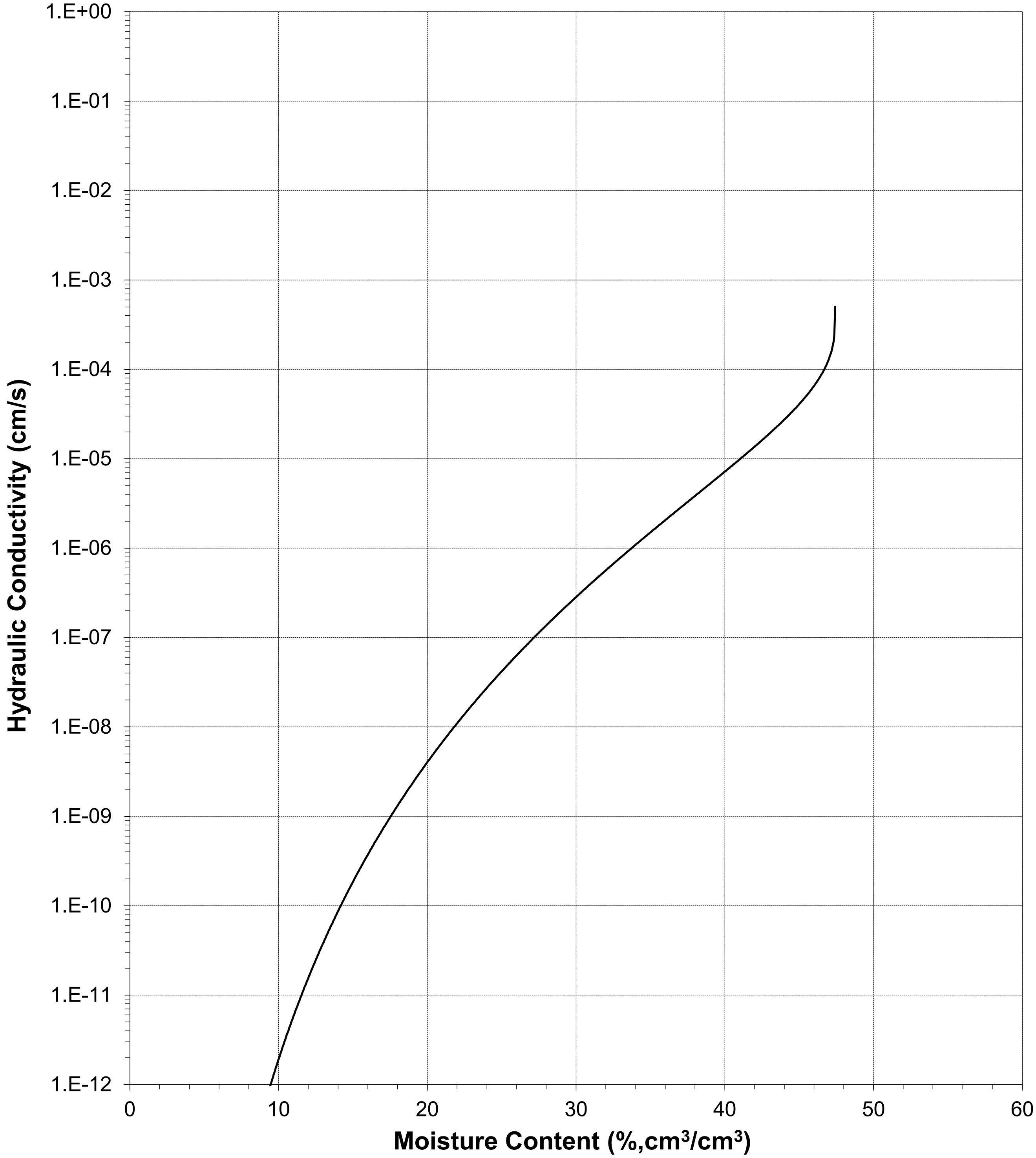
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: WB Borrow-1 (85%, 1.42)



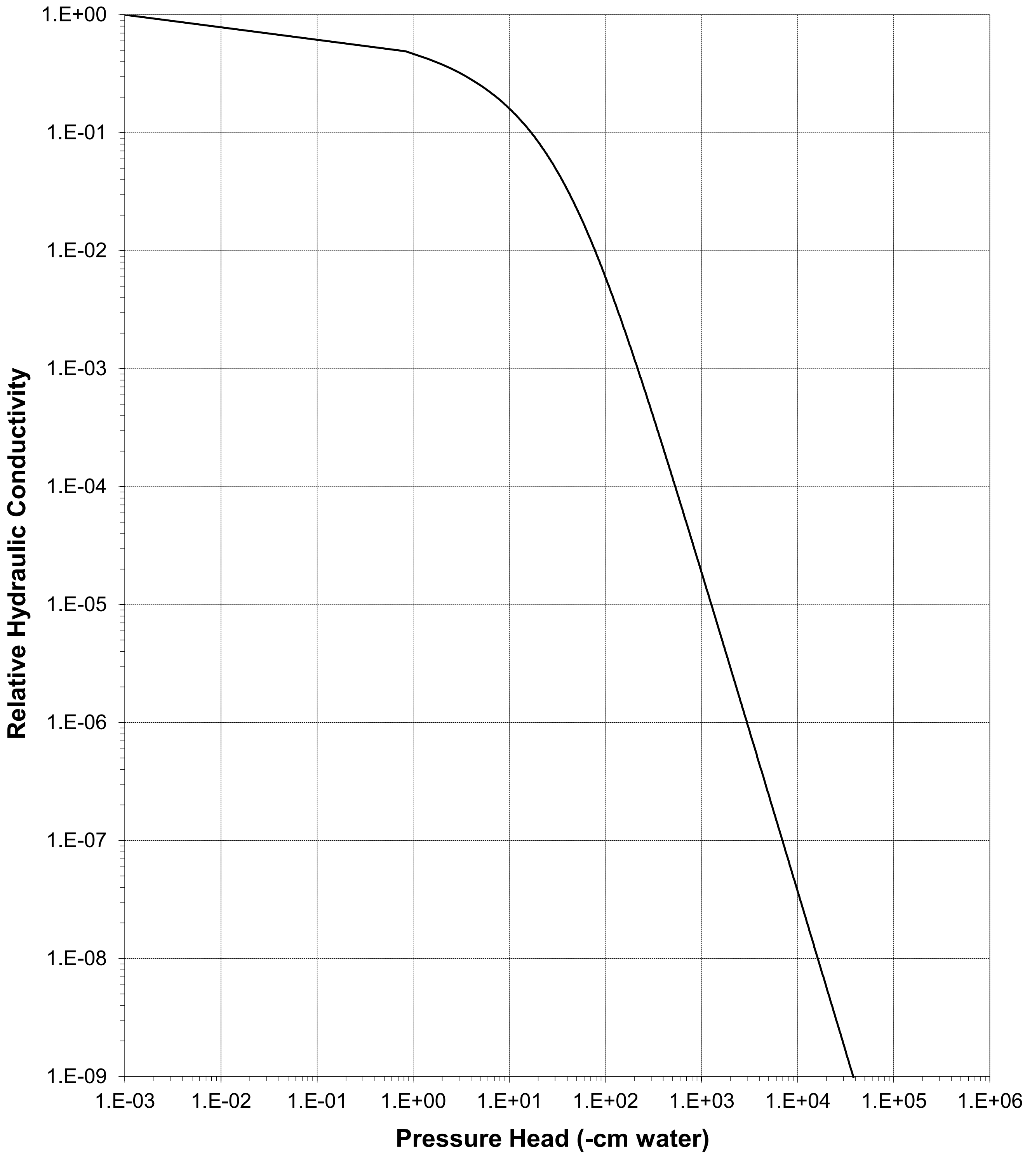
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: WB Borrow-1 (85%, 1.42)



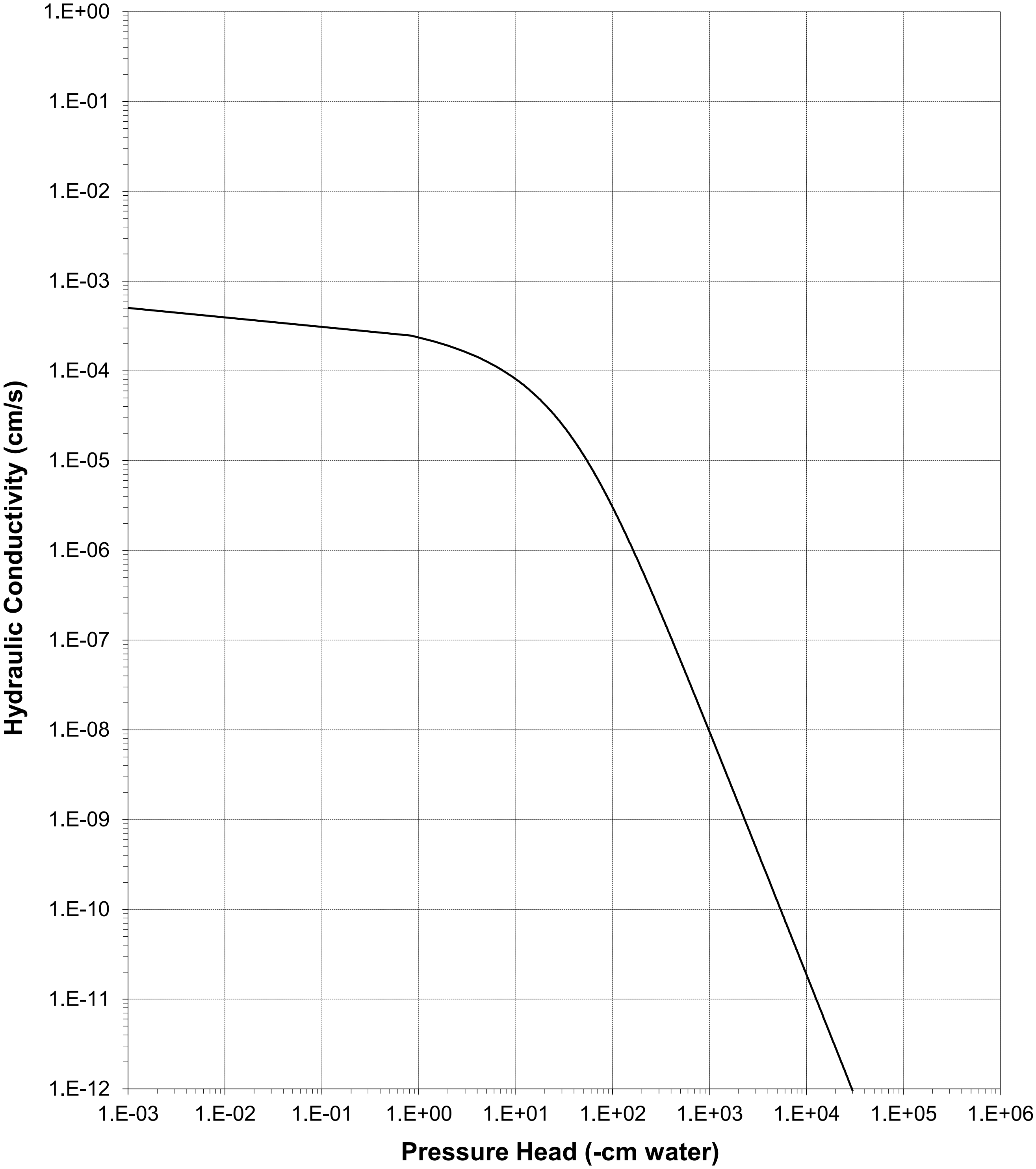
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: WB Borrow-1 (85%, 1.42)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: WB Borrow-1 (85%, 1.42)



Oversize Correction Data Sheet

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Borrow-1 (85%, 1.42)
Project Name:	VVL Composite Samples
PO Number:	12015
Split (3/4", 3/8", #4):	#4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	12.36	87.64	100.00
Mass Fraction (%):	12.36	87.64	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	43.19
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Initial Moisture Content (% vol):	0.00	25.97	24.15
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	43.19
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Saturated Moisture Content (% vol):	0.00	47.42	44.09
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	43.19
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Residual Moisture Content (% vol):	0.00	1.94	1.80
Ksat (cm/sec):	NM	5.0E-04	4.4E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	181.10
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	55.22
Sample Number:	WB Stockpile-1 (85%, 1.52)	*Tare wt., screen & clamp* (g):	27.82
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	119.42
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.52
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	42.77

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	3-Sep-14	11:55	316.20	0	43.60
	10-Sep-14	13:35	316.18	8.0	43.58
	17-Sep-14	10:45	315.76	27.0	43.23
	24-Sep-14	15:30	310.12	91.0	38.50
Pressure plate:	4-Oct-14	10:45	297.78	337	28.17

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	27.0	---	---	---	---
	91.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: WB Stockpile-1 (85%, 1.52)

Initial sample bulk density (g/cm³)*:* 1.52

Fraction of test sample used (<2.00mm fraction) (%): 88.43

Dry weight of dew point potentiometer sample* (g)*:* 157.01

Tare weight, jar (g)*:* 115.17

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	9:30	160.19	32430	10.19
	9-Sep-14	15:07	159.04	164494	6.51
	9-Sep-14	13:50	158.51	510308	4.81

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	32430	---	---	---	---
	164494	---	---	---	---
	510308	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 60.35

Tare weight (g)*:* 36.87

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	61.03	851293	3.90

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

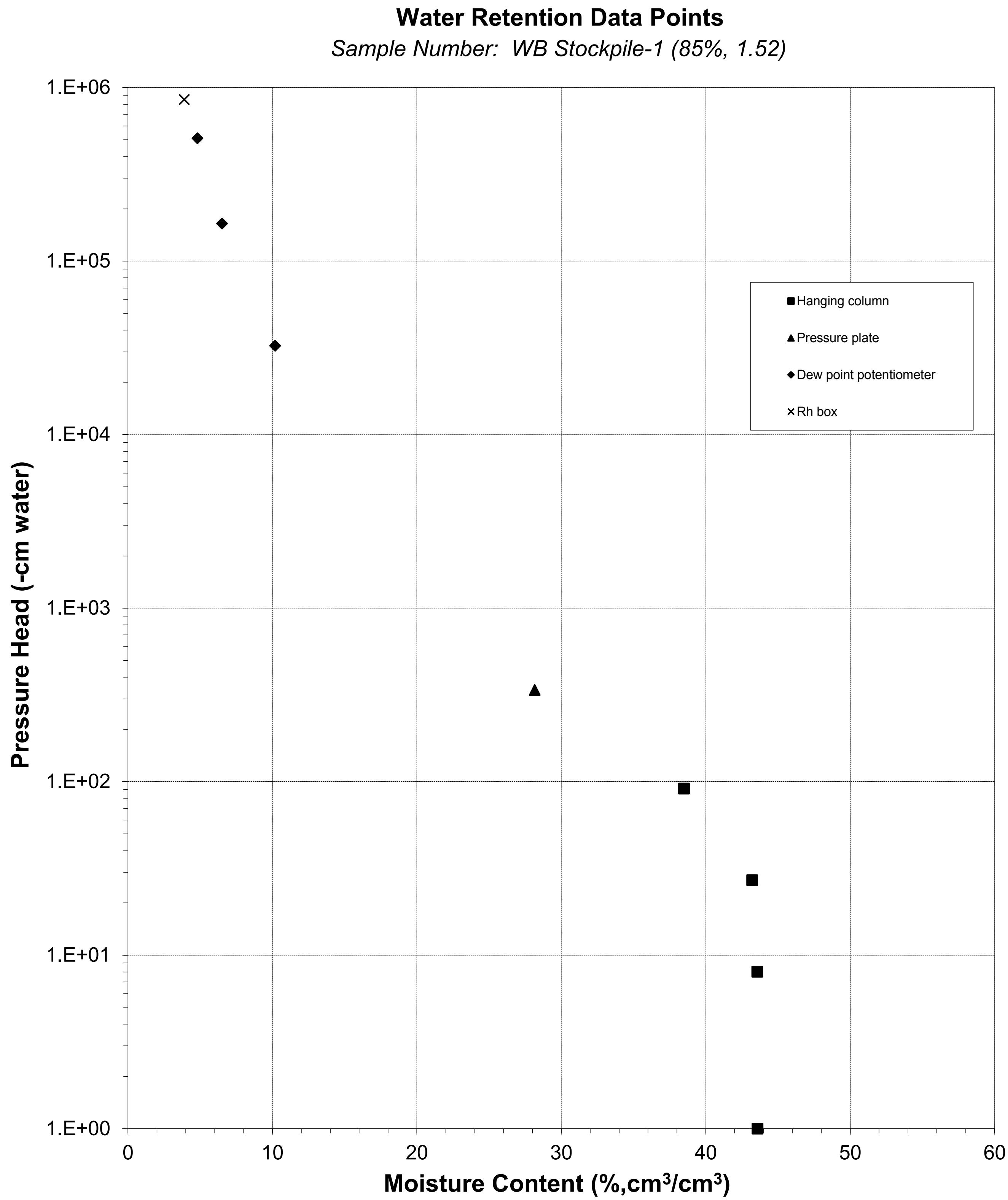
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd

Data entered by: D. O'Dowd

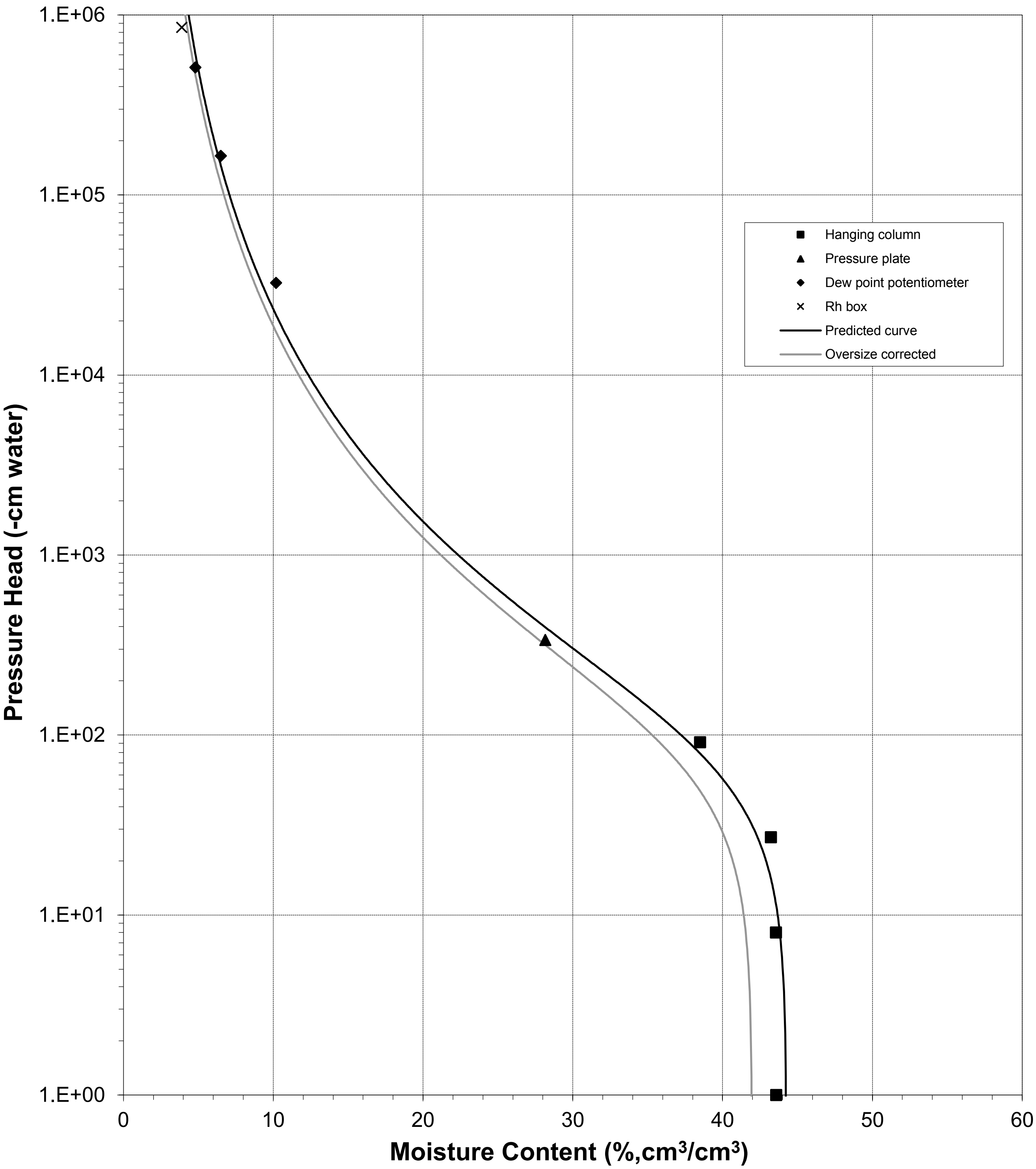
Checked by: J. Hines



Water Retention Data Points
Sample Number: WB Stockpile-1 (85%, 1.52)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)
Hanging column
Pressure plate
Dew point potentiometer
Rh box

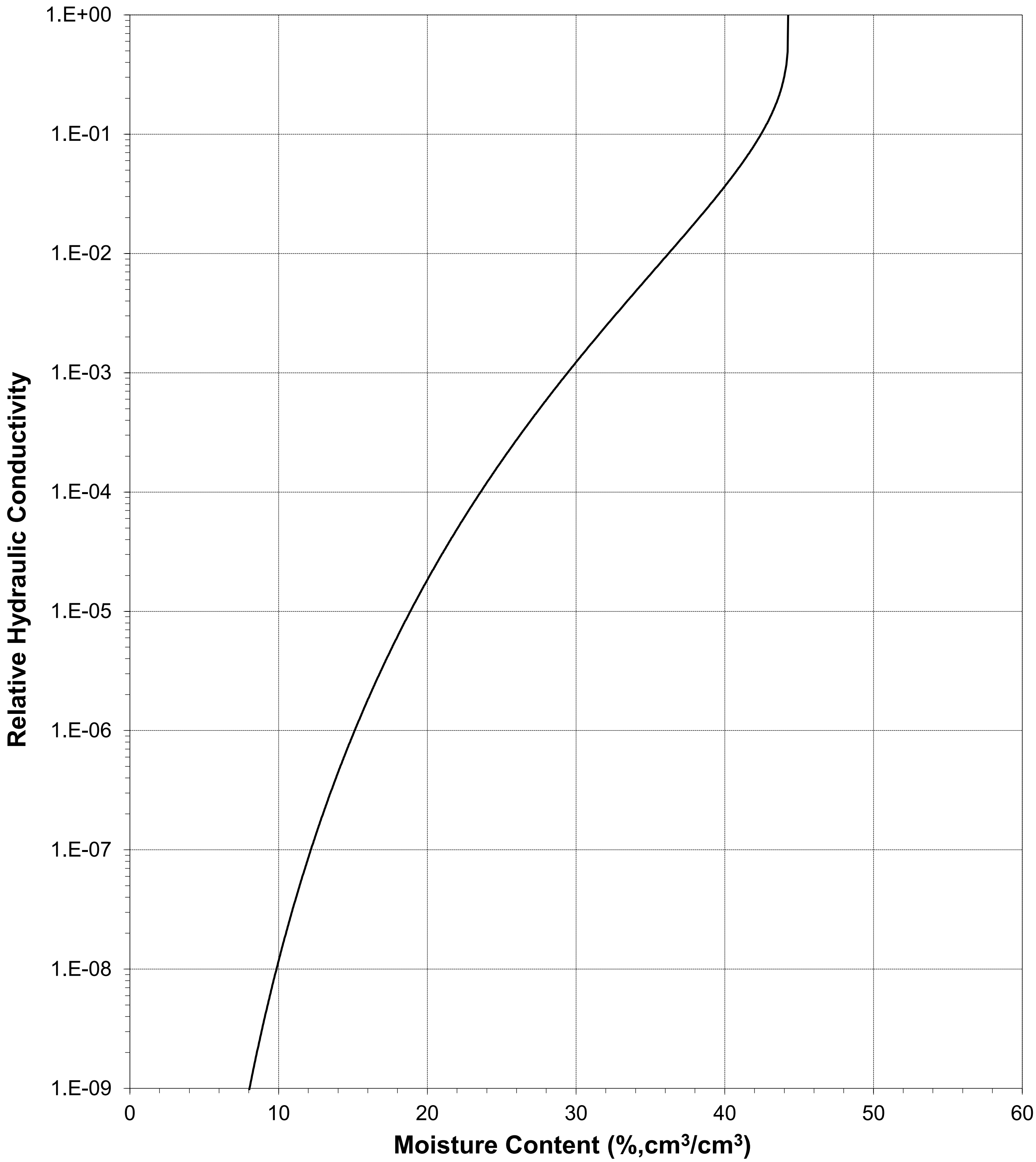
Predicted Water Retention Curve and Data Points

Sample Number: WB Stockpile-1 (85%, 1.52)



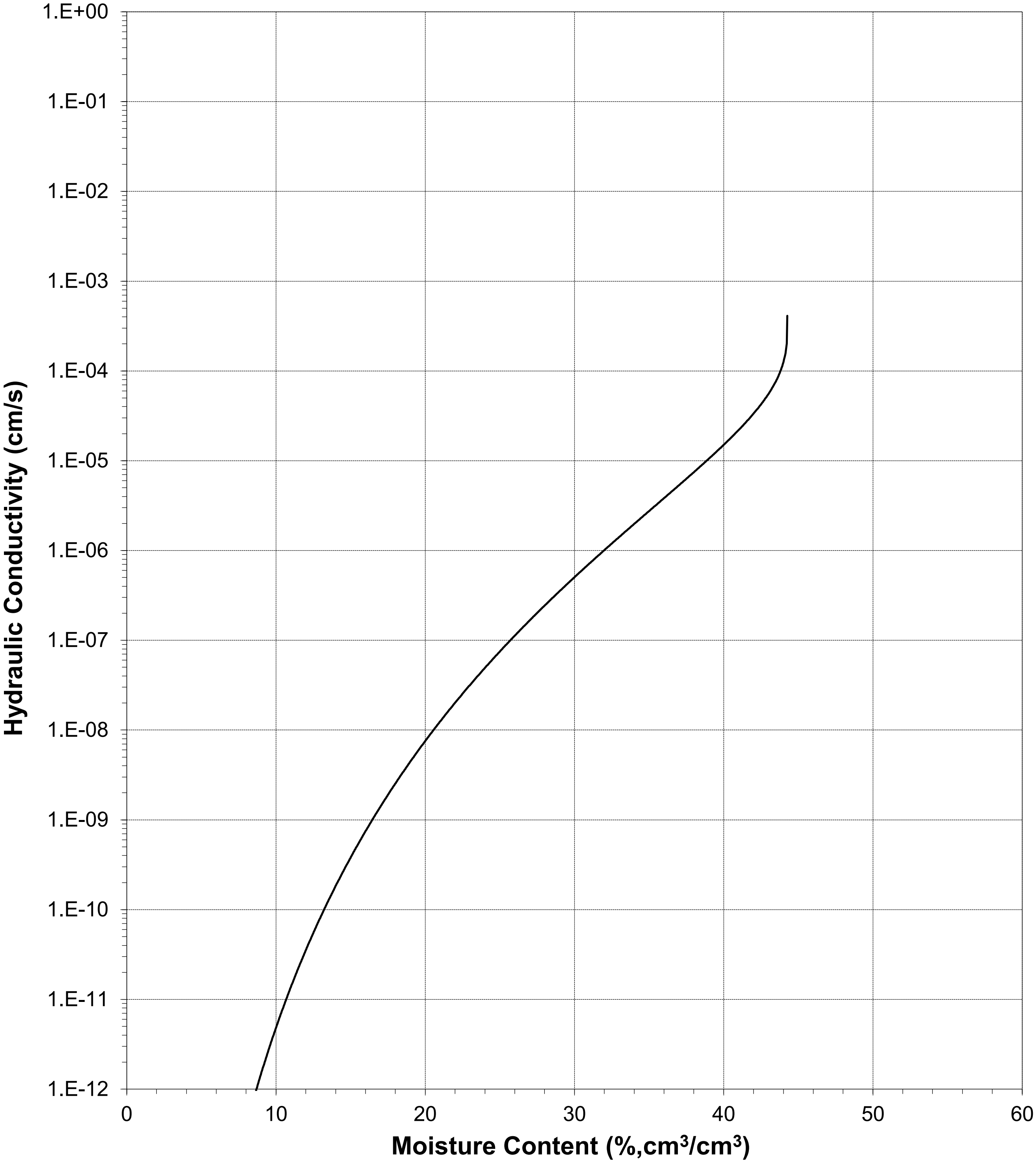
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: WB Stockpile-1 (85%, 1.52)



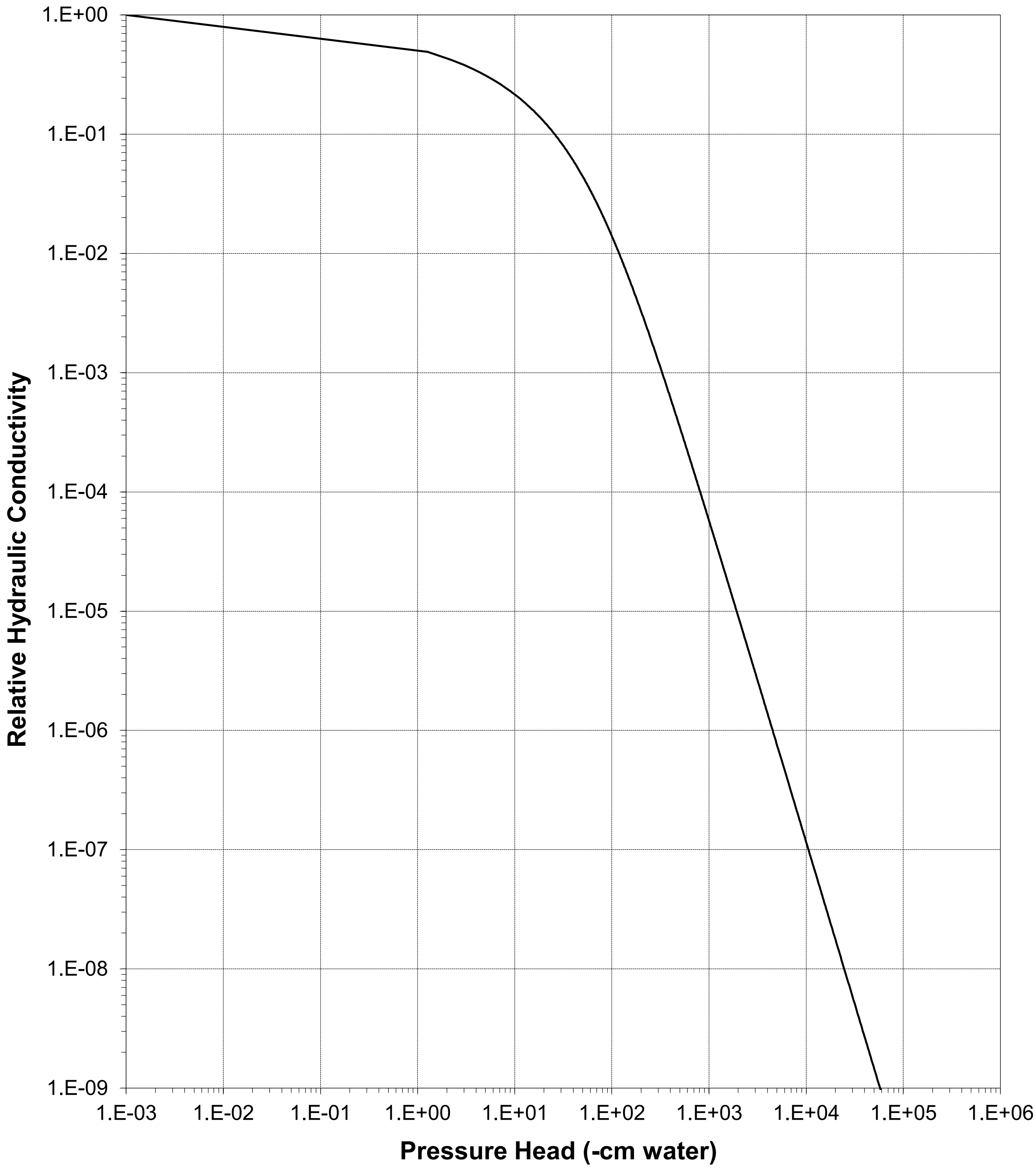
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: WB Stockpile-1 (85%, 1.52)



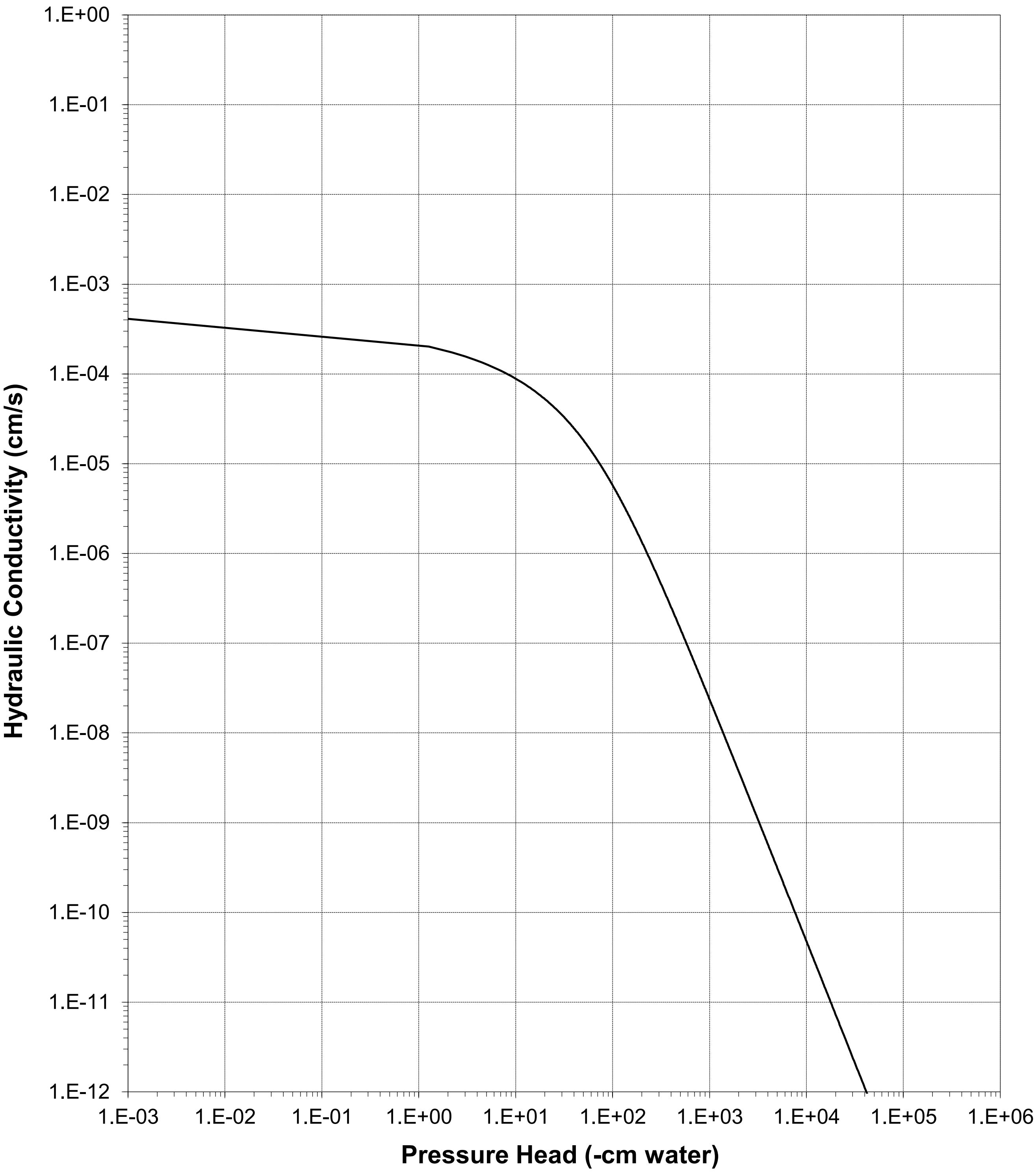
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: WB Stockpile-1 (85%, 1.52)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: WB Stockpile-1 (85%, 1.52)



Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-1 (85%, 1.52)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	8.73	91.27	100.00
Mass Fraction (%):	8.73	91.27	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	40.55
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Initial Moisture Content (% vol):	0.00	22.40	21.24
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	40.55
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Saturated Moisture Content (% vol):	0.00	44.26	41.97
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	40.55
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Residual Moisture Content (% vol):	0.00	1.45	1.38
Ksat (cm/sec):	NM	4.1E-04	3.8E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	167.66
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	72.21
Sample Number:	WB Stockpile-2 (85%, 1.48)	*Tare wt., screen & clamp* (g):	28.05
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	113.33
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.48
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	44.17

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	3-Sep-14	11:50	320.31	0	46.23
	10-Sep-14	13:40	320.22	8.0	46.15
	17-Sep-14	10:45	319.64	29.0	45.64
	24-Sep-14	15:30	310.13	91.0	37.25
Pressure plate:	4-Oct-14	10:45	297.10	337	25.75

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	29.0	---	---	---	---
	91.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: WB Stockpile-2 (85%, 1.48)

Initial sample bulk density (g/cm³)*:* 1.48

Fraction of test sample used (<2.00mm fraction) (%): 73.14

Dry weight of dew point potentiometer sample* (g)*:* 155.61

Tare weight, jar (g)*:* 115.27

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	9:05	159.14	24883	9.47
	10-Sep-14	8:20	158.50	64961	7.75
	9-Sep-14	14:15	157.52	285646	5.12

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	24883	---	---	---	---
	64961	---	---	---	---
	285646	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 64.63

Tare weight (g)*:* 41.90

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	65.37	851293	3.53

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

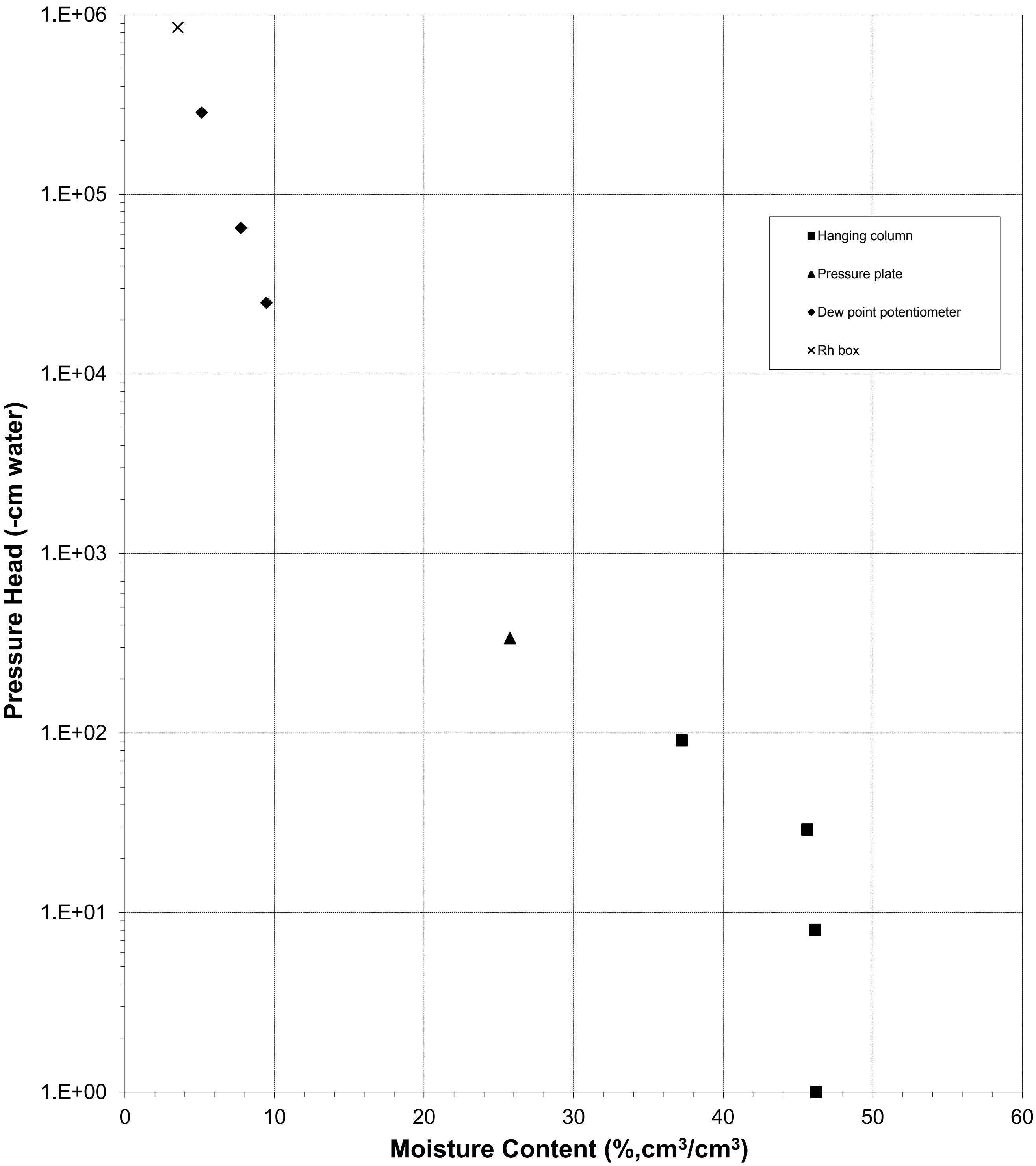
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

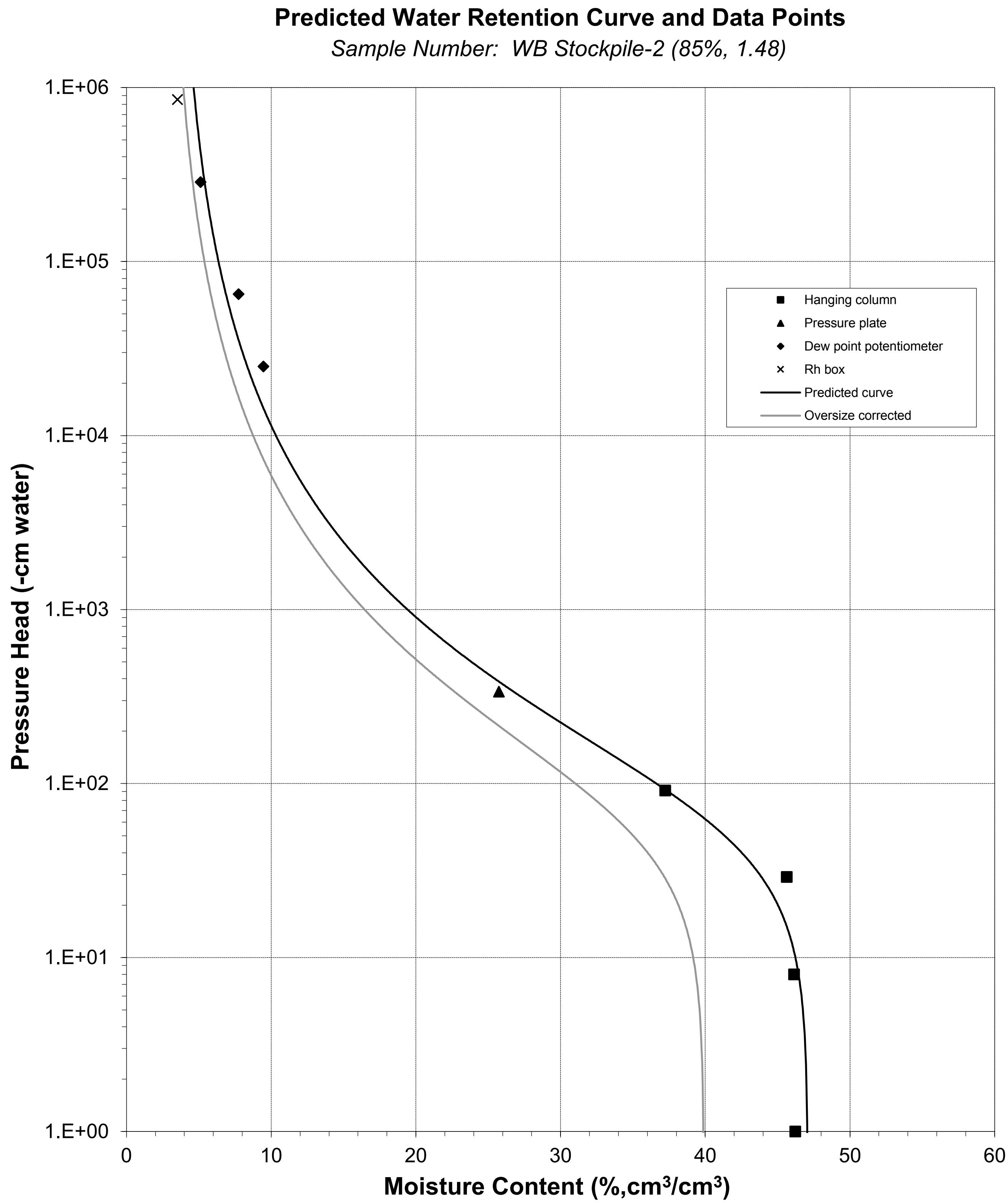
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Water Retention Data Points

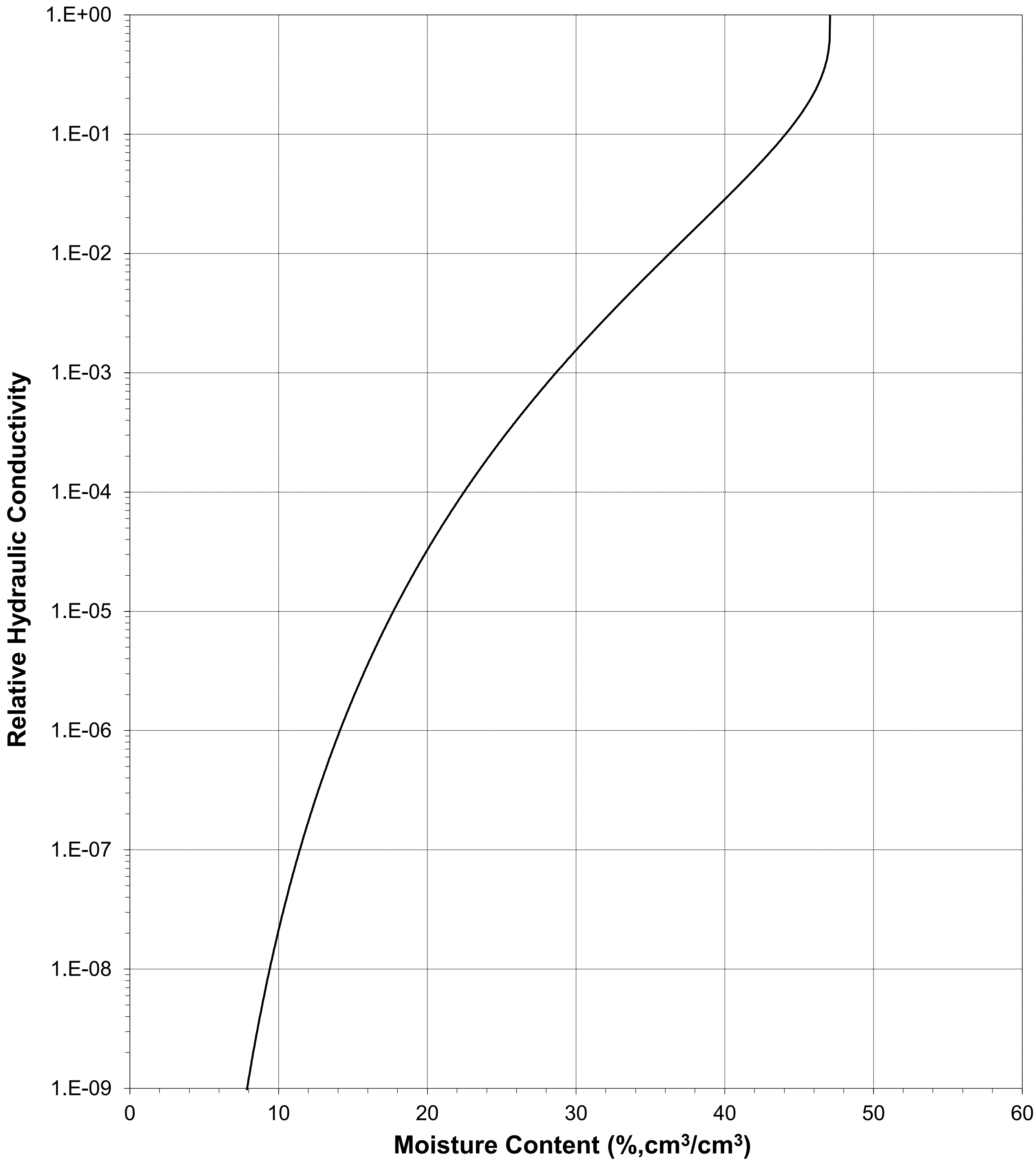
Sample Number: WB Stockpile-2 (85%, 1.48)




Predicted Water Retention Curve and Data Points
Sample Number: WB Stockpile-2 (85%, 1.48)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)
Hanging column
Pressure plate
Dew point potentiometer
Rh box
Predicted curve
Oversize corrected

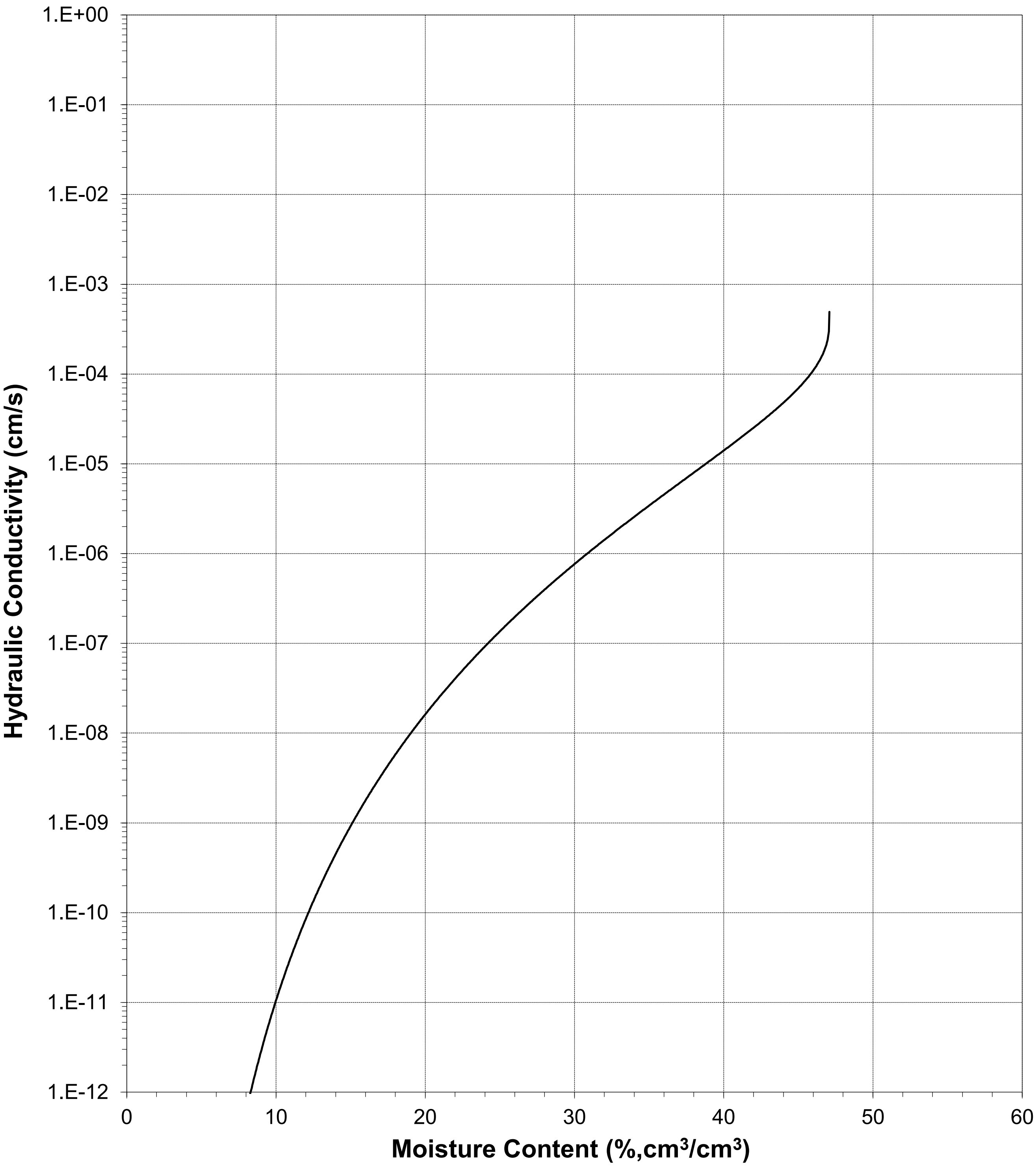
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: WB Stockpile-2 (85%, 1.48)



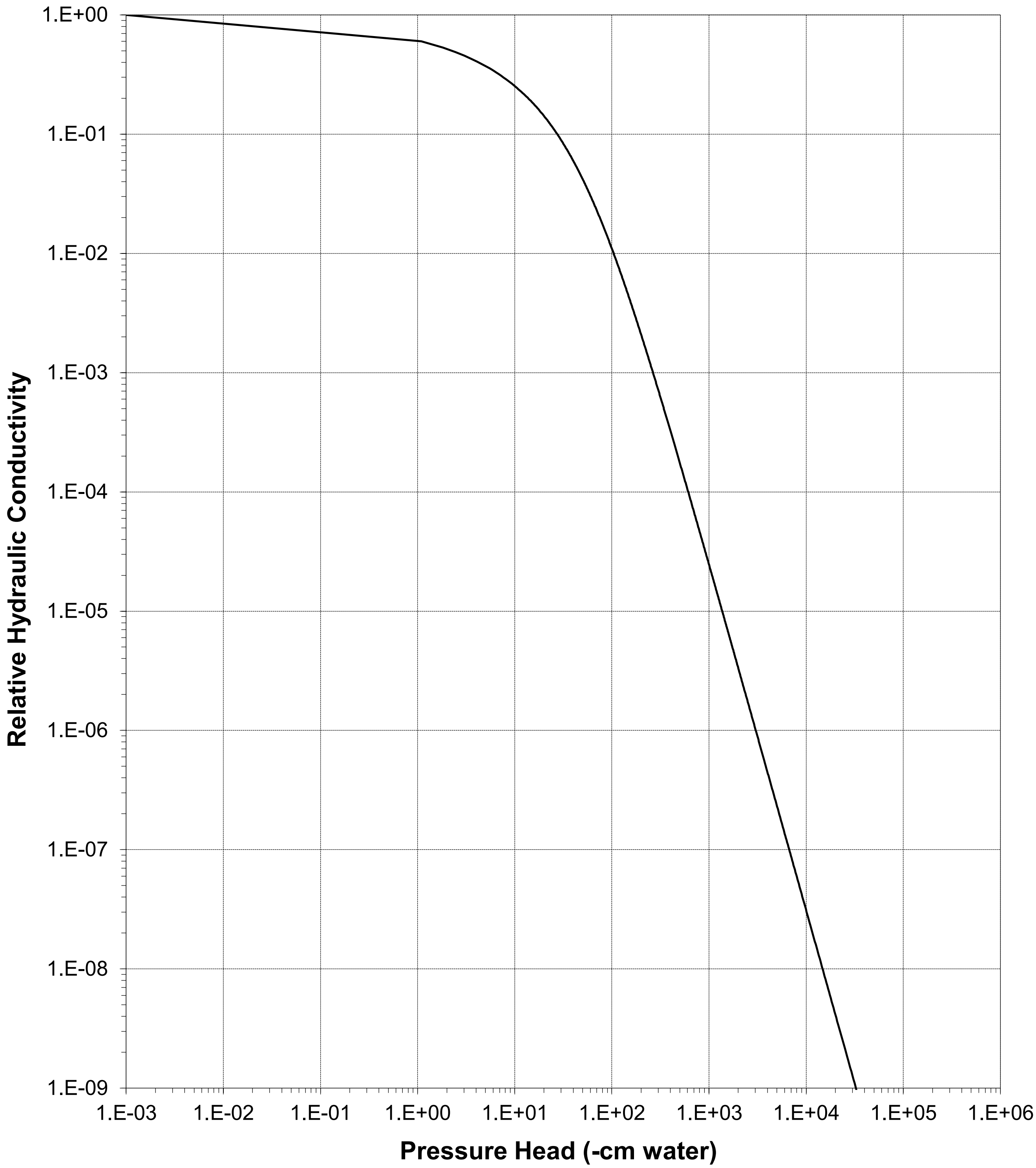
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: WB Stockpile-2 (85%, 1.48)



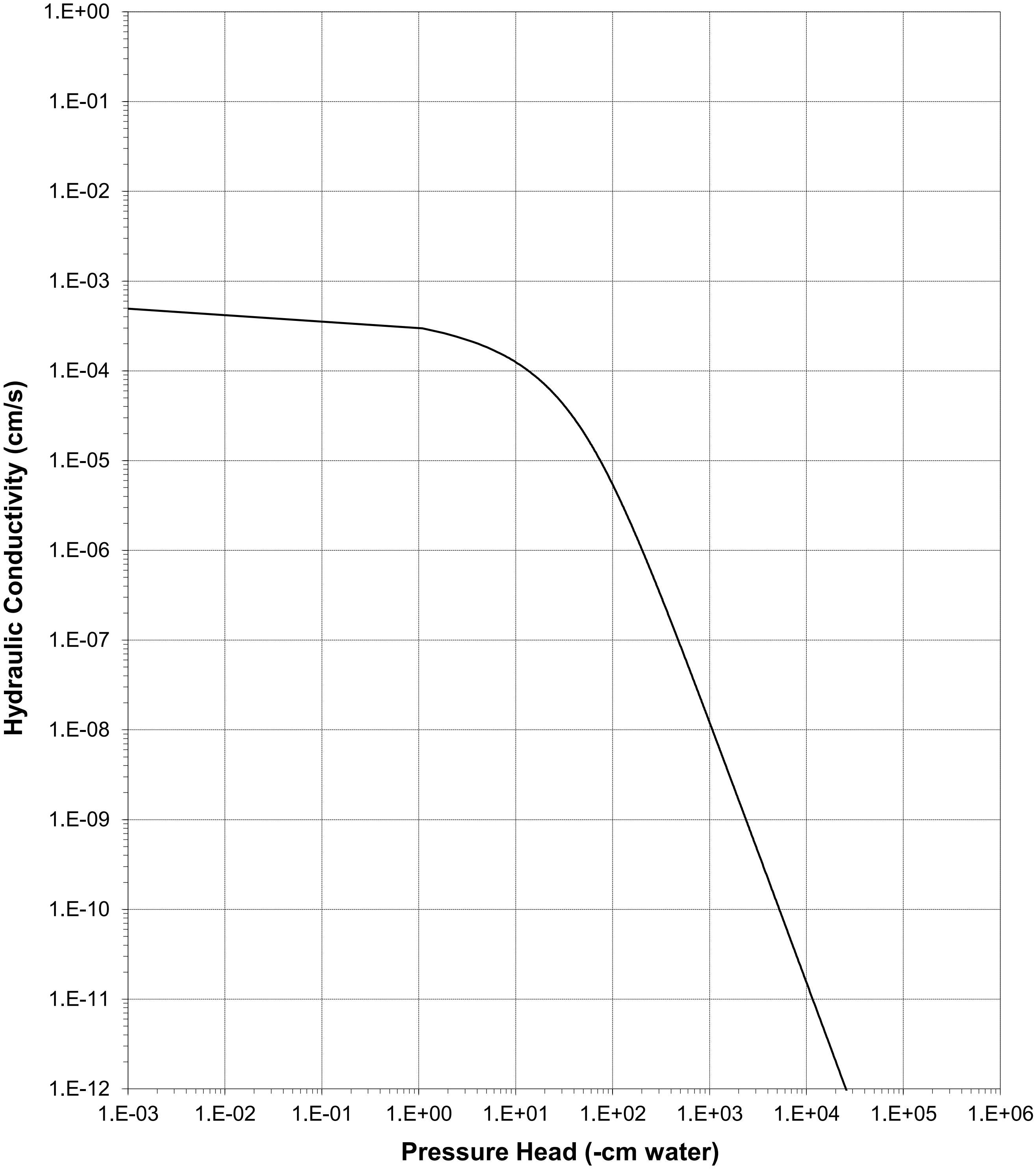
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: WB Stockpile-2 (85%, 1.48)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: WB Stockpile-2 (85%, 1.48)



Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2 (85%, 1.48)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	24.42	75.58	100.00
Mass Fraction (%):	24.42	75.58	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	37.42
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Initial Moisture Content (% vol):	0.00	24.52	20.77
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	37.42
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Saturated Moisture Content (% vol):	0.00	47.09	39.90
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	37.42
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Residual Moisture Content (% vol):	0.00	3.35	2.83
Ksat (cm/sec):	NM	4.9E-04	3.7E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	247.04
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	133.75
Sample Number:	Topsoil-1 (85%, 1.10)	*Tare wt., screen & clamp* (g):	27.21
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	224.14
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.10
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	58.41

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	3-Sep-14	12:00	539.82	0	58.81
	10-Sep-14	13:30	538.50	9.0	58.22
	17-Sep-14	10:30	538.08	30.0	58.04
	24-Sep-14	15:20	512.10	103.0	46.45
Pressure plate:	3-Oct-14	16:25	481.65	337	32.86

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	9.0	---	---	---	---
	30.0	---	---	---	---
	103.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Topsoil-1 (85%, 1.10)

Initial sample bulk density (g/cm^3)*:* 1.10

Fraction of test sample used (<2.00mm fraction) (%): 96.44

Dry weight of dew point potentiometer sample* (g)*:* 143.78

Tare weight, jar (g)*:* 112.67

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	10-Sep-14	9:55	147.47	12646	12.61
	9-Sep-14	15:07	146.28	78729	8.54
	9-Sep-14	13:33	145.43	412101	5.64

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	12646	---	---	---	---
	78729	---	---	---	---
	412101	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 62.95

Tare weight (g)*:* 41.74

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	9-Sep-14	11:00	63.82	851293	4.34

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	851293	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

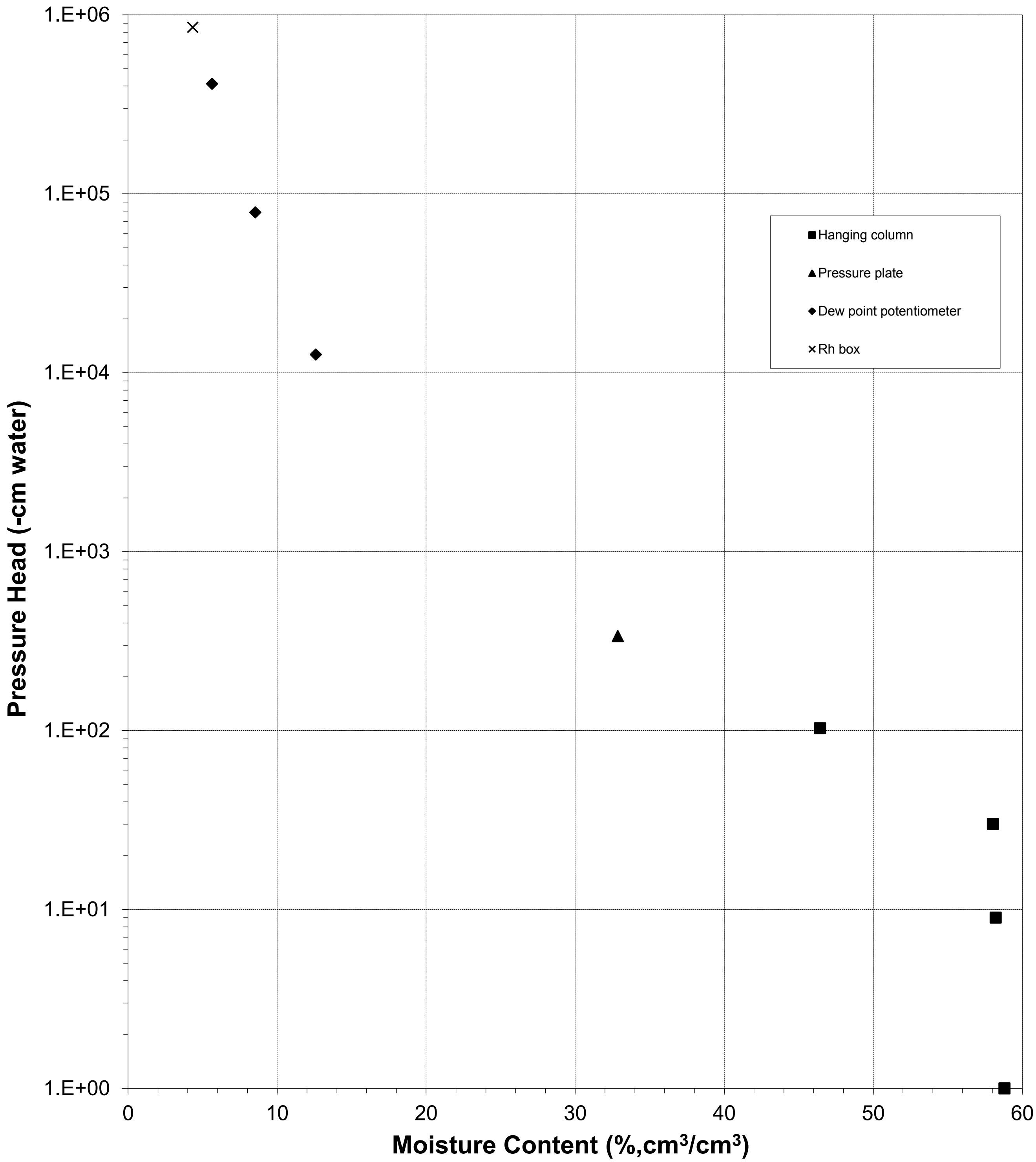
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O' Dowd/D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

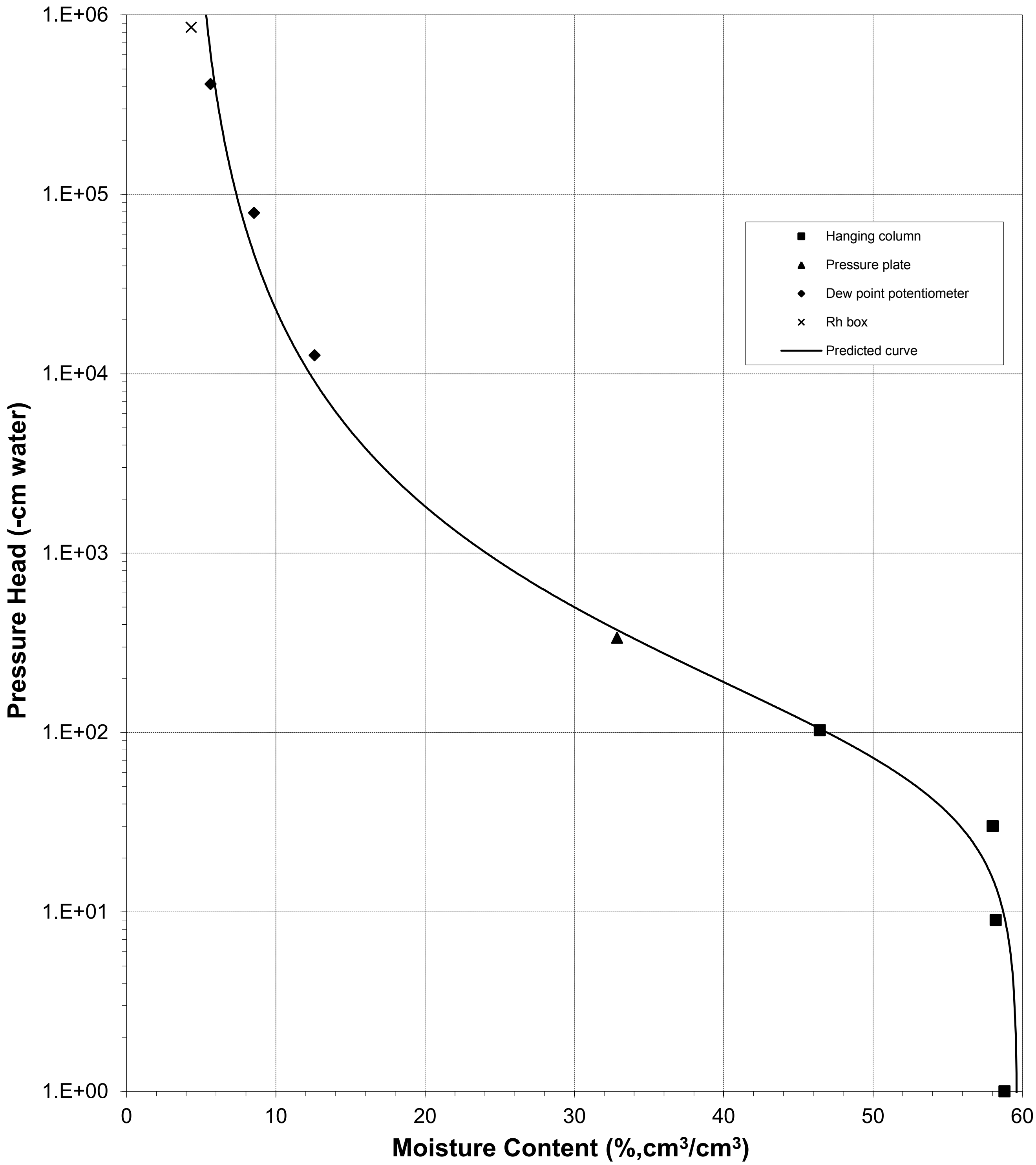
Water Retention Data Points

Sample Number: Topsoil-1 (85%, 1.10)



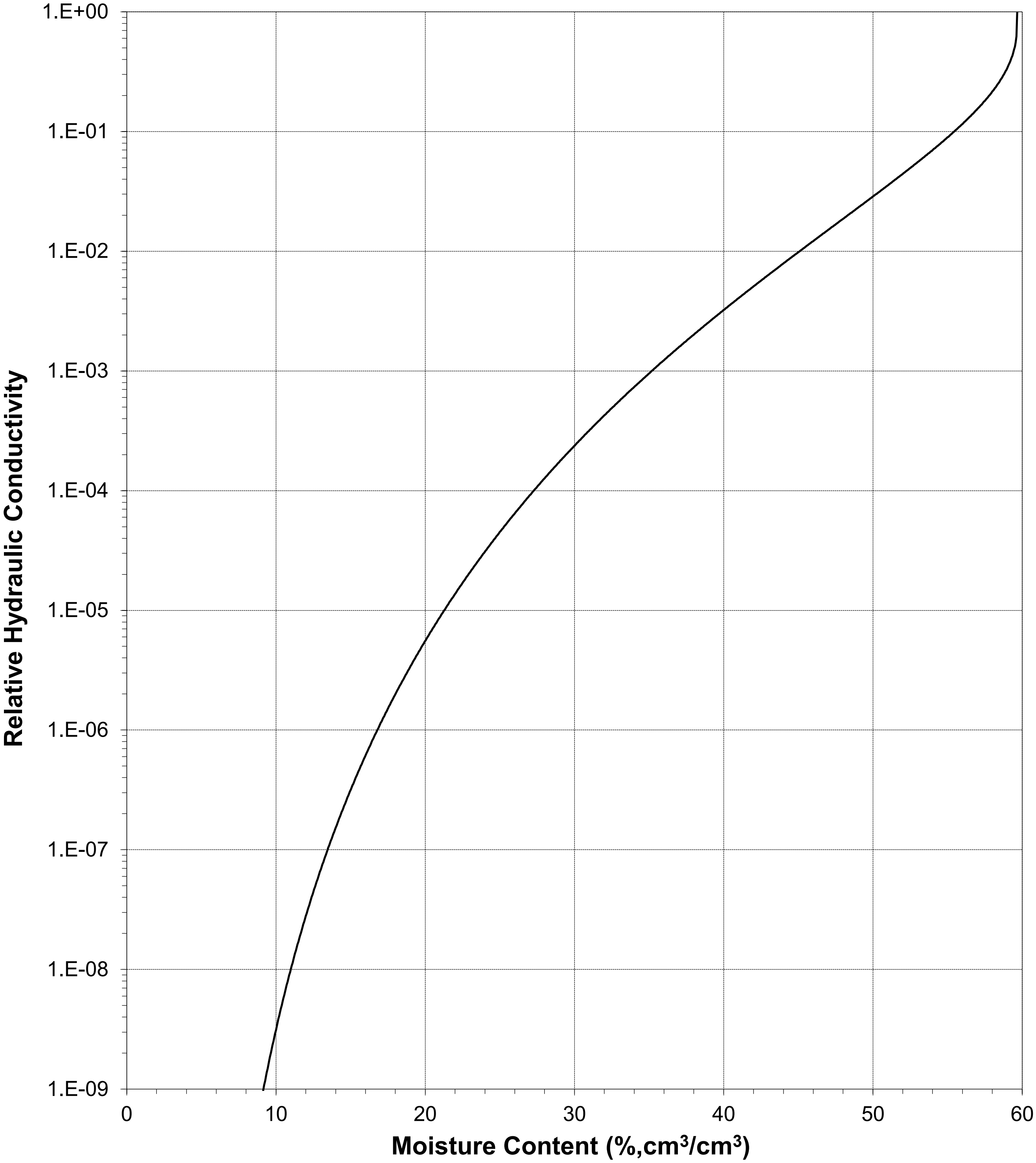
Predicted Water Retention Curve and Data Points

Sample Number: Topsoil-1 (85%, 1.10)



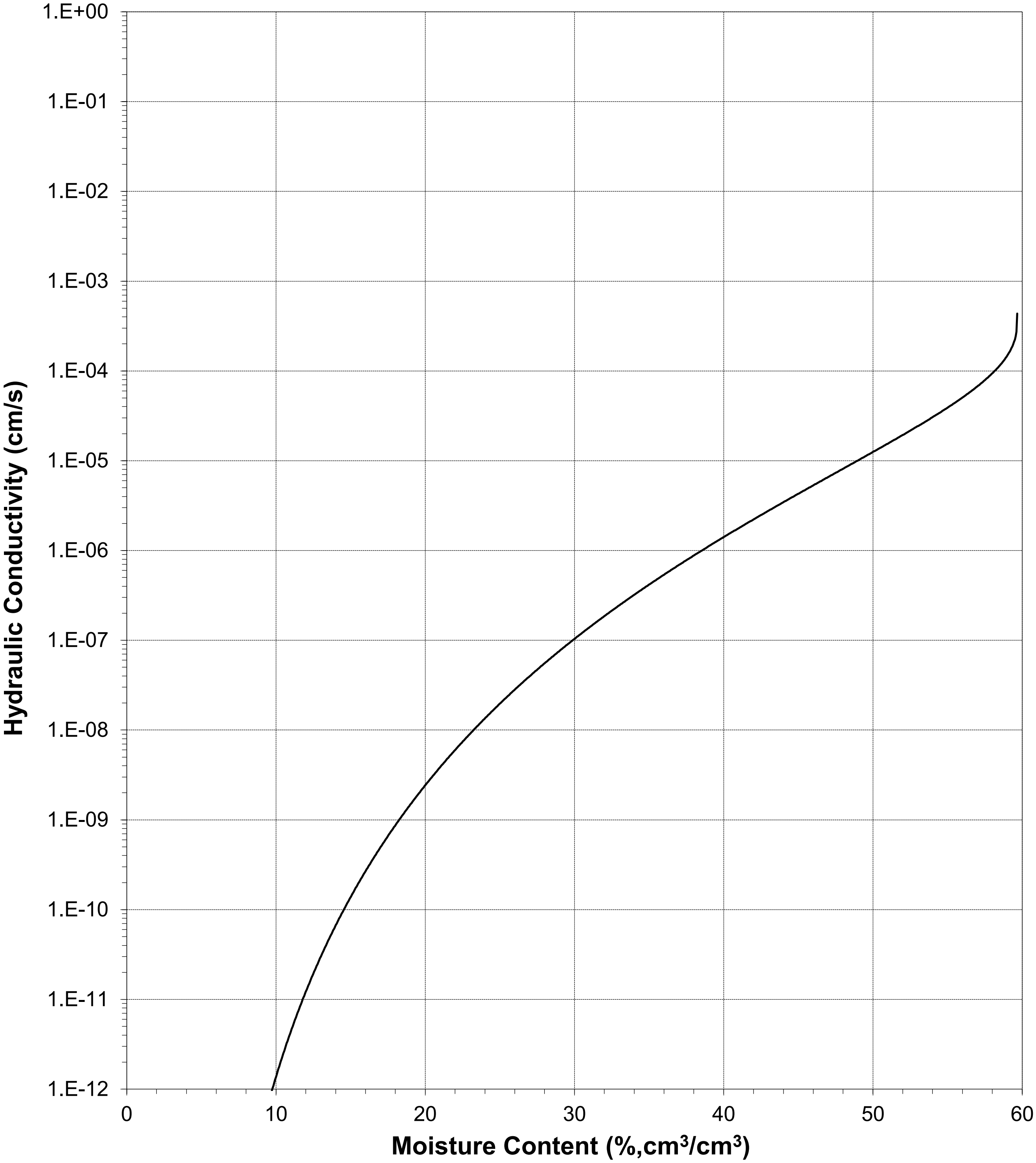
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: Topsoil-1 (85%, 1.10)



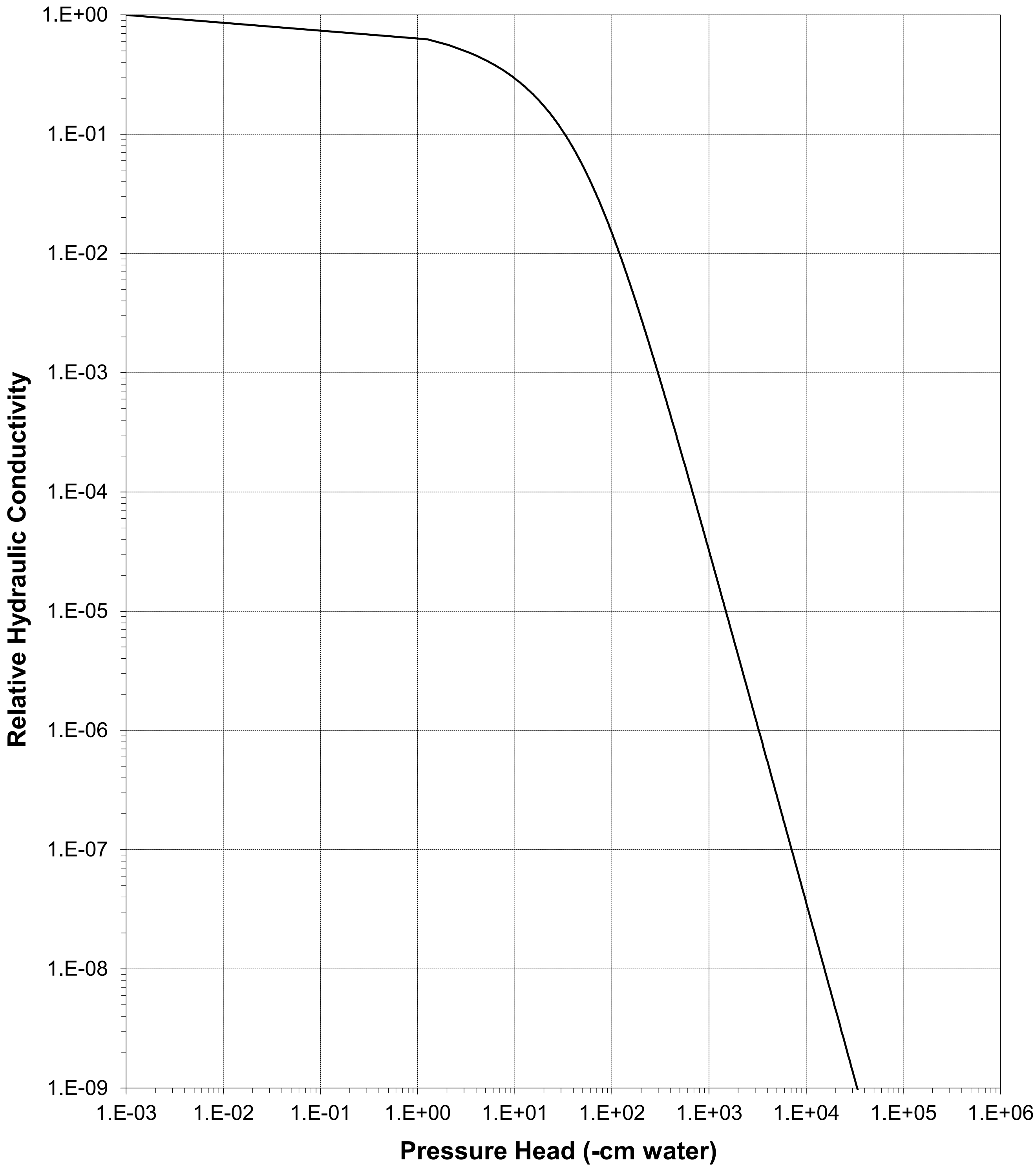
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: Topsoil-1 (85%, 1.10)



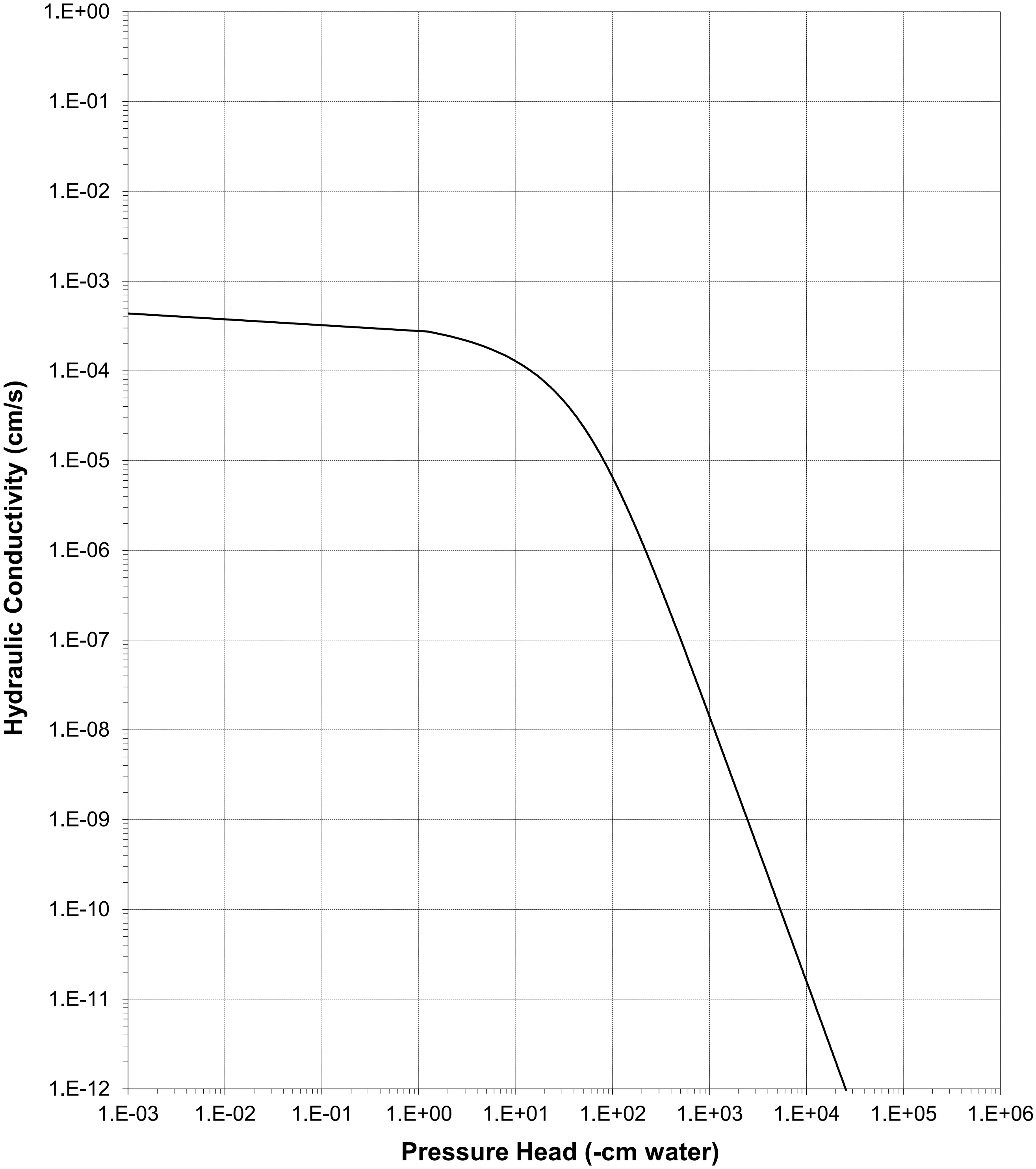
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: Topsoil-1 (85%, 1.10)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Topsoil-1 (85%, 1.10)



Water Holding Capacity

Summary of Moisture Retention (-1/3 Bar, -15 Bar, and Water Holding Capacity*)

Sample Number	-1/3 Bar Point Volumetric (%, cm^3/cm^3)	-15 Bar Point Volumetric (%, cm^3/cm^3)	Water Holding Capacity (%, cm^3/cm^3)	Oversize Corrected -1/3 Bar Point Volumetric (%, cm^3/cm^3)	Oversize Corrected -15 Bar Point Volumetric (%, cm^3/cm^3)	Oversize Corrected Water Holding Capacity (%, cm^3/cm^3)
VVL Composite 0-10 (85%, 1.46)	34.7	12.2	22.5	29.8	10.5	19.4
VVL Composite 11-15 (85%, 1.50)	27.2	8.1	19.2	24.0	7.1	16.9
VVL Composite 16-20 (85%, 1.45)	34.7	12.6	22.1	31.7	11.5	20.2
VVL Composite 21-30 (85%, 1.38)	36.0	13.3	22.7	31.7	11.7	20.0
VVL Composite 31+ (85%, 1.22)	46.6	21.5	25.0	43.8	20.2	23.6
VVL Composite TP-10 (85%, 1.51)	24.1	8.3	15.8	20.7	7.1	13.6
VVL Composite TP-12 (85%, 1.40)	36.9	14.6	22.2	32.4	12.9	19.6
VVL Composite TP-13 (85%, 1.37)	38.1	15.1	23.0	35.4	14.0	21.4
WB Borrow-1 (85%, 1.42)	26.4	11.0	15.4	24.5	10.3	14.3
WB Stockpile-1 (85%, 1.52)	28.2	11.1	17.1	26.7	10.5	16.2
WB Stockpile-2 (85%, 1.48)	25.7	9.3	16.4	21.8	7.9	13.9
Topsoil-1 (85%, 1.10)	32.9	11.0	21.9	---	---	---

*Water Holding Capacity (WHC) is defined here as the difference in the moisture content of the sample at -1/3 bar of water potential (commonly referred to as 'Field Capacity') and the moisture content of the sample at -15 bars of water potential (commonly referred to as 'Wilting Point').

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3181.06
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	265.08
Sample Number:	VVL Composite 0-10 (85%, 1.46)	*Tare wt., screen & clamp* (g):	48.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2175.34
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.46
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	44.82

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Pressure plate:	8-Oct-14	13:05	4248.60	337	34.67

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 34.7

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 29.8

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer
(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10 (85%, 1.46)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.46
Fraction of test sample used (<2.00mm fraction) (%): 52.36

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)
-15 bar[3] :	NA	NA	NA	15297	12.17

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): **12.2**

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): **10.5**

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10 (85%, 1.46)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	22.66	77.34	100.00
Mass Fraction (%):	22.66	77.34	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	38.58
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Initial Moisture Content (% vol):	0.00	24.10	20.75
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	44.82
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Moisture Content (% vol):	0.00	34.67	29.85
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.46	1.63
Calculated Porosity (% vol):	0.00	44.82	44.82
Volume of Solids (cm^3):	8.55	29.19	37.74
Volume of Voids (cm^3):	0.00	23.70	23.70
Total Volume (cm^3):	8.55	52.89	61.44
Volumetric Fraction (%):	13.91	86.09	100.00
Moisture Content (% vol):	0.00	12.17	10.47
Ksat (cm/sec):	NA	2.9E-04	2.2E-04

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3332.92
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	270.65
Sample Number:	VVL Composite 11-15 (85%, 1.50)	*Tare wt., screen & clamp* (g):	57.66
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2220.20
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.50
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	43.35

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Pressure plate:	9-Oct-14	7:40	4259.00	337	27.24	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	2194.13	-1.17%	1.52	42.68

Moisture content at -1/3 bar (% cm^3/cm^3): 27.2

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 24.0

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15 (85%, 1.50)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.50
Fraction of test sample used (<2.00mm fraction) (%): 56.44

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
-15 bar[3] :	NA	NA	NA	15297	8.08	‡‡

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	2194.13	-1.17%	1.52	42.68

Moisture content at -15 bars (% cm^3/cm^3): **8.1**

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): **7.1**

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15 (85%, 1.50)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	18.97	81.03	100.00
Mass Fraction (%):	18.97	81.03	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.50	1.64
Calculated Porosity (% vol):	0.00	43.35	38.28
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	23.40	23.40
Total Volume (cm^3):	7.16	53.98	61.14
Volumetric Fraction (%):	11.71	88.29	100.00
Initial Moisture Content (% vol):	0.00	20.94	18.49
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.52	1.65
Calculated Porosity (% vol):	0.00	42.68	42.68
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	22.77	22.77
Total Volume (cm^3):	7.16	53.34	60.50
Volumetric Fraction (%):	11.83	88.17	100.00
Moisture Content (% vol):	0.00	27.24	24.02
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.52	1.65
Calculated Porosity (% vol):	0.00	42.68	42.68
Volume of Solids (cm^3):	7.16	30.58	37.74
Volume of Voids (cm^3):	0.00	22.77	22.77
Total Volume (cm^3):	7.16	53.34	60.50
Volumetric Fraction (%):	11.83	88.17	100.00
Moisture Content (% vol):	0.00	8.08	7.13
Ksat (cm/sec):	NA	1.5E-03	1.2E-03

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3186.29
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	269.93
Sample Number:	VVL Composite 16-20 (85%, 1.45)	*Tare wt., screen & clamp* (g):	47.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2194.77
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.45
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	45.22

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Pressure plate:	8-Oct-14	13:00	4264.80	337	34.69

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 34.7

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 31.7

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20 (85%, 1.45)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.45
Fraction of test sample used (<2.00mm fraction) (%): 57.04

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)
-15 bar[3] :	NA	NA	NA	15297	12.57

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): 12.6

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 11.5

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20 (85%, 1.45)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	14.48	85.52	100.00
Mass Fraction (%):	14.48	85.52	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	41.38
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Initial Moisture Content (% vol):	0.00	24.76	22.66
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	45.22
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Moisture Content (% vol):	0.00	34.69	31.74
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.45	1.55
Calculated Porosity (% vol):	0.00	45.22	45.22
Volume of Solids (cm^3):	5.46	32.27	37.74
Volume of Voids (cm^3):	0.00	26.64	26.64
Total Volume (cm^3):	5.46	58.91	64.37
Volumetric Fraction (%):	8.49	91.51	100.00
Moisture Content (% vol):	0.00	12.57	11.50
Ksat (cm/sec):	NA	5.3E-04	4.5E-04

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3048.84
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	271.14
Sample Number:	VVL Composite 21-30 (85%, 1.38)	*Tare wt., screen & clamp* (g):	60.30
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2201.91
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.38
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	47.75

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Pressure plate:	8-Oct-14	12:40	4172.90	337	36.00

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 36.0

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 31.7

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer
(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.38
Fraction of test sample used (<2.00mm fraction) (%): 56.28

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
-15 bar [3] :	NA	NA	NA	15297	13.30

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar [3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): 13.3

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 11.7

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30 (85%, 1.38)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	20.52	79.48	100.00
Mass Fraction (%):	20.52	79.48	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	42.07
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Initial Moisture Content (% vol):	0.00	25.09	22.11
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	47.75
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Moisture Content (% vol):	0.00	36.00	31.72
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.38	1.54
Calculated Porosity (% vol):	0.00	47.75	47.75
Volume of Solids (cm^3):	7.74	29.99	37.74
Volume of Voids (cm^3):	0.00	27.41	27.41
Total Volume (cm^3):	7.74	57.40	65.14
Volumetric Fraction (%):	11.89	88.11	100.00
Moisture Content (% vol):	0.00	13.30	11.72
Ksat (cm/sec):	NA	3.3E-04	2.6E-04

NA = Not analyzed

* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.

** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+ (85%, 1.22)
Project Name: VVL Composite Samples
PO Number: 12015

Dry wt. of sample (g): 2700.23
Tare wt., ring (g): 272.82
Tare wt., screen & clamp (g): 67.12
Initial sample volume (cm^3): 2217.25
Initial dry bulk density (g/cm^3): 1.22
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 54.04

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Pressure plate:	4-Oct-14	10:45	4072.50	337	46.56

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 46.6

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 43.8

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+ (85%, 1.22)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.22
Fraction of test sample used (<2.00mm fraction) (%): 78.45

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
-15 bar[3] :	NA	NA	NA	15297	21.51

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): **21.5**

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): **20.2**

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+ (85%, 1.22)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	12.02	87.98	100.00
Mass Fraction (%):	12.02	87.98	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	50.85
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Initial Moisture Content (% vol):	0.00	33.05	31.10
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	54.04
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Moisture Content (% vol):	0.00	46.56	43.81
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.22	1.30
Calculated Porosity (% vol):	0.00	54.04	54.04
Volume of Solids (cm^3):	4.54	33.20	37.74
Volume of Voids (cm^3):	0.00	39.04	39.04
Total Volume (cm^3):	4.54	72.24	76.78
Volumetric Fraction (%):	5.91	94.09	100.00
Moisture Content (% vol):	0.00	21.51	20.24
Ksat (cm/sec):	NA	1.1E-04	9.5E-05

NA = Not analyzed

* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.

** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3342.18
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	272.60
Sample Number:	VVL Composite TP-10 (85%, 1.51)	*Tare wt., screen & clamp* (g):	53.78
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2220.60
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.51
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	43.20

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Pressure plate:	4-Oct-14	10:30	4174.90	337	24.15	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	2096.96	-5.57%	1.59	39.86

Moisture content at -1/3 bar (% cm^3/cm^3): 24.1

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 20.7

Comments:

1 Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer
(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10 (85%, 1.51)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.51
Fraction of test sample used (<2.00mm fraction) (%): 63.04

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
-15 bar[3] :	NA	NA	NA	15297	8.31	‡‡

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	2096.96	-5.57%	1.59	39.86

Moisture content at -15 bars (% cm^3/cm^3): **8.3**

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): **7.1**

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10 (85%, 1.51)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	21.58	78.42	100.00
Mass Fraction (%):	21.58	78.42	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.51	1.66
Calculated Porosity (% vol):	0.00	43.20	37.36
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	22.51	22.51
Total Volume (cm^3):	8.14	52.10	60.25
Volumetric Fraction (%):	13.52	86.48	100.00
Initial Moisture Content (% vol):	0.00	23.65	20.46
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.59	1.74
Calculated Porosity (% vol):	0.00	39.86	39.86
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	19.61	19.61
Total Volume (cm^3):	8.14	49.20	57.34
Volumetric Fraction (%):	14.20	85.80	100.00
Moisture Content (% vol):	0.00	24.15	20.72
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.59	1.74
Calculated Porosity (% vol):	0.00	39.86	39.86
Volume of Solids (cm^3):	8.14	29.59	37.74
Volume of Voids (cm^3):	0.00	19.61	19.61
Total Volume (cm^3):	8.14	49.20	57.34
Volumetric Fraction (%):	14.20	85.80	100.00
Moisture Content (% vol):	0.00	8.31	7.13
Ksat (cm/sec):	NA	2.5E-03	2.0E-03

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3091.19
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	270.01
Sample Number:	VVL Composite TP-12 (85%, 1.40)	*Tare wt., screen & clamp* (g):	56.79
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2203.81
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.40
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	47.07

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Pressure plate:	4-Oct-14	10:37	4184.50	337	36.86	‡‡

Volume Adjusted Data[1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	2079.65	-5.63%	1.49	43.91

Moisture content at -1/3 bar (% cm^3/cm^3): 36.9

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 32.4

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12 (85%, 1.40)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3): 1.40
Fraction of test sample used (<2.00mm fraction) (%): 60.23

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
-15 bar[3] :	NA	NA	NA	15297	14.62	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	2079.65	-5.63%	1.49	43.91

Moisture content at -15 bars (% cm^3/cm^3): 14.6

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 12.9

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12 (85%, 1.40)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	19.61	80.39	100.00
Mass Fraction (%):	19.61	80.39	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.40	1.55
Calculated Porosity (% vol):	0.00	47.07	41.69
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	26.98	26.98
Total Volume (cm^3):	7.40	57.31	64.71
Volumetric Fraction (%):	11.44	88.56	100.00
Initial Moisture Content (% vol):	0.00	26.07	23.09
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.49	1.63
Calculated Porosity (% vol):	0.00	43.91	43.91
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	23.75	23.75
Total Volume (cm^3):	7.40	54.08	61.48
Volumetric Fraction (%):	12.04	87.96	100.00
Moisture Content (% vol):	0.00	36.86	32.42
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.49	1.63
Calculated Porosity (% vol):	0.00	43.91	43.91
Volume of Solids (cm^3):	7.40	30.33	37.74
Volume of Voids (cm^3):	0.00	23.75	23.75
Total Volume (cm^3):	7.40	54.08	61.48
Volumetric Fraction (%):	12.04	87.96	100.00
Moisture Content (% vol):	0.00	14.62	12.86
Ksat (cm/sec):	NA	1.2E-04	9.6E-05

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data
Pressure Plate
(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	3086.05
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	275.53
Sample Number:	VVL Composite TP-13 (85%, 1.37)	*Tare wt., screen & clamp* (g):	55.27
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	2250.16
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.37
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	48.25

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Pressure plate:	8-Oct-14	12:48	4289.80	337	38.10	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	2291.03	+1.82%	1.35	49.17

Moisture content at -1/3 bar (% cm^3/cm^3): 38.1

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 35.4

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer
(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13 (85%, 1.37)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.37
Fraction of test sample used (<2.00mm fraction) (%): 65.88

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
-15 bar[3] :	NA	NA	NA	15297	15.07	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	2291.03	+1.82%	1.35	49.17

Moisture content at -15 bars (% cm^3/cm^3): 15.1

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 14.0

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13 (85%, 1.37)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): 3/4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	13.14	86.86	100.00
Mass Fraction (%):	13.14	86.86	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.37	1.46
Calculated Porosity (% vol):	0.00	48.25	44.74
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	30.56	30.56
Total Volume (cm^3):	4.96	63.33	68.29
Volumetric Fraction (%):	7.26	92.74	100.00
Initial Moisture Content (% vol):	0.00	28.91	26.81
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.35	1.44
Calculated Porosity (% vol):	0.00	49.17	49.17
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	31.71	31.71
Total Volume (cm^3):	4.96	64.49	69.44
Volumetric Fraction (%):	7.14	92.86	100.00
Moisture Content (% vol):	0.00	38.10	35.38
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.35	1.44
Calculated Porosity (% vol):	0.00	49.17	49.17
Volume of Solids (cm^3):	4.96	32.78	37.74
Volume of Voids (cm^3):	0.00	31.71	31.71
Total Volume (cm^3):	4.96	64.49	69.44
Volumetric Fraction (%):	7.14	92.86	100.00
Moisture Content (% vol):	0.00	15.07	13.99
Ksat (cm/sec):	NA	2.6E-04	2.3E-04

NA = Not analyzed

* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.

** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Pressure Plate
(-1/3 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1 (85%, 1.42)
Project Name: VVL Composite Samples
PO Number: 12015

Dry wt. of sample (g): 164.29
Tare wt., ring (g): 53.27
Tare wt., screen & clamp (g): 25.51
Initial sample volume (cm^3): 115.77
Initial dry bulk density (g/cm^3): 1.42
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 46.45

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Pressure plate:	3-Oct-14	16:25	273.63	337	26.40

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 26.4

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 24.5

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1 (85%, 1.42)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.42
Fraction of test sample used (<2.00mm fraction) (%): 82.87

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
-15 bar [3] :	NA	NA	NA	15297	11.03

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar [3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): 11.0

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 10.3

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1 (85%, 1.42)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	12.36	87.64	100.00
Mass Fraction (%):	12.36	87.64	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	43.19
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Initial Moisture Content (% vol):	0.00	25.97	24.15
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	46.45
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Moisture Content (% vol):	0.00	26.40	24.54
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.42	1.51
Calculated Porosity (% vol):	0.00	46.45	46.45
Volume of Solids (cm^3):	4.66	33.07	37.74
Volume of Voids (cm^3):	0.00	28.68	28.68
Total Volume (cm^3):	4.66	61.76	66.42
Volumetric Fraction (%):	7.02	92.98	100.00
Moisture Content (% vol):	0.00	11.03	10.26
Ksat (cm/sec):	NA	5.0E-04	4.4E-04

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Pressure Plate
(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	181.10
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	55.22
Sample Number:	WB Stockpile-1 (85%, 1.52)	*Tare wt., screen & clamp* (g):	27.82
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	119.42
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.52
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	42.77

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Pressure plate:	4-Oct-14	10:45	297.78	337	28.17

Volume Adjusted Data[1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 28.2

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 26.7

Comments:

1 Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-1 (85%, 1.52)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.52
Fraction of test sample used (<2.00mm fraction) (%): 88.43

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
-15 bar [3] :	NA	NA	NA	15297	11.08

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar [3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): 11.1

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): 10.5

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-1 (85%, 1.52)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	8.73	91.27	100.00
Mass Fraction (%):	8.73	91.27	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	40.55
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Initial Moisture Content (% vol):	0.00	22.40	21.24
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	42.77
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Moisture Content (% vol):	0.00	28.17	26.71
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.52	1.58
Calculated Porosity (% vol):	0.00	42.77	42.77
Volume of Solids (cm^3):	3.30	34.44	37.74
Volume of Voids (cm^3):	0.00	25.74	25.74
Total Volume (cm^3):	3.30	60.18	63.48
Volumetric Fraction (%):	5.19	94.81	100.00
Moisture Content (% vol):	0.00	11.08	10.51
Ksat (cm/sec):	NA	4.1E-04	3.8E-04

NA = Not analyzed
* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	167.66
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	72.21
Sample Number:	WB Stockpile-2 (85%, 1.48)	*Tare wt., screen & clamp* (g):	28.05
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	113.33
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.48
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	44.17

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Pressure plate:	4-Oct-14	10:45	297.10	337	25.75

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 25.7

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): 21.8

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Dew Point Potentiometer
(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2 (85%, 1.48)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.48
Fraction of test sample used (<2.00mm fraction) (%): 73.14

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
-15 bar [3] :	NA	NA	NA	15297	9.34

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar [3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): **9.3**

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): **7.9**

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2 (85%, 1.48)
Project Name: VVL Composite Samples
PO Number: 12015

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	24.42	75.58	100.00
Mass Fraction (%):	24.42	75.58	100.00
Initial Sample			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	37.42
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Initial Moisture Content (% vol):	0.00	24.52	20.77
Sample at -1/3 Bar			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	44.17
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Moisture Content (% vol):	0.00	25.75	21.81
Sample at -15 Bar			
Bulk Density (g/cm^3):	2.65	1.48	1.66
Calculated Porosity (% vol):	0.00	44.17	44.17
Volume of Solids (cm^3):	9.21	28.52	37.74
Volume of Voids (cm^3):	0.00	22.57	22.57
Total Volume (cm^3):	9.21	51.09	60.30
Volumetric Fraction (%):	15.28	84.72	100.00
Moisture Content (% vol):	0.00	9.34	7.91
Ksat (cm/sec):	NA	4.9E-04	3.7E-04

NA = Not analyzed

* = Porosity and moisture content of coarse fraction assumed to be zero, and coarse fraction bulk density assumed to be equal to particle density.

** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Pressure Plate

(-1/3 Bar)

Job Name:	Hydrometrics, Inc.	*Dry wt. of sample* (g):	247.04
Job Number:	LB14.0168.00	*Tare wt., ring* (g):	133.75
Sample Number:	Topsoil-1 (85%, 1.10)	*Tare wt., screen & clamp* (g):	27.21
Project Name:	VVL Composite Samples	*Initial sample volume* (cm^3):	224.14
PO Number:	12015	*Initial dry bulk density* (g/cm^3):	1.10
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	58.41

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Pressure plate:	3-Oct-14	16:25	481.65	337	32.86

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Pressure plate:	337	---	---	---	---

Moisture content at -1/3 bar (% cm^3/cm^3): 32.9

Oversize corrected moisture content at -1/3 bar (% cm^3/cm^3): NA

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent volume change measurements obtained after the pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer

(-15 Bar)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: Topsoil-1 (85%, 1.10)
Project Name: VVL Composite Samples
PO Number: 12015

Initial sample bulk density (g/cm^3)*:* 1.10
Fraction of test sample used (<2.00mm fraction) (%): 96.44

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)
-15 bar[3] :	NA	NA	NA	15297	11.00

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change[2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
-15 bar[3] :	15297	---	---	---	---

Moisture content at -15 bars (% cm^3/cm^3): 11.0

Oversize corrected moisture content at -15 bars (% cm^3/cm^3): NA

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

[3] The moisture content of the sample at -15 bars of water potential was interpolated from the predicted water retention curve.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Particle Size Analysis

Daniel B. Stephens & Associates, Inc.

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification
VVL Composite 0-10	0.00024	1.6	4.4	1.8E+04	50	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 11-15	0.0069	1.1	3.4	493	2.1	WS/H	Silty sand with gravel (SM)g	Sandy Loam †
VVL Composite 16-20	2.8E-05	0.81	4.2	1.5E+05	103	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 21-30	0.00020	0.89	4.8	2.4E+04	9.2	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite 31+	2.3E-10	0.021	0.058	2.5E+08	5877	WS/H	Sandy fat clay with gravel s(CH)g	Clay † (Est)
VVL Composite TP-10	0.0082	0.64	1.5	183	2.3	WS/H	Clayey sand with gravel (SC)g	Sandy Loam †
VVL Composite TP-12	1.2E-06	0.63	1.9	1.6E+06	2274	WS/H	Clayey gravel with sand (GC)s	Sandy Clay Loam † (Est)
VVL Composite TP-13	0.00038	0.49	1.1	2895	4.4	WS/H	Clayey sand with gravel (SC)g	Sandy Clay Loam † (Est)
WB Borrow-1	0.0013	0.095	0.22	169	3.1	WS/H	Clayey sand (SC)	Sandy Loam † (Est)
WB Stockpile-1	0.00028	0.035	0.063	225	9.6	WS/H	Sandy lean clay s(CL)	Loam † (Est)
WB Stockpile-2	0.0011	0.091	0.31	282	2.0	WS/H	Clayey sand with gravel (SC)g	Loam † (Est)
Topsoil-1	0.0036	0.047	0.070	19	1.3	WS/H	Sandy silt s(ML)	Loam

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
VVL Composite 0-10	39.3	35.6	11.4	13.7
VVL Composite 11-15	37.8	42.0	12.7	7.5
VVL Composite 16-20	39.6	32.3	14.7	13.4
VVL Composite 21-30	40.1	31.0	13.4	15.5
VVL Composite 31+	18.2	21.4	27.6	32.8
VVL Composite TP-10	34.1	44.3	15.1	6.5
VVL Composite TP-12	36.4	33.5	13.8	16.3
VVL Composite TP-13	28.9	37.8	15.6	17.6
WB Borrow-1	12.4	40.3	35.7	11.6
WB Stockpile-1	8.7	29.1	46.9	15.3
WB Stockpile-2	24.4	27.1	35.3	13.1
Topsoil-1	0.4	37.9	53.6	8.0

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 46048.20
Weight Passing #4 (g): 27973.21
Weight Retained #4 (g): 18074.99
Weight of Hydrometer Sample (g): 58.78
Calculated Weight of Sieve Sample (g): 96.76

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	46048.20	100.00
	2"	50	1282.51	1282.51	44765.69	97.21
	1.5"	38.1	3282.85	4565.36	41482.84	90.09
	1"	25	3756.91	8322.27	37725.93	81.93
	3/4"	19.0	2110.31	10432.58	35615.62	77.34
	3/8"	9.5	2484.86	12917.44	33130.76	71.95
	4	4.75	5157.55	18074.99	27973.21	60.75
-4			(Based on calculated sieve wt.)			
	10	2.00	8.12	46.10	50.66	52.36
	20	0.85	8.83	54.93	41.83	43.23
	40	0.425	8.31	63.24	33.52	34.64
	60	0.250	4.02	67.26	29.50	30.49
	140	0.106	4.12	71.38	25.38	26.23
	200	0.075	1.06	72.44	24.32	25.13
	dry pan		0.46	72.90	23.86	
	wet pan			23.86	0.00	

d_{10} (mm): 0.00024
d_{16} (mm): 0.0060
d_{30} (mm): 0.23
d_{50} (mm): 1.6
d_{60} (mm): 4.4
d_{84} (mm): 28

Median Particle Diameter --d_{50} (mm): 1.6
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 1.8E+04
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 50
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 9.9

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Clayey gravel with sand (GC)s
USDA Soil Classification: Sandy Clay Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 27-Aug-14
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

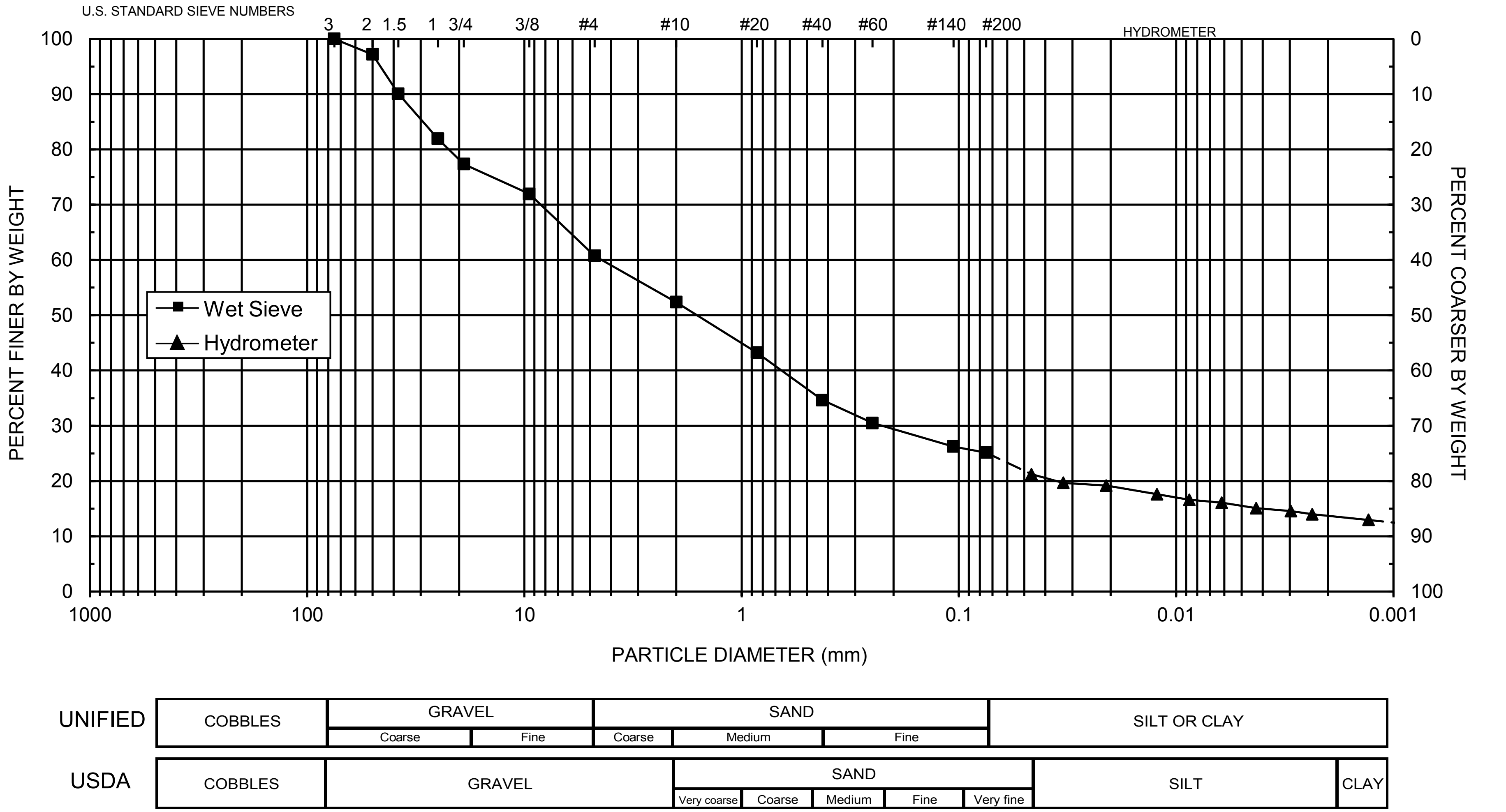
Initial Wt. (g): 58.78
Total Sample Wt. (g): 46048.20
Wt. Passing #4 (g): 27973.21

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
27-Aug-14	1	21.5	26.5	6.0	20.5	12.0	0.04625	34.9	21.2
	2	21.5	25.0	6.0	19.0	12.2	0.03304	32.4	19.7
	5	21.5	24.5	6.0	18.5	12.3	0.02097	31.5	19.2
	15	21.5	23.0	6.0	17.0	12.5	0.01223	29.0	17.6
	30	21.6	22.0	6.0	16.1	12.7	0.00869	27.3	16.6
	60	21.6	21.5	6.0	15.6	12.8	0.00617	26.5	16.1
	126	21.7	20.5	5.9	14.6	12.9	0.00428	24.8	15.1
	264	21.7	20.0	5.9	14.1	13.0	0.00296	23.9	14.5
	421	21.5	19.5	6.0	13.5	13.1	0.00236	23.0	14.0
28-Aug-14	1404	21.4	18.5	6.0	12.5	13.3	0.00130	21.3	12.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.00024**	d_{30} = **0.23**	d_{50} = **1.6**	d_{60} = **4.4**	C_u = **1.8E+04**	C_c = **50**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite 0-10	**12015**	**Clayey gravel with sand (GC)s**	**Sandy Clay Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 46786.10
Weight Passing #4 (g): 29099.72
Weight Retained #4 (g): 17686.38
Weight of Hydrometer Sample (g): 78.23
Calculated Weight of Sieve Sample (g): 125.78

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	46786.10	100.00
	2"	50	1977.56	1977.56	44808.54	95.77
	1.5"	38.1	2330.19	4307.75	42478.35	90.79
	1"	25	2770.31	7078.06	39708.04	84.87
	3/4"	19.0	1796.78	8874.84	37911.26	81.03
	3/8"	9.5	3816.83	12691.67	34094.43	72.87
	4	4.75	4994.71	17686.38	29099.72	62.20
-4			(Based on calculated sieve wt.)			
	10	2.00	7.24	54.79	70.99	56.44
	20	0.85	10.95	65.74	60.04	47.74
	40	0.425	10.15	75.89	49.89	39.67
	60	0.250	10.66	86.55	39.23	31.19
	140	0.106	11.19	97.74	28.04	22.29
	200	0.075	2.68	100.42	25.36	20.16
	dry pan		0.57	100.99	24.79	
	wet pan			24.79	0.00	

d_{10} (mm): 0.0069 | d_{50} (mm): 1.1
d_{16} (mm): 0.036 | d_{60} (mm): 3.4
d_{30} (mm): 0.22 | d_{84} (mm): 23

Median Particle Diameter --d_{50} (mm): 1.1
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 493
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.1
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 8.0

Classification of fines: ML

ASTM Soil Classification: Silty sand with gravel (SM)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

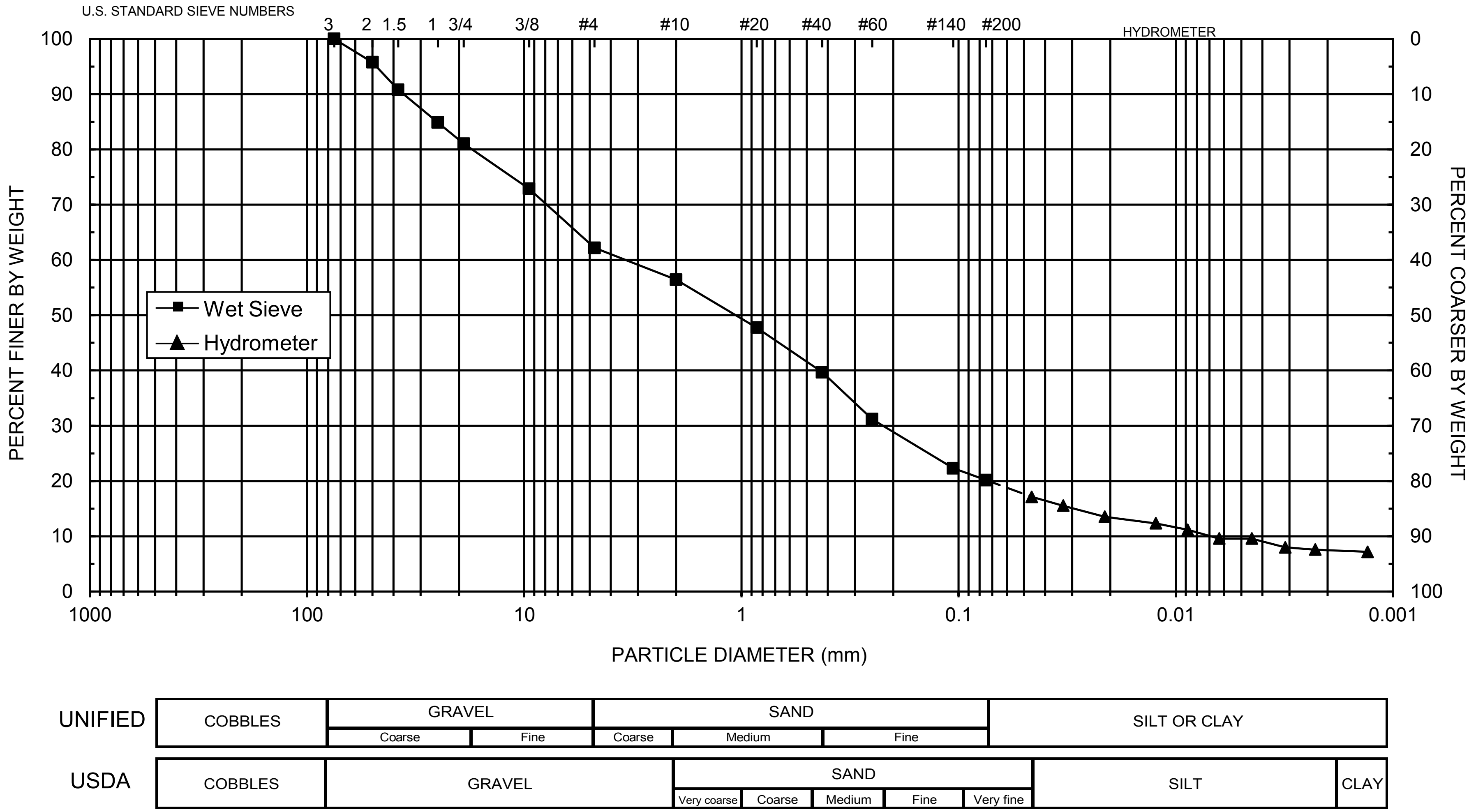
Initial Wt. (g): 78.23
Total Sample Wt. (g): 46786.10
Wt. Passing #4 (g): 29099.72

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.4	27.5	6.0	21.5	11.8	0.04599	27.5	17.1
	2	21.4	25.5	6.0	19.5	12.1	0.03297	25.0	15.5
	5	21.4	23.0	6.0	17.0	12.5	0.02120	21.8	13.5
	15	21.4	21.5	6.0	15.5	12.8	0.01236	19.8	12.3
	30	21.5	20.0	6.0	14.0	13.0	0.00881	17.9	11.2
	60	21.5	18.0	6.0	12.0	13.3	0.00631	15.4	9.6
	120	21.5	18.0	6.0	12.0	13.3	0.00446	15.4	9.6
	250	21.4	16.0	6.0	10.0	13.7	0.00313	12.8	8.0
	476	21.4	15.5	6.0	9.5	13.8	0.00228	12.2	7.6
27-Aug-14	1454	21.4	15.0	6.0	9.0	13.8	0.00131	11.5	7.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.0069**	d_{30} = **0.22**	d_{50} = **1.1**	d_{60} = **3.4**	C_u = **493**	C_c = **2.1**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite 11-15	**12015**	**Silty sand with gravel (SM)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 46745.40
Weight Passing #4 (g): 28253.52
Weight Retained #4 (g): 18491.88
Weight of Hydrometer Sample (g): 67.19
Calculated Weight of Sieve Sample (g): 111.17

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	46745.40	100.00
	2"	50	242.97	242.97	46502.43	99.48
	1.5"	38.1	1258.91	1501.88	45243.52	96.79
	1"	25	3527.46	5029.34	41716.06	89.24
	3/4"	19.0	1739.24	6768.58	39976.82	85.52
	3/8"	9.5	5820.55	12589.13	34156.27	73.07
	4	4.75	5902.75	18491.88	28253.52	60.44
-4			(Based on calculated sieve wt.)			
	10	2.00	3.78	47.76	63.41	57.04
	20	0.85	7.15	54.91	56.26	50.61
	40	0.425	8.83	63.74	47.43	42.67
	60	0.250	6.78	70.52	40.65	36.57
	140	0.106	7.51	78.03	33.14	29.81
	200	0.075	1.82	79.85	31.32	28.17
	dry pan		0.45	80.30	30.87	
	wet pan			30.87	0.00	

d_{10} (mm): 2.8E-05
d_{16} (mm): 0.0065
d_{30} (mm): 0.11
d_{50} (mm): 0.81
d_{60} (mm): 4.2
d_{84} (mm): 17

Median Particle Diameter --d_{50} (mm): 0.81
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 1.5E+05
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 103
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 5.9

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Clayey gravel with sand (GC)s
USDA Soil Classification: Sandy Clay Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

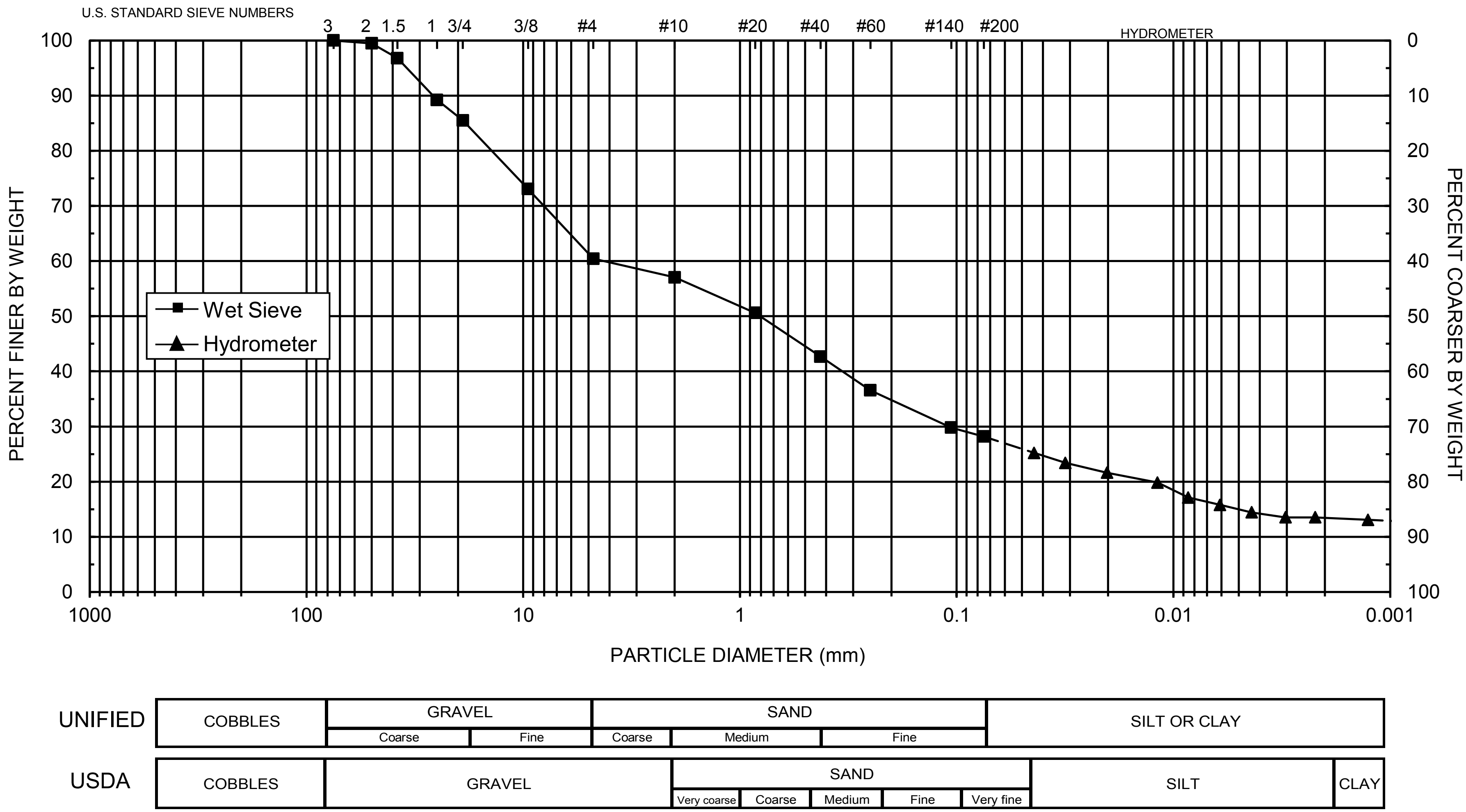
Job Name:	Hydrometrics, Inc.	*Type of Water Used:*	DISTILLED
Job Number:	LB14.0168.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	VVL Composite 16-20	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	VVL Composite Samples	*Assumed particle density:*	2.65
PO Number:	12015	*Initial Wt. (g):*	67.19
Test Date:	26-Aug-14	*Total Sample Wt. (g):*	46745.40
Start Time:	9:06	*Wt. Passing #4 (g):*	28253.52

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.4	34.0	6.0	28.0	10.7	0.04386	41.7	25.2
	2	21.4	32.0	6.0	26.0	11.1	0.03149	38.7	23.4
	5	21.4	30.0	6.0	24.0	11.4	0.02021	35.7	21.6
	15	21.5	28.0	6.0	22.0	11.7	0.01183	32.8	19.8
	30	21.5	25.0	6.0	19.0	12.2	0.00853	28.3	17.1
	60	21.5	23.5	6.0	17.5	12.4	0.00609	26.1	15.8
	120	21.5	22.0	6.0	16.0	12.7	0.00435	23.9	14.4
	250	21.4	21.0	6.0	15.0	12.9	0.00304	22.4	13.5
	471	21.4	21.0	6.0	15.0	12.9	0.00221	22.4	13.5
27-Aug-14	1449	21.4	20.5	6.0	14.5	12.9	0.00127	21.6	13.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **2.8E-05**	d_{30} = **0.11**	d_{50} = **0.81**	d_{60} = **4.2**	C_u = **1.5E+05**	C_c = **103**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite 16-20	**12015**	**Clayey gravel with sand (GC)s**	**Sandy Clay Loam** †

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 45742.40
Weight Passing #4 (g): 27411.98
Weight Retained #4 (g): 18330.42
Weight of Hydrometer Sample (g): 64.42
Calculated Weight of Sieve Sample (g): 107.50

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	45742.40	100.00
	2"	50	2331.12	2331.12	43411.28	94.90
	1.5"	38.1	1923.92	4255.04	41487.36	90.70
	1"	25	3223.75	7478.79	38263.61	83.65
	3/4"	19.0	1907.88	9386.67	36355.73	79.48
	3/8"	9.5	5658.41	15045.08	30697.32	67.11
	4	4.75	3285.34	18330.42	27411.98	59.93
-4			(Based on calculated sieve wt.)			
	10	2.00	3.92	47.00	60.50	56.28
	20	0.85	7.13	54.13	53.37	49.65
	40	0.425	7.82	61.95	45.55	42.37
	60	0.250	6.06	68.01	39.49	36.74
	140	0.106	6.64	74.65	32.85	30.56
	200	0.075	1.74	76.39	31.11	28.94
	dry pan		0.36	76.75	30.75	
	wet pan			30.75	0.00	

d_{10} (mm): 0.00020
d_{16} (mm): 0.0032
d_{30} (mm): 0.094
d_{50} (mm): 0.89
d_{60} (mm): 4.8
d_{84} (mm): 26

Median Particle Diameter --d_{50} (mm): 0.89
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 2.4E+04
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 9.2
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 9.0

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Clayey gravel with sand (GC)s
USDA Soil Classification: Sandy Clay Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 21-30
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

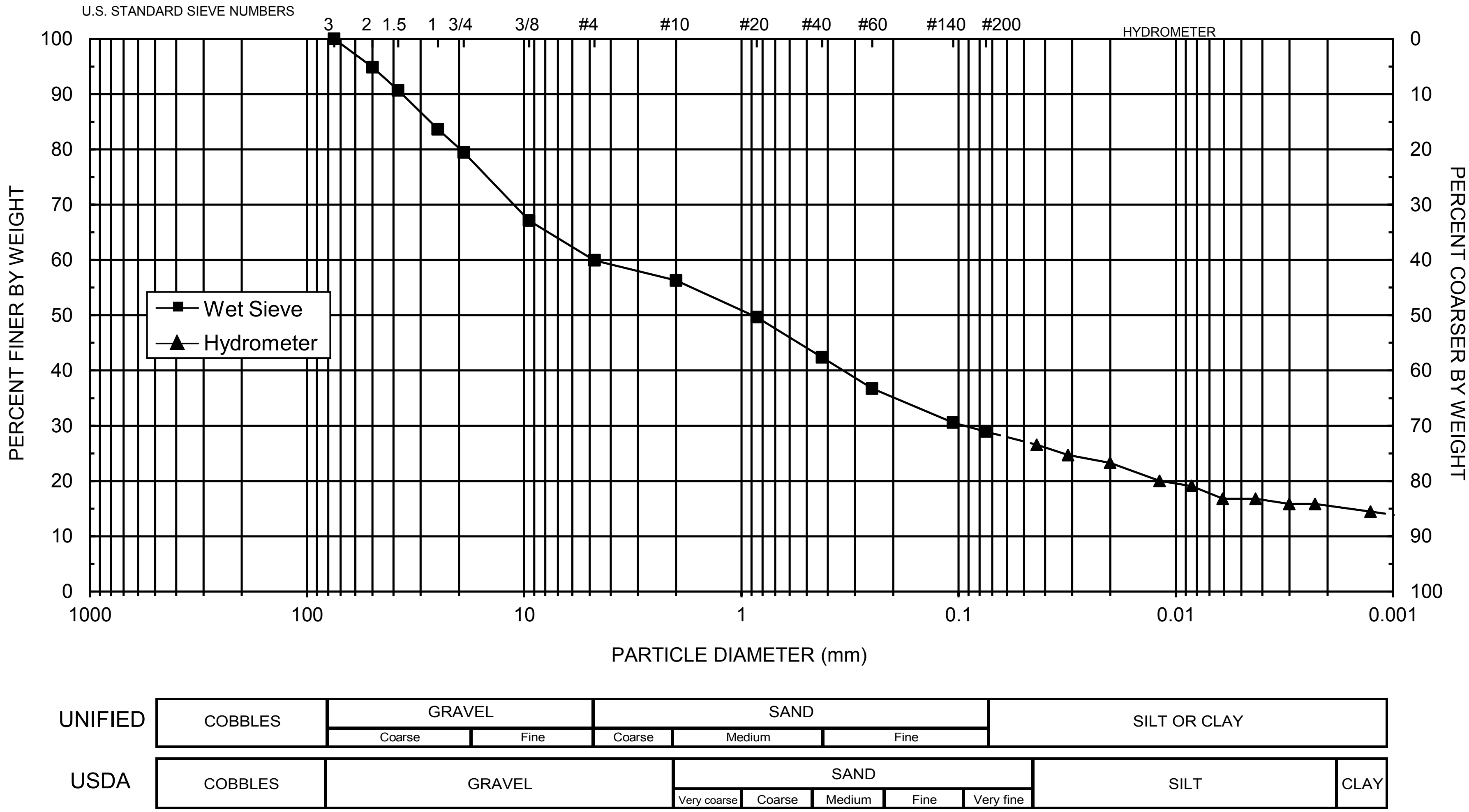
Initial Wt. (g): 64.42
Total Sample Wt. (g): 45742.40
Wt. Passing #4 (g): 27411.98

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	34.5	6.0	28.5	10.6	0.04364	44.3	26.5
	2	21.5	32.5	6.0	26.5	11.0	0.03133	41.2	24.7
	5	21.5	31.0	6.0	25.0	11.2	0.02005	38.9	23.3
	15	21.4	27.5	6.0	21.5	11.8	0.01187	33.4	20.0
	30	21.4	26.5	6.0	20.5	12.0	0.00845	31.9	19.1
	60	21.5	24.0	6.0	18.0	12.4	0.00607	28.0	16.8
	120	21.5	24.0	6.0	18.0	12.4	0.00429	28.0	16.8
	250	21.4	23.0	6.0	17.0	12.5	0.00300	26.4	15.8
	431	21.4	23.0	6.0	17.0	12.5	0.00228	26.4	15.8
27-Aug-14	1423	21.4	21.5	6.0	15.5	12.8	0.00127	24.1	14.4

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.00020**	d_{30} = **0.094**	d_{50} = **0.89**	d_{60} = **4.8**	C_u = **2.4E+04**	C_c = **9.2**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite 21-30	**12015**	**Clayey gravel with sand (GC)s**	**Sandy Clay Loam** †

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 38759.70
Weight Passing #4 (g): 31712.72
Weight Retained #4 (g): 7046.98
Weight of Hydrometer Sample (g): 51.03
Calculated Weight of Sieve Sample (g): 62.37

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	38759.70	100.00
	2"	50	741.04	741.04	38018.66	98.09
	1.5"	38.1	1188.51	1929.55	36830.15	95.02
	1"	25	1814.33	3743.88	35015.82	90.34
	3/4"	19.0	915.68	4659.56	34100.14	87.98
	3/8"	9.5	1605.74	6265.30	32494.40	83.84
	4	4.75	781.68	7046.98	31712.72	81.82
-4			(Based on calculated sieve wt.)			
	10	2.00	2.10	13.44	48.93	78.45
	20	0.85	2.07	15.51	46.86	75.13
	40	0.425	2.01	17.52	44.85	71.91
	60	0.250	2.00	19.52	42.85	68.70
	140	0.106	3.54	23.06	39.31	63.03
	200	0.075	1.61	24.67	37.70	60.45
	dry pan		0.29	24.96	37.41	
	wet pan			37.41	0.00	

d_{10} (mm): 2.3E-10
d_{16} (mm): 1.5E-08
d_{30} (mm): 0.00028
d_{50} (mm): 0.021
d_{60} (mm): 0.058
d_{84} (mm): 9.8

Median Particle Diameter -- d_{50} (mm): 0.021
Uniformity Coefficient, Cu -- $[d_{60}/d_{10}]$ (mm): 2.5E+08
Coefficient of Curvature, Cc -- $[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 5877
Mean Particle Diameter -- $[(d_{16}+d_{50}+d_{84})/3]$ (mm): 3.3

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Sandy fat clay with gravel s(CH)g
USDA Soil Classification: Clay †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 31+
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

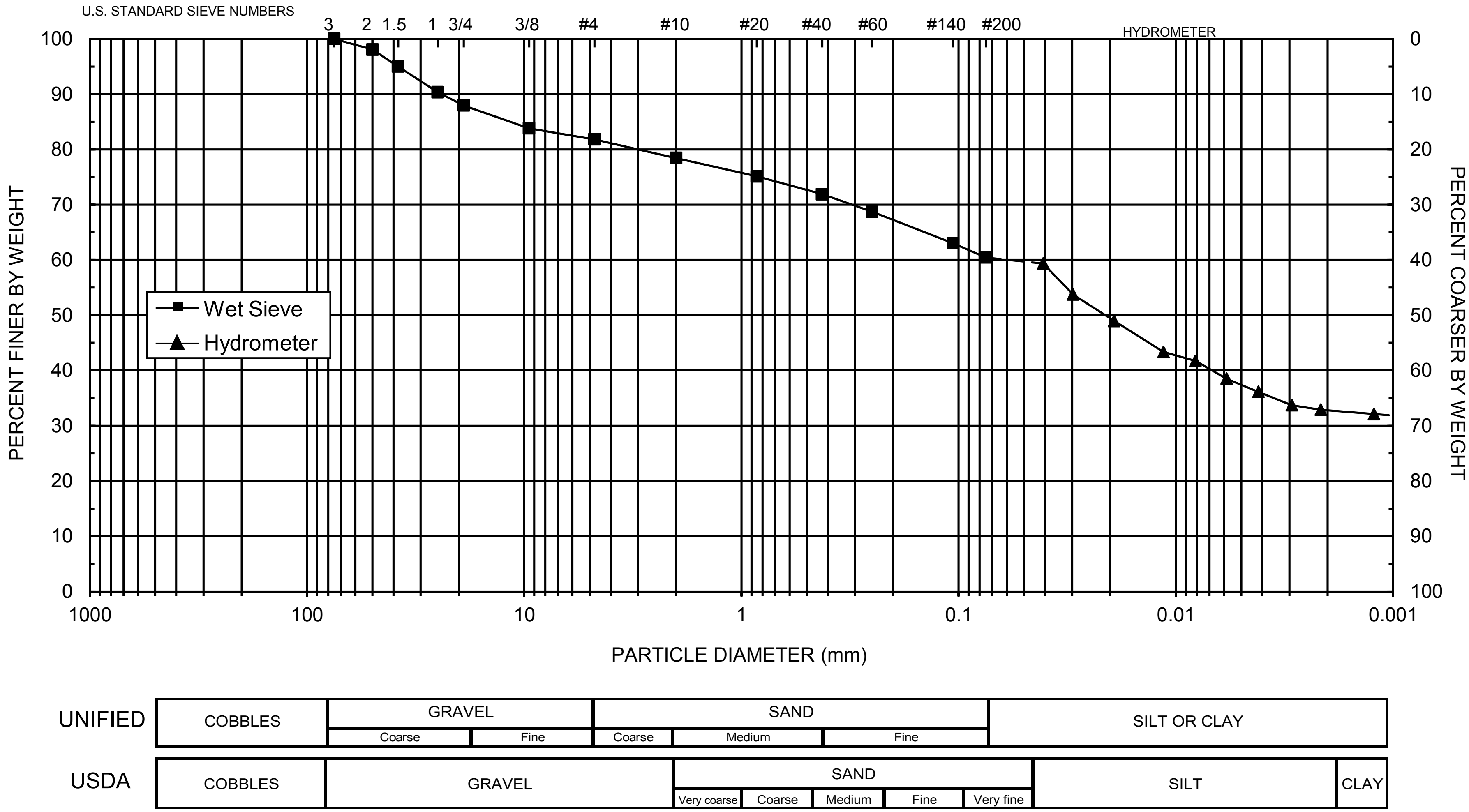
Initial Wt. (g): 51.03
Total Sample Wt. (g): 38759.70
Wt. Passing #4 (g): 31712.72

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.4	43.0	6.0	37.0	9.3	0.04073	72.5	59.4
	2	21.4	39.5	6.0	33.5	9.8	0.02968	65.7	53.7
	5	21.5	36.5	6.0	30.5	10.3	0.01923	59.8	49.0
	15	21.5	33.0	6.0	27.0	10.9	0.01140	53.0	43.3
	30	21.5	32.0	6.0	26.0	11.1	0.00812	51.0	41.7
	60	21.4	30.0	6.0	24.0	11.4	0.00583	47.1	38.5
	120	21.5	28.5	6.0	22.5	11.6	0.00416	44.2	36.1
	250	21.4	27.0	6.0	21.0	11.9	0.00292	41.2	33.7
	466	21.4	26.5	6.0	20.5	12.0	0.00215	40.2	32.9
27-Aug-14	1444	21.4	26.0	6.0	20.0	12.0	0.00122	39.2	32.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **2.3E-10**	d_{30} = **0.00028**	d_{50} = **0.021**	d_{60} = **0.058**	C_u = **2.5E+08**	C_c = **5877**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite 31+	**12015**	**Sandy fat clay with gravel s(CH)g**	**Clay †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 49431.50
Weight Passing #4 (g): 32599.59
Weight Retained #4 (g): 16831.91
Weight of Hydrometer Sample (g): 50.78
Calculated Weight of Sieve Sample (g): 77.00

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	49431.50	100.00
	2"	50	2970.88	2970.88	46460.62	93.99
	1.5"	38.1	2128.74	5099.62	44331.88	89.68
	1"	25	3658.05	8757.67	40673.83	82.28
	3/4"	19.0	1911.54	10669.21	38762.29	78.42
	3/8"	9.5	2319.17	12988.38	36443.12	73.72
	4	4.75	3843.53	16831.91	32599.59	65.95
-4			(Based on calculated sieve wt.)			
	10	2.00	2.24	28.46	48.54	63.04
	20	0.85	6.36	34.82	42.18	54.78
	40	0.425	8.93	43.75	33.25	43.18
	60	0.250	6.58	50.33	26.67	34.64
	140	0.106	7.92	58.25	18.75	24.35
	200	0.075	2.10	60.35	16.65	21.62
	dry pan		0.74	61.09	15.91	
	wet pan			15.91	0.00	

d_{10} (mm): 0.0082 d_{50} (mm): 0.64
d_{16} (mm): 0.036 d_{60} (mm): 1.5
d_{30} (mm): 0.17 d_{84} (mm): 28

Median Particle Diameter --d_{50} (mm): 0.64
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 183
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2.3
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 9.6

Classification of fines: CL

ASTM Soil Classification: Clayey sand with gravel (SC)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:18

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

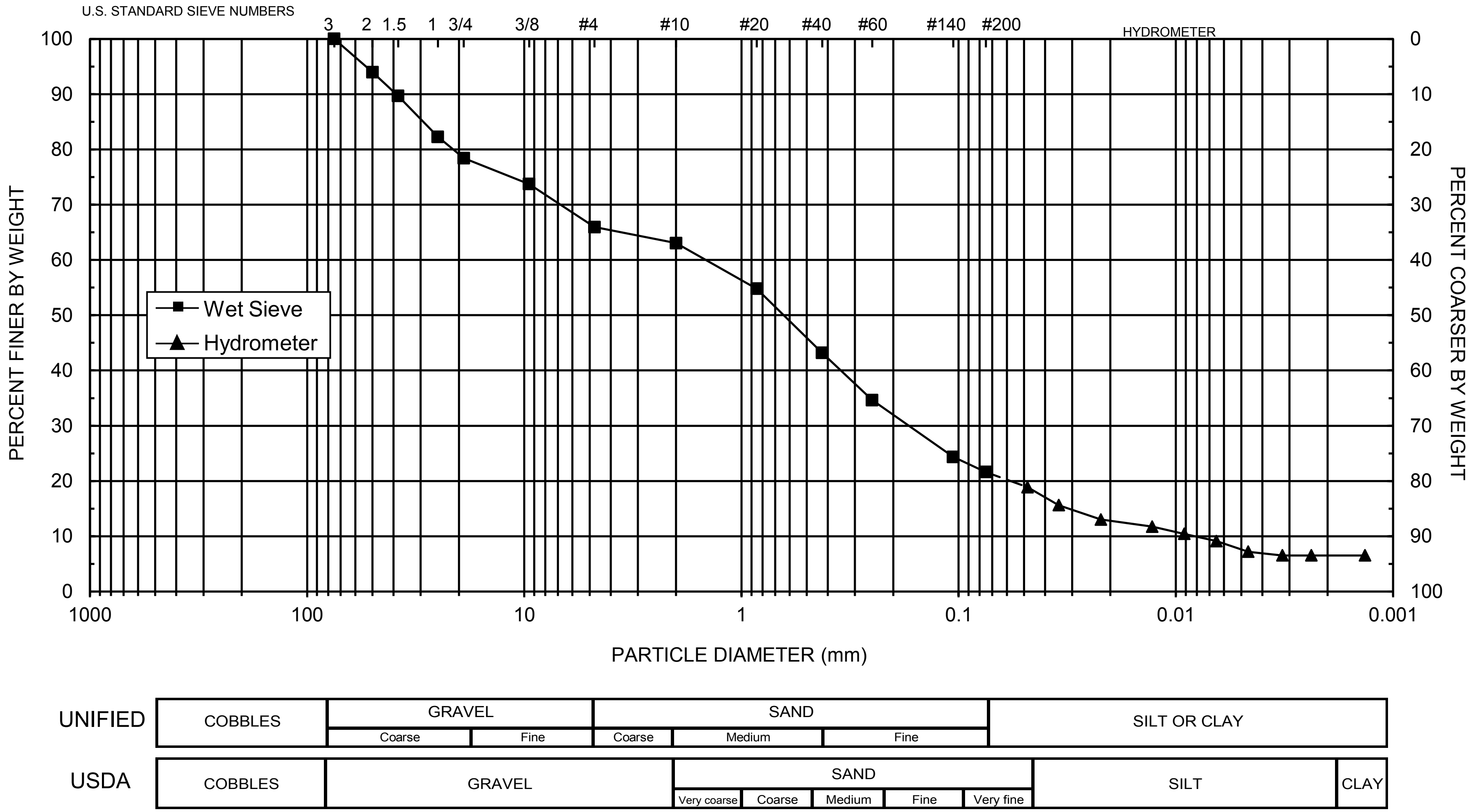
Initial Wt. (g): 50.78
Total Sample Wt. (g): 49431.50
Wt. Passing #4 (g): 32599.59

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	20.5	6.0	14.5	12.9	0.04815	28.6	18.9
	2	21.5	18.0	6.0	12.0	13.3	0.03458	23.7	15.6
	5	21.5	16.0	6.0	10.0	13.7	0.02214	19.8	13.0
	15	21.5	15.0	6.0	9.0	13.8	0.01285	17.8	11.7
	30	21.5	14.0	6.0	8.0	14.0	0.00914	15.8	10.4
	60	21.4	13.0	6.0	7.0	14.2	0.00651	13.8	9.1
	120	21.5	11.5	6.0	5.5	14.4	0.00464	10.9	7.2
	250	21.4	11.0	6.0	5.0	14.5	0.00323	9.9	6.5
	461	21.4	11.0	6.0	5.0	14.5	0.00237	9.9	6.5
27-Aug-14	1439	21.4	11.0	6.0	5.0	14.5	0.00134	9.9	6.5

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.0082**	d_{30} = **0.17**	d_{50} = **0.64**	d_{60} = **1.5**	C_u = **183**	C_c = **2.3**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite TP-10	**12015**	**Clayey sand with gravel (SC)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 50102.30
Weight Passing #4 (g): 31847.26
Weight Retained #4 (g): 18255.04
Weight of Hydrometer Sample (g): 66.12
Calculated Weight of Sieve Sample (g): 104.02

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	50102.30	100.00
	2"	50	464.09	464.09	49638.21	99.07
	1.5"	38.1	2822.07	3286.16	46816.14	93.44
	1"	25	4675.36	7961.52	42140.78	84.11
	3/4"	19.0	1865.31	9826.83	40275.47	80.39
	3/8"	9.5	4844.84	14671.67	35430.63	70.72
	4	4.75	3583.37	18255.04	31847.26	63.56
-4			(Based on calculated sieve wt.)			
	10	2.00	3.47	41.37	62.65	60.23
	20	0.85	7.07	48.44	55.58	53.43
	40	0.425	8.35	56.79	47.23	45.40
	60	0.250	7.18	63.97	40.05	38.50
	140	0.106	6.94	70.91	33.11	31.83
	200	0.075	1.82	72.73	31.29	30.08
	dry pan		0.30	73.03	30.99	
	wet pan			30.99	0.00	

d_{10} (mm): 1.2E-06
d_{16} (mm): 0.0014
d_{30} (mm): 0.072
d_{50} (mm): 0.63
d_{60} (mm): 1.9
d_{84} (mm): 25

Median Particle Diameter --d_{50} (mm): 0.63
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 1.6E+06
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 2274
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 8.5

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Clayey gravel with sand (GC)s
USDA Soil Classification: Sandy Clay Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

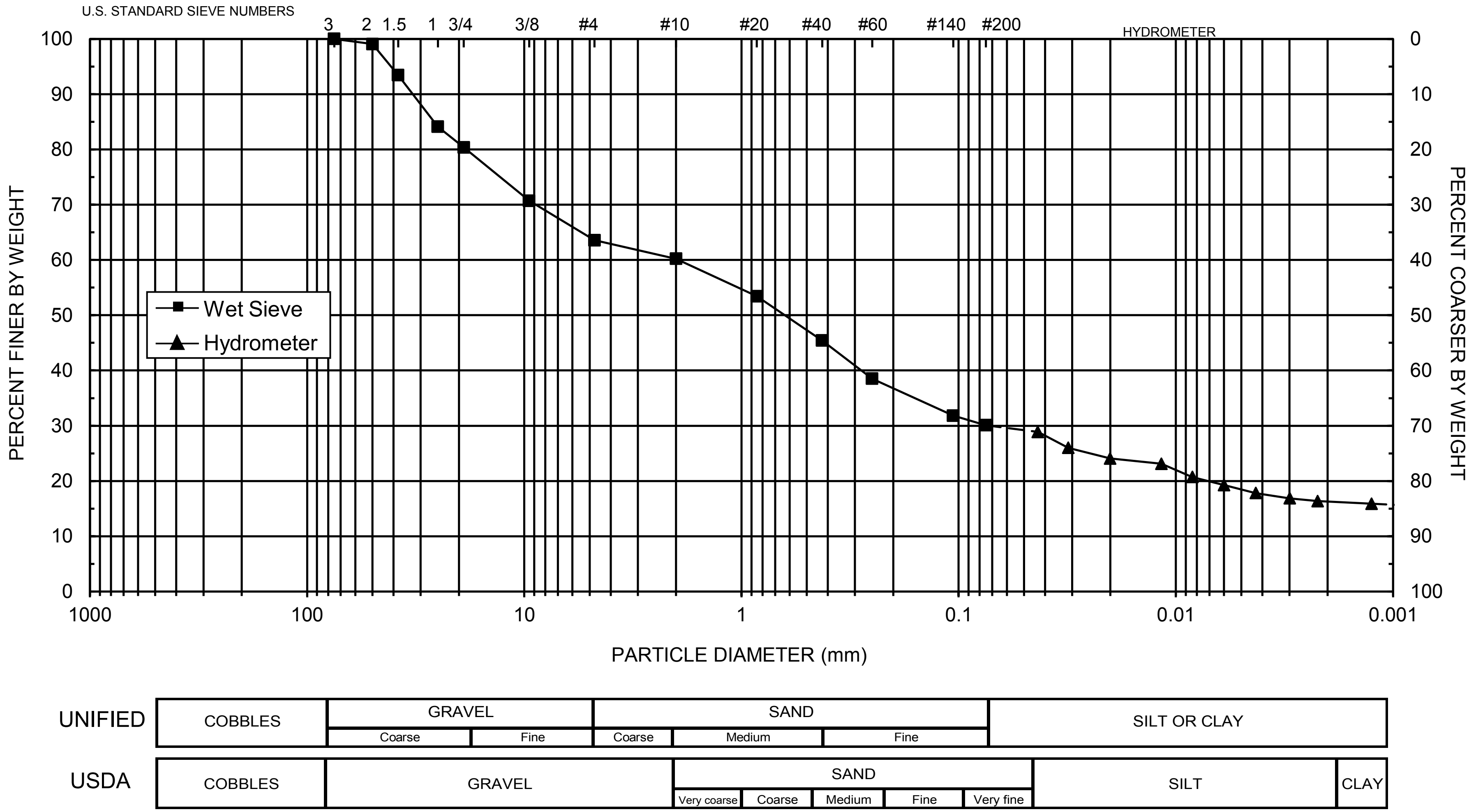
Initial Wt. (g): 66.12
Total Sample Wt. (g): 50102.30
Wt. Passing #4 (g): 31847.26

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	36.0	6.0	30.0	10.4	0.04314	45.4	28.9
	2	21.5	33.0	6.0	27.0	10.9	0.03121	40.9	26.0
	5	21.5	31.0	6.0	25.0	11.2	0.02004	37.9	24.1
	15	21.5	30.0	6.0	24.0	11.4	0.01165	36.3	23.1
	30	21.5	27.5	6.0	21.5	11.8	0.00839	32.6	20.7
	60	21.4	26.0	6.0	20.0	12.0	0.00600	30.3	19.2
	120	21.5	24.5	6.0	18.5	12.3	0.00428	28.0	17.8
	250	21.5	23.5	6.0	17.5	12.4	0.00298	26.5	16.8
	456	21.4	23.0	6.0	17.0	12.5	0.00222	25.7	16.4
27-Aug-14	1435	21.4	22.5	6.0	16.5	12.6	0.00126	25.0	15.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **1.2E-06**	d_{30} = **0.072**	d_{50} = **0.63**	d_{60} = **1.9**	C_u = **1.6E+06**	C_c = **2274**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite TP-12	**12015**	**Clayey gravel with sand (GC)s**	**Sandy Clay Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name:	Hydrometrics, Inc.	*Initial Dry Weight of Sample (g):*	40176.50
Job Number:	LB14.0168.00	*Weight Passing #4 (g):*	28546.92
Sample Number:	VVL Composite TP-13	*Weight Retained #4 (g):*	11629.58
Project Name:	VVL Composite Samples	*Weight of Hydrometer Sample (g):*	54.65
PO Number:	12015	*Calculated Weight of Sieve Sample (g):*	76.91
Test Date:	3-Sep-14	*Shape:*	Rounded
		Hardness:	Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	40176.50	100.00
	2"	50	808.64	808.64	39367.86	97.99
	1.5"	38.1	1303.26	2111.90	38064.60	94.74
	1"	25	2175.67	4287.57	35888.93	89.33
	3/4"	19.0	990.64	5278.21	34898.29	86.86
	3/8"	9.5	3730.51	9008.72	31167.78	77.58
	4	4.75	2620.86	11629.58	28546.92	71.05
-4			(Based on calculated sieve wt.)			
	10	2.00	3.98	26.24	50.67	65.88
	20	0.85	6.39	32.63	44.28	57.57
	40	0.425	7.26	39.89	37.02	48.13
	60	0.250	5.03	44.92	31.99	41.59
	140	0.106	5.13	50.05	26.86	34.92
	200	0.075	1.29	51.34	25.57	33.25
	dry pan		0.34	51.68	25.23	
	wet pan			25.23	0.00	

d_{10} (mm):	0.00038	d_{50} (mm):	0.49
d_{16} (mm):	0.0014	d_{60} (mm):	1.1
d_{30} (mm):	0.043	d_{84} (mm):	15

Median Particle Diameter --d_{50} (mm): 0.49

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 2895

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 4.4

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 5.2

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Clayey sand with gravel (SC)g

USDA Soil Classification: Sandy Clay Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant*: $(NaPO_3)_6$
Assumed particle density: 2.65

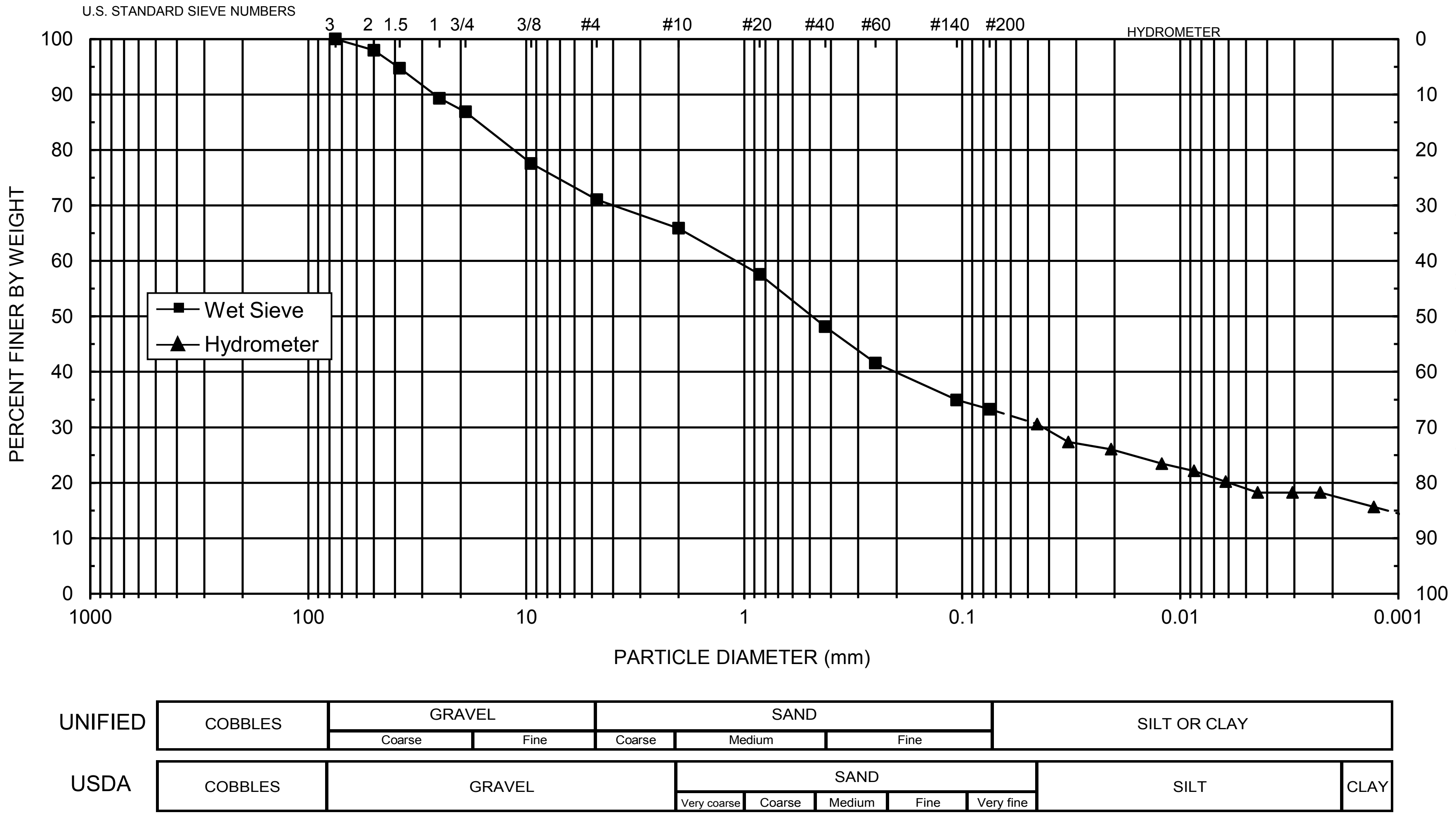
Initial Wt. (g): 54.65
Total Sample Wt. (g): 40176.50
Wt. Passing #4 (g): 28546.92

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	29.5	6.0	23.5	11.5	0.04529	43.1	30.6
	2	21.5	27.0	6.0	21.0	11.9	0.03259	38.5	27.3
	5	21.5	26.0	6.0	20.0	12.0	0.02076	36.7	26.0
	15	21.5	24.0	6.0	18.0	12.4	0.01215	33.0	23.4
	30	21.5	23.0	6.0	17.0	12.5	0.00865	31.2	22.1
	60	21.4	21.5	6.0	15.5	12.8	0.00618	28.4	20.2
	120	21.5	20.0	6.0	14.0	13.0	0.00441	25.7	18.2
	250	21.5	20.0	6.0	14.0	13.0	0.00305	25.7	18.2
	451	21.4	20.0	6.0	14.0	13.0	0.00228	25.7	18.2
27-Aug-14	1430	21.4	18.0	6.0	12.0	13.3	0.00129	22.0	15.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.00038**	d_{30} = **0.043**	d_{50} = **0.49**	d_{60} = **1.1**	C_u = **2895**	C_c = **4.4**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
VVL Composite TP-13	**12015**	**Clayey sand with gravel (SC)g**	**Sandy Clay Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 21015.60
Weight Passing #4 (g): 18417.80
Weight Retained #4 (g): 2597.80
Weight of Hydrometer Sample (g): 60.40
Calculated Weight of Sieve Sample (g): 68.92

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	21015.60	100.00
	2"	50	0.00	0.00	21015.60	100.00
	1.5"	38.1	83.67	83.67	20931.93	99.60
	1"	25	782.19	865.86	20149.74	95.88
	3/4"	19.0	227.82	1093.68	19921.92	94.80
	3/8"	9.5	748.95	1842.63	19172.97	91.23
	4	4.75	755.17	2597.80	18417.80	87.64
-4			(Based on calculated sieve wt.)			
	10	2.00	3.29	11.81	57.11	82.87
	20	0.85	4.18	15.99	52.93	76.80
	40	0.425	5.35	21.34	47.58	69.04
	60	0.250	5.34	26.68	42.24	61.29
	140	0.106	6.91	33.59	35.33	51.26
	200	0.075	2.69	36.28	32.64	47.36
	dry pan		0.50	36.78	32.14	
	wet pan			32.14	0.00	

d_{10} (mm): 0.0013
d_{16} (mm): 0.0044
d_{30} (mm): 0.030
d_{50} (mm): 0.095
d_{60} (mm): 0.22
d_{84} (mm): 2.5

Median Particle Diameter --d_{50} (mm): 0.095
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 169
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 3.1
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.87

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Clayey sand (SC)
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 27-Aug-14
Start Time: 10:00

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

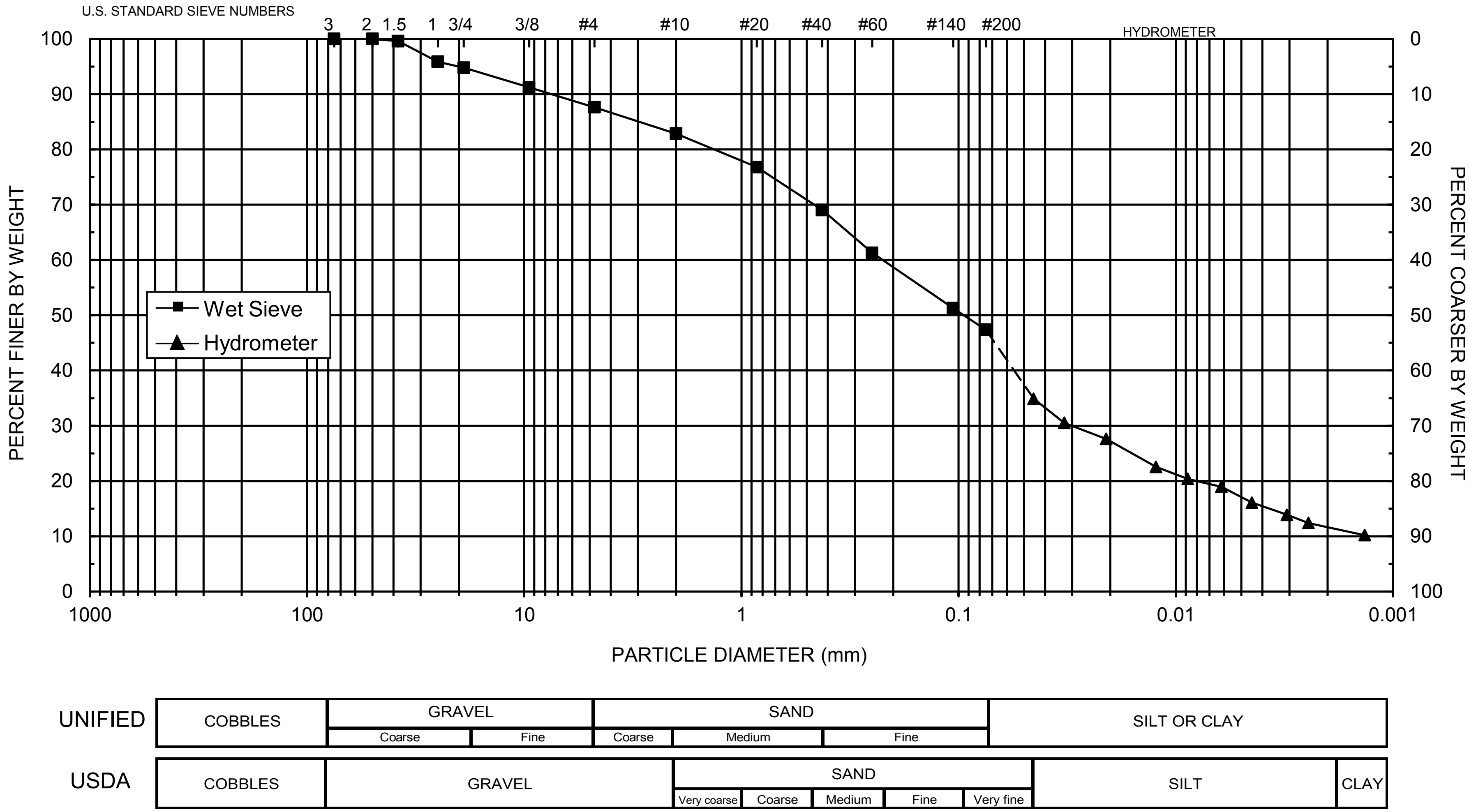
Initial Wt. (g): 60.40
Total Sample Wt. (g): 21015.60
Wt. Passing #4 (g): 18417.80

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
27-Aug-14	1	21.5	30.0	6.0	24.0	11.4	0.04513	39.8	34.9
	2	21.5	27.0	6.0	21.0	11.9	0.03259	34.8	30.5
	5	21.5	25.0	6.0	19.0	12.2	0.02090	31.5	27.6
	15	21.6	21.5	6.0	15.5	12.8	0.01234	25.7	22.5
	30	21.6	20.0	6.0	14.1	13.0	0.00880	23.3	20.4
	62	21.6	19.0	6.0	13.1	13.2	0.00616	21.6	18.9
	121	21.7	17.0	5.9	11.1	13.5	0.00446	18.3	16.1
	259	21.7	15.5	5.9	9.6	13.8	0.00308	15.8	13.9
	416	21.5	14.5	6.0	8.5	13.9	0.00245	14.1	12.4
28-Aug-14	1399	21.4	13.0	6.0	7.0	14.2	0.00135	11.6	10.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.0013**	d_{30} = **0.030**	d_{50} = **0.095**	d_{60} = **0.22**	C_u = **169**	C_c = **3.1**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
WB Borrow-1	**12015**	**Clayey sand (SC)**	**Sandy Loam** †

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name:	Hydrometrics, Inc.	*Initial Dry Weight of Sample (g):*	19965.00
Job Number:	LB14.0168.00	*Weight Passing #4 (g):*	18221.55
Sample Number:	WB Stockpile-1	*Weight Retained #4 (g):*	1743.45
Project Name:	VVL Composite Samples	*Weight of Hydrometer Sample (g):*	58.16
PO Number:	12015	*Calculated Weight of Sieve Sample (g):*	63.72
Test Date:	3-Sep-14	*Shape:*	Angular
		Hardness:	Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	19965.00	100.00
	2"	50	0.00	0.00	19965.00	100.00
	1.5"	38.1	110.93	110.93	19854.07	99.44
	1"	25	287.18	398.11	19566.89	98.01
	3/4"	19.0	318.60	716.71	19248.29	96.41
	3/8"	9.5	495.43	1212.14	18752.86	93.93
	4	4.75	531.31	1743.45	18221.55	91.27
-4			(Based on calculated sieve wt.)			
	10	2.00	1.81	7.37	56.35	88.43
	20	0.85	2.64	10.01	53.71	84.28
	40	0.425	3.75	13.76	49.96	78.40
	60	0.250	3.45	17.21	46.51	72.99
	140	0.106	4.80	22.01	41.71	65.45
	200	0.075	2.07	24.08	39.64	62.20
	dry pan		0.68	24.76	38.96	
	wet pan			38.96	0.00	

d_{10} (mm):	0.00028	d_{50} (mm):	0.035
d_{16} (mm):	0.0025	d_{60} (mm):	0.063
d_{30} (mm):	0.013	d_{84} (mm):	0.82

Median Particle Diameter --d_{50} (mm): 0.035

Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 225

Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 9.6

Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.29

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Sandy lean clay s(CL)

USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher

Data entered by: C. Krous

Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

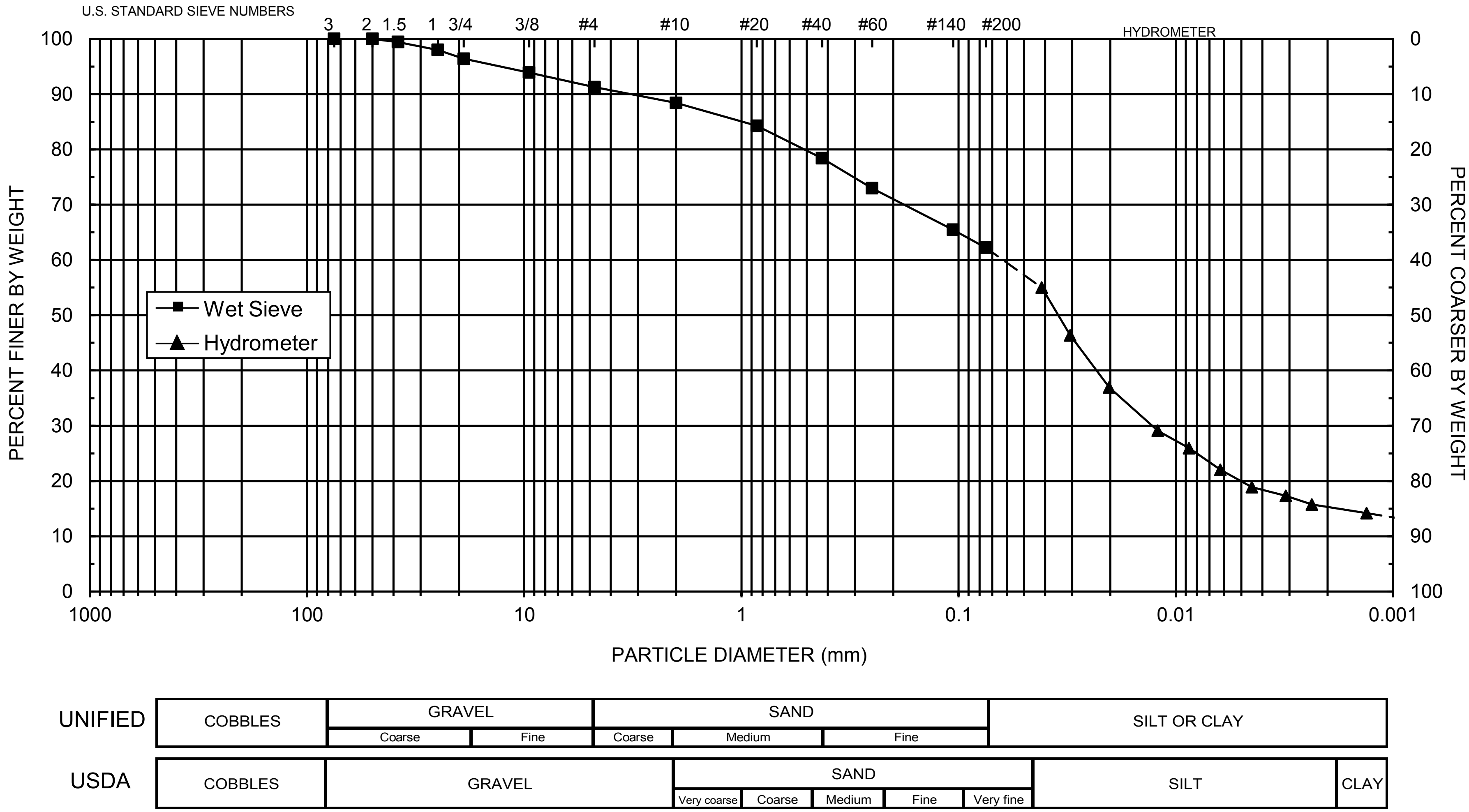
Job Name:	Hydrometrics, Inc.	*Type of Water Used:*	DISTILLED
Job Number:	LB14.0168.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	WB Stockpile-1	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	VVL Composite Samples	*Assumed particle density:*	2.65
PO Number:	12015	*Initial Wt. (g):*	58.16
Test Date:	26-Aug-14	*Total Sample Wt. (g):*	19965.00
Start Time:	9:42	*Wt. Passing #4 (g):*	18221.55

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	41.0	6.0	35.0	9.6	0.04140	60.2	55.0
	2	21.5	35.5	6.0	29.5	10.5	0.03062	50.8	46.3
	5	21.5	29.5	6.0	23.5	11.5	0.02026	40.5	36.9
	15	21.5	24.5	6.0	18.5	12.3	0.01211	31.9	29.1
	30	21.4	22.5	6.0	16.5	12.6	0.00868	28.4	25.9
	60	21.5	20.0	6.0	14.0	13.0	0.00623	24.1	22.0
	120	21.5	18.0	6.0	12.0	13.3	0.00446	20.7	18.9
	250	21.4	17.0	6.0	11.0	13.5	0.00311	18.9	17.3
	441	21.4	16.0	6.0	10.0	13.7	0.00236	17.2	15.7
27-Aug-14	1422	21.4	15.0	6.0	9.0	13.8	0.00132	15.5	14.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.00028**	d_{30} = **0.013**	d_{50} = **0.035**	d_{60} = **0.063**	C_u = **225**	C_c = **9.6**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
WB Stockpile-1	**12015**	**Sandy lean clay s(CL)**	**Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 23971.00
Weight Passing #4 (g): 18117.64
Weight Retained #4 (g): 5853.36
Weight of Hydrometer Sample (g): 59.40
Calculated Weight of Sieve Sample (g): 78.59

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	23971.00	100.00
	2"	50	187.62	187.62	23783.38	99.22
	1.5"	38.1	867.05	1054.67	22916.33	95.60
	1"	25	2498.89	3553.56	20417.44	85.18
	3/4"	19.0	1357.89	4911.45	19059.55	79.51
	3/8"	9.5	493.55	5405.00	18566.00	77.45
	4	4.75	448.36	5853.36	18117.64	75.58
-4			(Based on calculated sieve wt.)			
	10	2.00	1.92	21.11	57.48	73.14
	20	0.85	3.79	24.90	53.69	68.32
	40	0.425	4.39	29.29	49.30	62.73
	60	0.250	3.65	32.94	45.65	58.09
	140	0.106	5.36	38.30	40.29	51.27
	200	0.075	2.21	40.51	38.08	48.45
	dry pan		0.65	41.16	37.43	
	wet pan			37.43	0.00	

d_{10} (mm): 0.0011 d_{50} (mm): 0.091
d_{16} (mm): 0.0049 d_{60} (mm): 0.31
d_{30} (mm): 0.026 d_{84} (mm): 24

Median Particle Diameter --d_{50} (mm): 0.091
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 282
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10} * d_{60})$] (mm): 2.0
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 8.0

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Clayey sand with gravel (SC)g
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

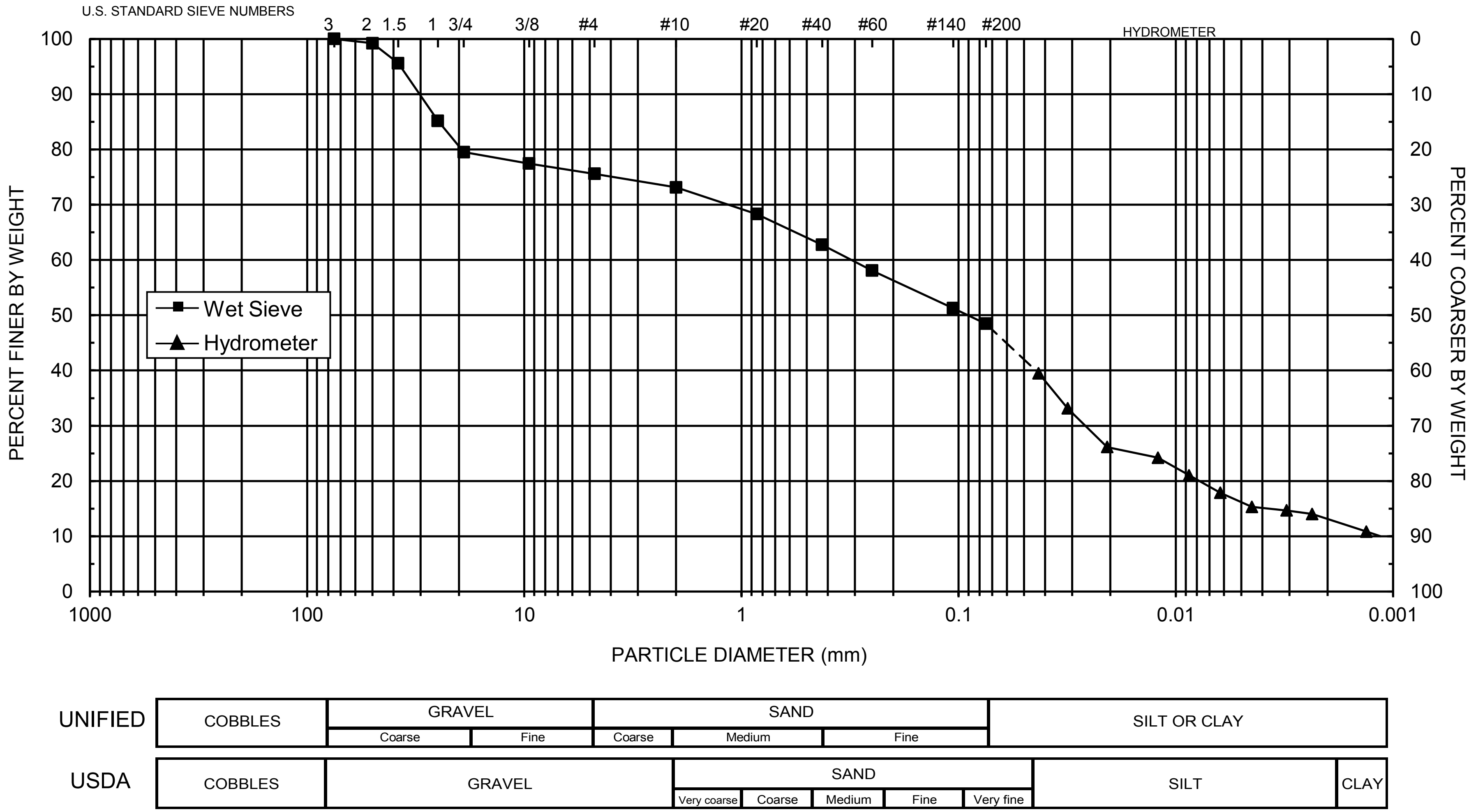
Initial Wt. (g): 59.40
Total Sample Wt. (g): 23971.00
Wt. Passing #4 (g): 18117.64

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	37.0	6.0	31.0	10.2	0.04279	52.2	39.5
	2	21.5	32.0	6.0	26.0	11.1	0.03145	43.8	33.1
	5	21.5	26.5	6.0	20.5	12.0	0.02069	34.6	26.1
	15	21.4	25.0	6.0	19.0	12.2	0.01208	32.0	24.2
	30	21.4	22.5	6.0	16.5	12.6	0.00868	27.8	21.0
	60	21.5	20.0	6.0	14.0	13.0	0.00623	23.6	17.9
	120	21.5	18.0	6.0	12.0	13.3	0.00446	20.3	15.3
	253	21.4	17.5	6.0	11.5	13.4	0.00309	19.4	14.7
	436	21.4	17.0	6.0	11.0	13.5	0.00236	18.6	14.0
27-Aug-14	1423	21.4	14.5	6.0	8.5	13.9	0.00132	14.3	10.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.0011**	d_{30} = **0.026**	d_{50} = **0.091**	d_{60} = **0.31**	C_u = **282**	C_c = **2.0**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
WB Stockpile-2	**12015**	**Clayey sand with gravel (SC)g**	**Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#4 Split)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: Topsoil-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 3-Sep-14

Initial Dry Weight of Sample (g): 13376.20
Weight Passing #4 (g): 13316.24
Weight Retained #4 (g): 59.96
Weight of Hydrometer Sample (g): 60.44
Calculated Weight of Sieve Sample (g): 60.71

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+4						
	3"	75	0.00	0.00	13376.20	100.00
	2"	50	0.00	0.00	13376.20	100.00
	1.5"	38.1	0.00	0.00	13376.20	100.00
	1"	25	0.00	0.00	13376.20	100.00
	3/4"	19.0	0.00	0.00	13376.20	100.00
	3/8"	9.5	12.81	12.81	13363.39	99.90
	4	4.75	47.15	59.96	13316.24	99.55
-4			(Based on calculated sieve wt.)			
	10	2.00	1.89	2.16	58.55	96.44
	20	0.85	2.12	4.28	56.43	92.95
	40	0.425	2.02	6.30	54.41	89.62
	60	0.250	3.19	9.49	51.22	84.37
	140	0.106	10.06	19.55	41.16	67.80
	200	0.075	3.75	23.30	37.41	61.62
	dry pan		0.89	24.19	36.52	
	wet pan			36.52	0.00	

d_{10} (mm): 0.0036
d_{16} (mm): 0.0059
d_{30} (mm): 0.018
d_{50} (mm): 0.047
d_{60} (mm): 0.070
d_{84} (mm): 0.25

Median Particle Diameter --d_{50} (mm): 0.047
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 19
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.3
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.10

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Loam

Laboratory analysis by: J. Fisher
Data entered by: C. Krous
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: Topsoil-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 26-Aug-14
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

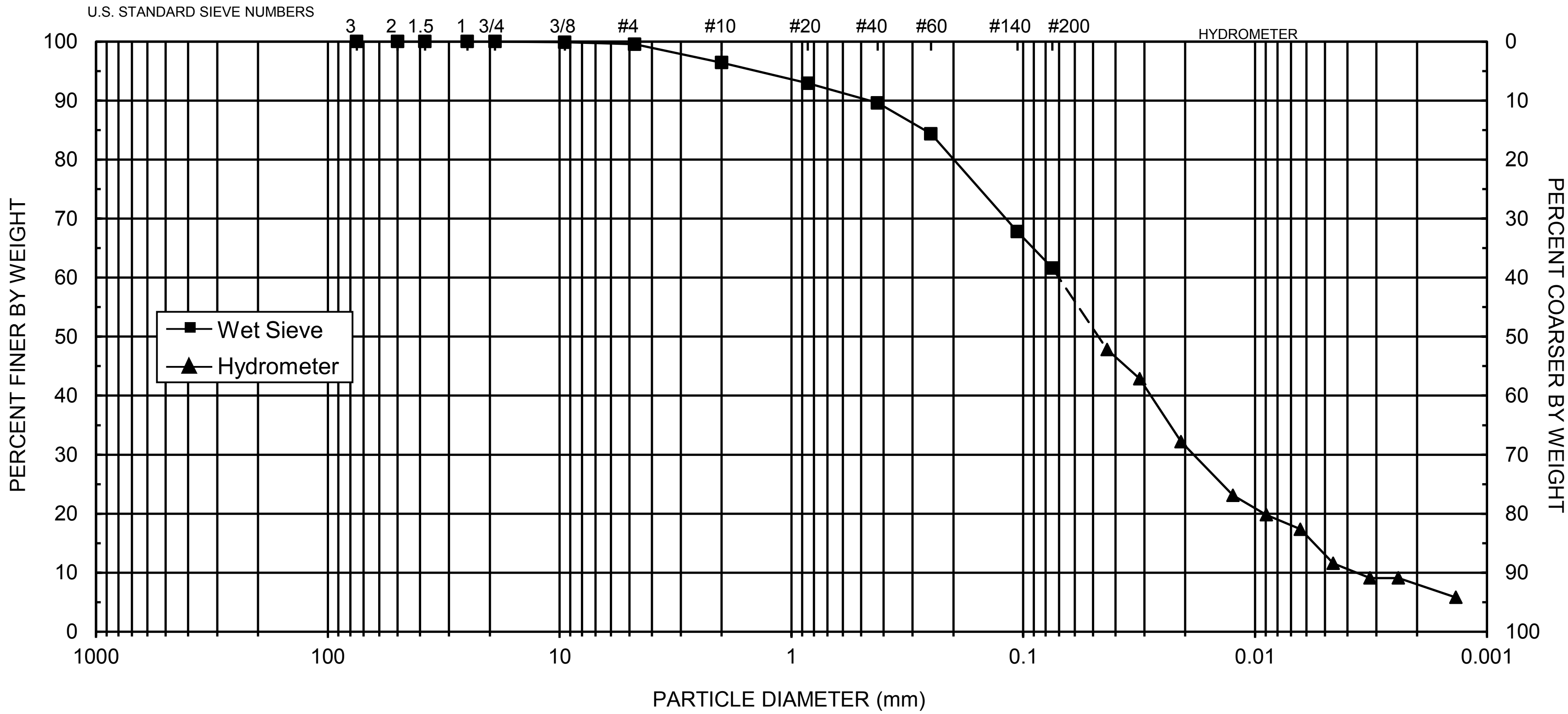
Initial Wt. (g): 60.44
Total Sample Wt. (g): 13376.20
Wt. Passing #4 (g): 13316.24

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
26-Aug-14	1	21.5	35.0	6.0	29.0	10.6	0.04347	48.0	47.8
	2	21.5	32.0	6.0	26.0	11.1	0.03145	43.1	42.9
	5	21.5	25.5	6.0	19.5	12.1	0.02083	32.3	32.2
	15	21.5	20.0	6.0	14.0	13.0	0.01246	23.2	23.1
	30	21.4	18.0	6.0	12.0	13.3	0.00893	19.9	19.8
	60	21.5	16.5	6.0	10.5	13.6	0.00637	17.4	17.3
	120	21.5	13.0	6.0	7.0	14.2	0.00460	11.6	11.6
	254	21.4	11.5	6.0	5.5	14.4	0.00319	9.1	9.1
	446	21.4	11.5	6.0	5.5	14.4	0.00241	9.1	9.1
27-Aug-14	1427	21.4	9.5	6.0	3.5	14.7	0.00136	5.8	5.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: S. Hanhardt
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0036**	d_{30} = **0.018**	d_{50} = **0.047**	d_{60} = **0.070**	C_u = **19**	C_c = **1.3**

SAMPLE NUMBER	PO NUMBER	ASTM CLASSIFICATION	USDA CLASSIFICATION
Topsoil-1	**12015**	**Sandy silt s(ML)**	**Loam**

Daniel B. Stephens & Associates, Inc.

Atterberg Limits/ Identification of Fines

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
VVL Composite 0-10	75	25	50	CH
VVL Composite 11-15	33	27	6	ML
VVL Composite 16-20	54	24	30	CH
VVL Composite 21-30	68	25	43	CH
VVL Composite 31+	65	30	35	CH
VVL Composite TP-10	38	24	14	CL
VVL Composite TP-12	72	25	47	CH
VVL Composite TP-13	66	26	40	CH
WB Borrow-1	34	23	11	CL
WB Stockpile-1	31	19	12	CL
WB Stockpile-2	32	21	11	CL
Topsoil-1	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Atterberg Limits

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 0-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	38	29	18
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.24	128.04	123.86
Weight of pan plus dry soil (g)	121.13	123.60	119.76
Weight of pan (g):	115.27	117.57	114.55
Gravimetric moisture content (% g/g):	70.14	73.63	78.69
Liquid Limit:	75		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.76	118.35
Weight of pan plus dry soil (g)	121.47	117.08
Weight of pan (g):	116.43	112.07
Gravimetric moisture content (% g/g):	25.60	25.35
Plastic Limit:	25	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 75
Plastic Limit: 25
Plasticity Index: 50

Classification: CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 11-15
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	31	23	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	127.88	123.40	124.43
Weight of pan plus dry soil (g)	124.91	120.20	121.35
Weight of pan (g):	115.62	110.85	112.67
Gravimetric moisture content (% g/g):	31.97	34.22	35.48

Liquid Limit: 33

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	120.24	123.10
Weight of pan plus dry soil (g)	118.66	121.70
Weight of pan (g):	112.69	116.48
Gravimetric moisture content (% g/g):	26.47	26.82

Plastic Limit: 27

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 33
Plastic Limit: 27
Plasticity Index: 6

Classification: ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite 16-20
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	33	26	18
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	128.15	130.81	130.75
Weight of pan plus dry soil (g)	124.54	126.16	127.49
Weight of pan (g):	117.50	117.45	121.84
Gravimetric moisture content (% g/g):	51.28	53.39	57.70
Liquid Limit:	54		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	121.56	118.60
Weight of pan plus dry soil (g)	120.45	117.48
Weight of pan (g):	115.78	112.70
Gravimetric moisture content (% g/g):	23.77	23.43
Plastic Limit:	24	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 54
Plastic Limit: 24
Plasticity Index: 30

Classification: CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite 21-30
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	37	29	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	122.68	128.07	123.11
Weight of pan plus dry soil (g)	119.77	123.39	118.34
Weight of pan (g):	115.16	116.46	111.63
Gravimetric moisture content (% g/g):	63.12	67.53	71.09
Liquid Limit:	68		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	117.97	117.74
Weight of pan plus dry soil (g)	116.88	116.63
Weight of pan (g):	112.58	112.27
Gravimetric moisture content (% g/g):	25.35	25.46
Plastic Limit:	25	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	68
Plastic Limit:	25
Plasticity Index:	43
Classification:	CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite 31+
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	34	26	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.02	120.06	126.62
Weight of pan plus dry soil (g)	121.86	117.36	123.29
Weight of pan (g):	116.80	113.15	118.40
Gravimetric moisture content (% g/g):	62.45	64.13	68.10
Liquid Limit:	65		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	116.83	115.29
Weight of pan plus dry soil (g)	115.82	114.30
Weight of pan (g):	112.50	110.99
Gravimetric moisture content (% g/g):	30.42	29.91
Plastic Limit:	30	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	65
Plastic Limit:	30
Plasticity Index:	35
Classification:	CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-10
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	34	25	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	122.13	120.28	127.26
Weight of pan plus dry soil (g)	119.79	117.92	124.28
Weight of pan (g):	113.15	111.65	116.87
Gravimetric moisture content (% g/g):	35.24	37.64	40.22
Liquid Limit:	38		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	119.47	124.67
Weight of pan plus dry soil (g)	118.23	123.39
Weight of pan (g):	113.24	118.05
Gravimetric moisture content (% g/g):	24.85	23.97
Plastic Limit:	24	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	38
Plastic Limit:	24
Plasticity Index:	14
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	VVL Composite TP-12
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	36	27	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	123.57	126.48	129.17
Weight of pan plus dry soil (g)	118.90	122.32	123.22
Weight of pan (g):	112.01	116.50	115.32
Gravimetric moisture content (% g/g):	67.78	71.48	75.32
Liquid Limit:	72		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	120.39	123.08
Weight of pan plus dry soil (g)	119.14	121.52
Weight of pan (g):	114.22	115.17
Gravimetric moisture content (% g/g):	25.41	24.57
Plastic Limit:	25	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	72
Plastic Limit:	25
Plasticity Index:	47
Classification:	CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	24	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	123.88	130.58	126.31
Weight of pan plus dry soil (g)	120.50	125.25	120.74
Weight of pan (g):	115.14	117.17	112.62
Gravimetric moisture content (% g/g):	63.06	65.97	68.60
Liquid Limit:	66		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	123.03	123.36
Weight of pan plus dry soil (g)	121.84	121.95
Weight of pan (g):	117.20	116.43
Gravimetric moisture content (% g/g):	25.65	25.54
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 66
Plastic Limit: 26
Plasticity Index: 40

Classification: CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Borrow-1
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	25	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	123.38	129.04	131.33
Weight of pan plus dry soil (g)	120.86	125.55	127.80
Weight of pan (g):	113.25	115.28	117.68
Gravimetric moisture content (% g/g):	33.11	33.98	34.88
Liquid Limit:	34		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	124.05	123.75
Weight of pan plus dry soil (g)	122.82	122.37
Weight of pan (g):	117.45	116.40
Gravimetric moisture content (% g/g):	22.91	23.12
Plastic Limit:	23	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	34
Plastic Limit:	23
Plasticity Index:	11
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	WB Stockpile-1
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	23	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	129.45	125.98	128.64
Weight of pan plus dry soil (g)	126.43	123.72	125.41
Weight of pan (g):	116.30	116.29	115.32
Gravimetric moisture content (% g/g):	29.81	30.42	32.01
Liquid Limit:	31		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.02	125.40
Weight of pan plus dry soil (g)	120.73	123.94
Weight of pan (g):	114.03	116.43
Gravimetric moisture content (% g/g):	19.25	19.44
Plastic Limit:	19	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	31
Plastic Limit:	19
Plasticity Index:	12
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	37	24	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	123.81	120.88	126.63
Weight of pan plus dry soil (g)	120.98	118.52	123.03
Weight of pan (g):	111.87	111.22	112.63
Gravimetric moisture content (% g/g):	31.06	32.33	34.62
Liquid Limit:	32		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	132.30	123.91
Weight of pan plus dry soil (g)	130.86	122.42
Weight of pan (g):	124.11	115.37
Gravimetric moisture content (% g/g):	21.33	21.13
Plastic Limit:	21	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 32
Plastic Limit: 21
Plasticity Index: 11

Classification: CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Atterberg Limits

Job Name:	Hydrometrics, Inc.
Job Number:	LB14.0168.00
Sample Number:	Topsoil-1
Project Name:	VVL Composite Samples
PO Number:	12015
Test Date:	28-Aug-14

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: Topsoil-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 28-Aug-14

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Black (10YR 2/1)
Odor: None
Moisture Condition: Moist
HCl Reaction: None

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction

Summary of Proctor Compaction Tests

Sample Number	Measured: Optimum Moisture Content (% g/g)	Measured: Maximum Dry Bulk Density (g/cm^3)	Oversize Corrected: Optimum Moisture Content (% g/g)	Oversize Corrected: Maximum Dry Bulk Density (g/cm^3)
VVL Composite 0-10	17.6	1.72	13.6	1.87
VVL Composite 11-15	15.0	1.76	12.2	1.88
VVL Composite 16-20	17.9	1.71	15.3	1.80
VVL Composite 21-30	19.5	1.62	15.5	1.76
VVL Composite 31+	27.5	1.44	24.2	1.52
VVL Composite TP-10	16.7	1.77	13.1	1.90
VVL Composite TP-12	19.5	1.65	15.7	1.78
VVL Composite TP-13	22.2	1.61	19.3	1.69
WB Borrow-1	18.9	1.67	16.6	1.75
WB Stockpile-1	15.8	1.79	14.4	1.84
WB Stockpile-2	17.3	1.74	13.0	1.89
Topsoil-1	29.2	1.30	---	---

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Proctor Compaction Data

Job Name:	Hydrometrics, Inc.	*Split (3/4", 3/8", #4):*	3/4
Job Number:	LB14.0168.00	*Mass of coarse material* (g):	22.65578242
Sample Number:	VVL Composite 0-10	*Mass of fines material* (g):	77.34421758
Project Name:	VVL Composite Samples	*Mold weight (g):*	5573
PO Number:	12015	*Mold volume* (cm^3):	2123.94
Test Date:	28-Aug-14	*Compaction Method:*	Standard C
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9653	820.83	747.66	283.83	1.66	15.78
2	9835	759.30	688.16	270.63	1.71	17.04
3	9877	769.95	688.56	283.91	1.69	20.11
4	9837	788.91	702.86	298.48	1.66	21.28
5	9888	710.02	644.20	289.72	1.71	18.57

Soil Fractions

Coarse Fraction (% g/g): 22.7
Fines Fraction (% g/g): 77.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.81	12.20
2	1.86	13.18
3	1.84	15.56
4	1.81	16.46
5	1.86	14.36

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

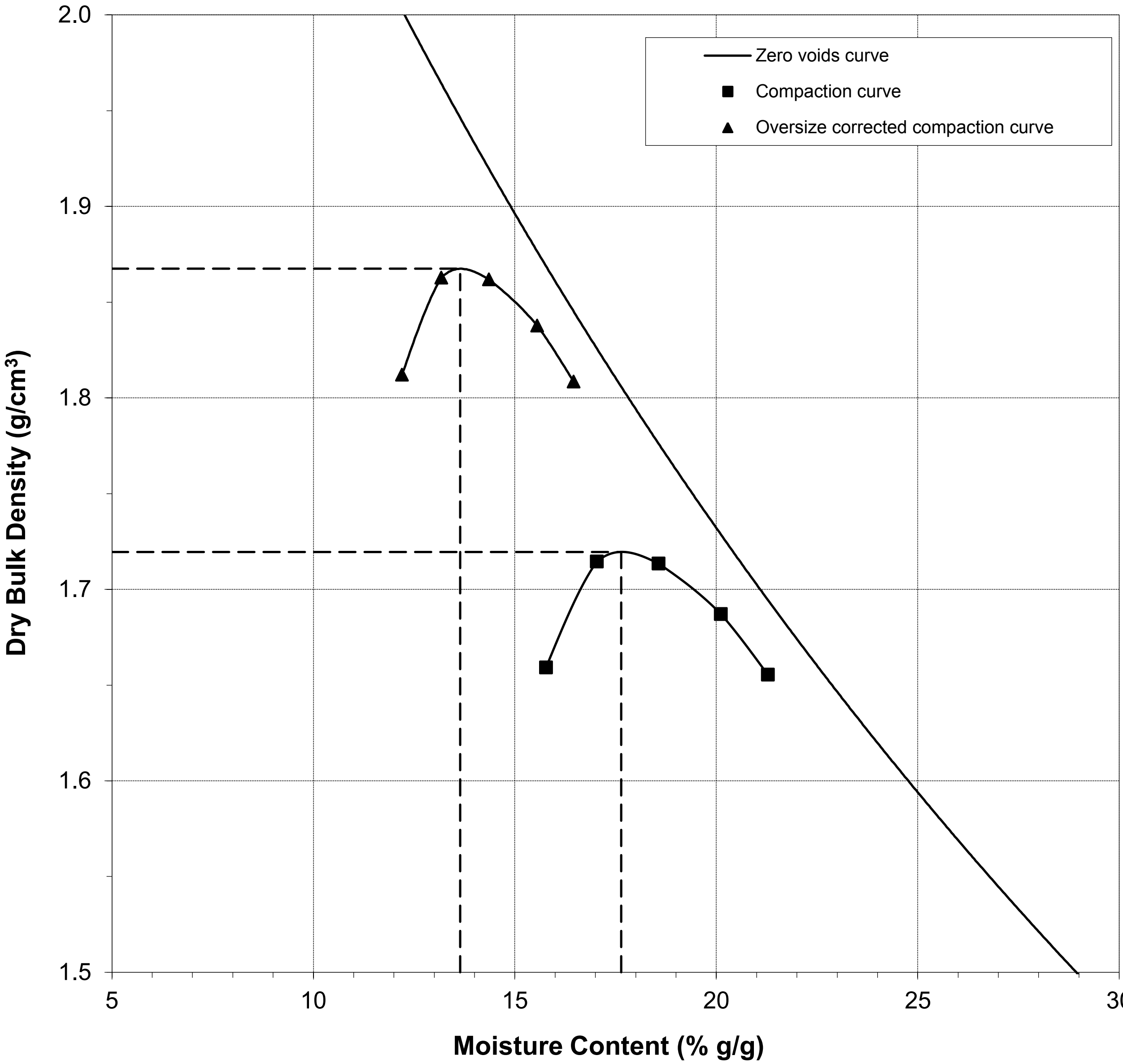
Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite 0-10

	Measured	Corrected
Optimum Moisture Content (% g/g):	17.6	13.6
Maximum Dry Bulk Density (g/cm^3):	1.72	1.87

Test Date: 28-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data

Job Name:	Hydrometrics, Inc.	*Split (3/4", 3/8", #4):*	3/4
Job Number:	LB14.0168.00	*Mass of coarse material* (g):	18.96896728
Sample Number:	VVL Composite 11-15	*Mass of fines material* (g):	81.03103272
Project Name:	VVL Composite Samples	*Mold weight (g):*	5573
PO Number:	12015	*Mold volume* (cm^3):	2123.94
Test Date:	27-Aug-14	*Compaction Method:*	Standard C
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9635	759.53	717.50	296.54	1.74	9.98
2	9790	797.27	736.22	263.78	1.76	12.92
3	9916	951.47	859.39	287.01	1.76	16.09
4	9916	960.93	855.36	297.88	1.72	18.94
5	9868	820.15	732.17	301.51	1.68	20.43

Soil Fractions		Properties of Coarse Material	
Coarse Fraction (% g/g):	19.0	*Assumed particle density* (g/cm^3):	2.65
Fines Fraction (% g/g):	81.0	*Assumed Initial Moisture Content (% g/g):*	0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.86	8.09
2	1.88	10.47
3	1.88	13.04
4	1.84	15.34
5	1.80	16.55

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

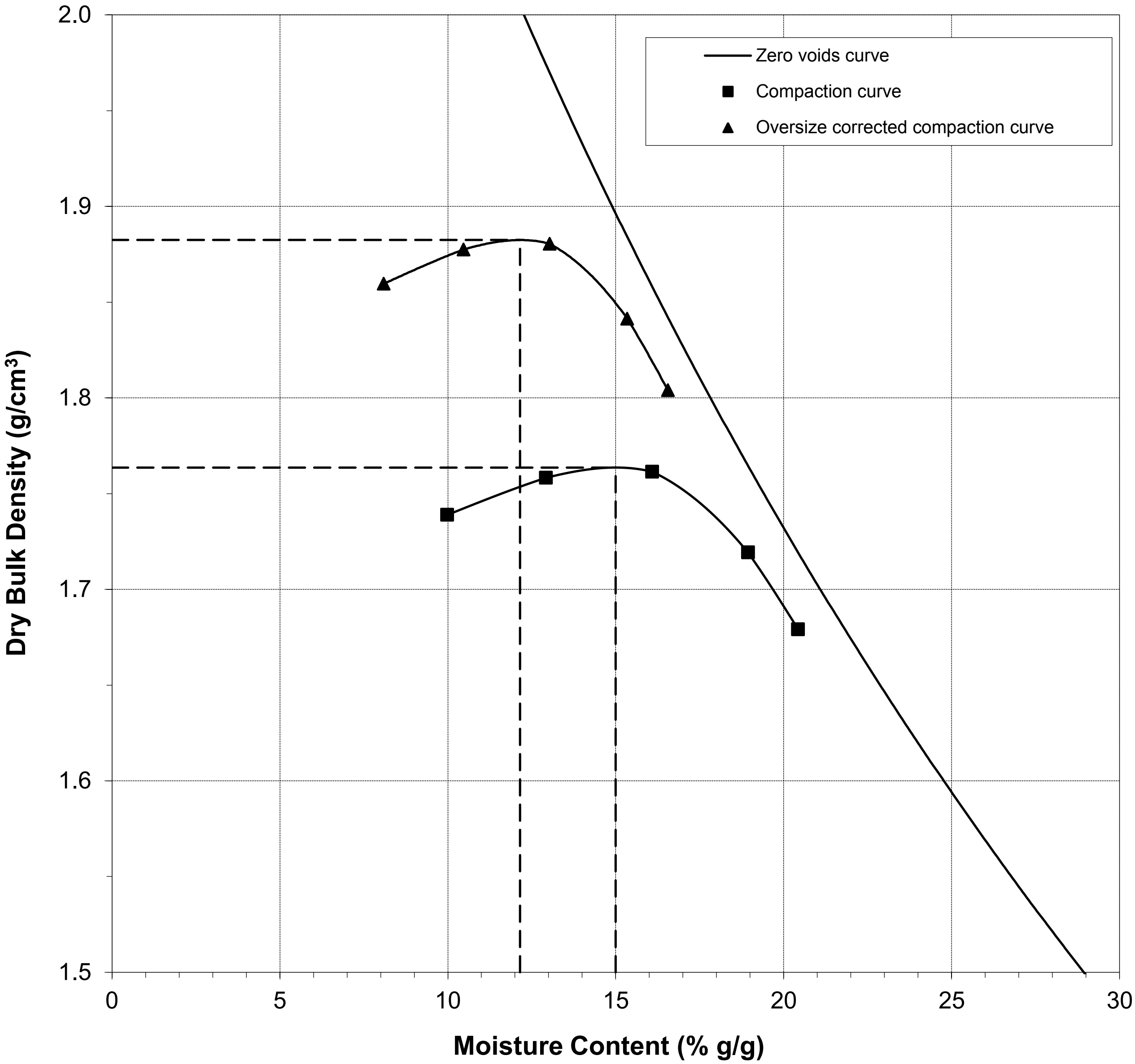
Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite 11-15

	Measured	Corrected
Optimum Moisture Content (% g/g):	15.0	12.2
Maximum Dry Bulk Density (g/cm^3):	1.76	1.88

Test Date: 27-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name:	Hydrometrics, Inc.	*Split (3/4", 3/8", #4):*	3/4
Job Number:	LB14.0168.00	*Mass of coarse material (g):*	14.47967073
Sample Number:	VVL Composite 16-20	*Mass of fines material (g):*	85.52032927
Project Name:	VVL Composite Samples	*Mold weight (g):*	5573
PO Number:	12015	*Mold volume (cm^3):*	2123.94
Test Date:	29-Aug-14	*Compaction Method:*	Standard C
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9490	808.77	748.56	284.74	1.63	12.98
2	9602	662.50	605.49	207.42	1.66	14.32
3	9846	785.87	711.57	297.45	1.71	17.94
4	9835	746.56	661.05	268.94	1.65	21.81
5	9845	744.09	668.31	296.82	1.67	20.40

Soil Fractions

Coarse Fraction (% g/g): 14.5
Fines Fraction (% g/g): 85.5

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.73	11.10
2	1.75	12.25
3	1.80	15.34
4	1.74	18.65
5	1.76	17.45

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

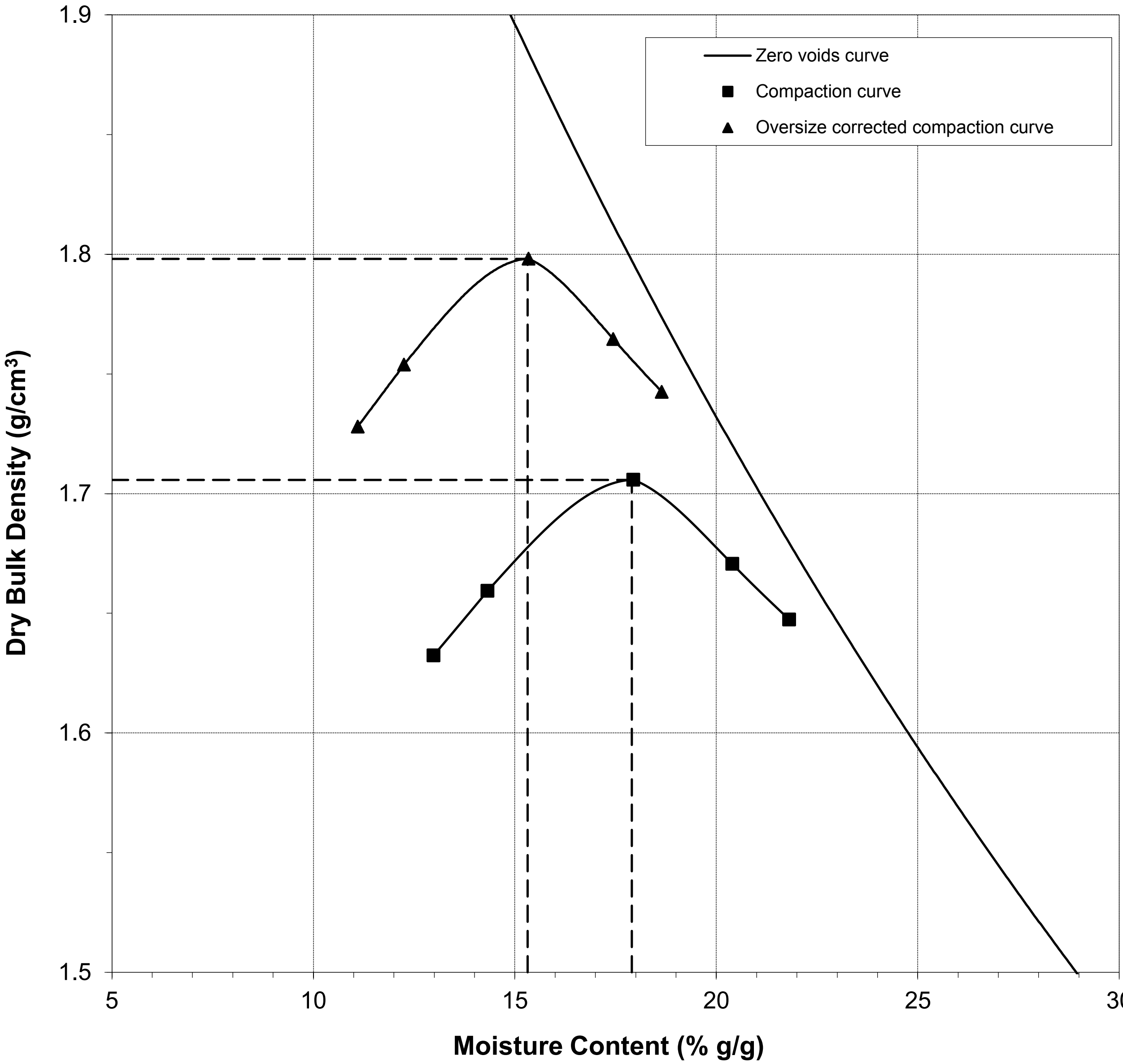
Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite 16-20

	Measured	Corrected
Optimum Moisture Content (% g/g):	17.9	15.3
Maximum Dry Bulk Density (g/cm^3):	1.71	1.80

Test Date: 29-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data

Job Name:	Hydrometrics, Inc.	*Split (3/4", 3/8", #4):*	3/4
Job Number:	LB14.0168.00	*Mass of coarse material* (g):	20.52072038
Sample Number:	VVL Composite 21-30	*Mass of fines material* (g):	79.47927962
Project Name:	VVL Composite Samples	*Mold weight (g):*	5573
PO Number:	12015	*Mold volume* (cm^3):	2123.94
Test Date:	27-Aug-14	*Compaction Method:*	Standard C
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9463	831.71	756.65	289.61	1.58	16.07
2	9671	891.57	794.90	283.08	1.62	18.89
3	9735	703.94	632.46	298.93	1.61	21.43
4	9714	743.70	653.29	283.51	1.57	24.45
5	9625	748.27	647.80	298.48	1.48	28.76

<u>Soil Fractions</u>

Coarse Fraction (% g/g): 20.5
Fines Fraction (% g/g): 79.5

<u>Properties of Coarse Material</u>

Assumed particle density (g/cm^3)*:* 2.65
Assumed Initial Moisture Content (% g/g): 0.0

<u>Oversize Corrected Values for Dry Bulk Density and Moisture Content</u>

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.72	12.77
2	1.76	15.01
3	1.75	17.03
4	1.71	19.43
5	1.63	22.86

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

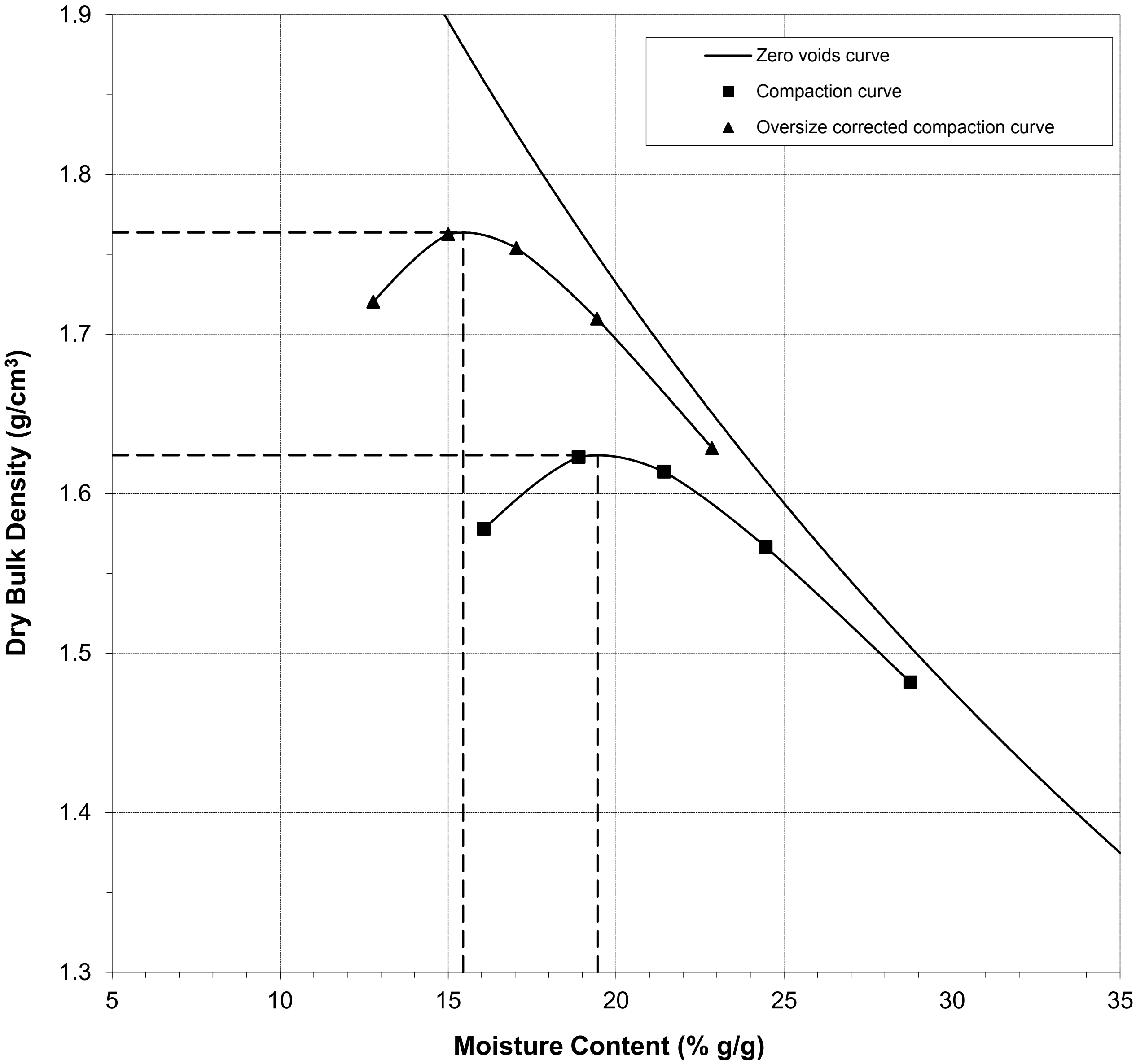
Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite 21-30

	Measured	Corrected
Optimum Moisture Content (% g/g):	19.5	15.5
Maximum Dry Bulk Density (g/cm^3):	1.62	1.76

Test Date: 27-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name:	Hydrometrics, Inc.	*Split (3/4", 3/8", #4):*	3/4
Job Number:	LB14.0168.00	*Mass of coarse material* (g):	12.02166167
Sample Number:	VVL Composite 31+	*Mass of fines material* (g):	87.97833833
Project Name:	VVL Composite Samples	*Mold weight (g):*	5573
PO Number:	12015	*Mold volume* (cm^3):	2123.94
Test Date:	25-Aug-14	*Compaction Method:*	Standard C
		Preparation Method:	Dry
As Received Moisture Content (% g/g):	NA	*Type of Rammer:*	Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9178	809.35	721.54	289.58	1.41	20.33
2	9377	797.94	696.92	293.65	1.43	25.05
3	9500	693.05	585.64	212.71	1.44	28.80
4	9485	776.19	656.97	269.82	1.41	30.79
5	9495	806.02	679.15	282.81	1.40	32.01

<u>Soil Fractions</u>

Coarse Fraction (% g/g): 12.0
Fines Fraction (% g/g): 88.0

<u>Properties of Coarse Material</u>

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

<u>Oversize Corrected Values for Dry Bulk Density and Moisture Content</u>

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.49	17.88
2	1.52	22.04
3	1.52	25.34
4	1.49	27.09
5	1.48	28.16

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

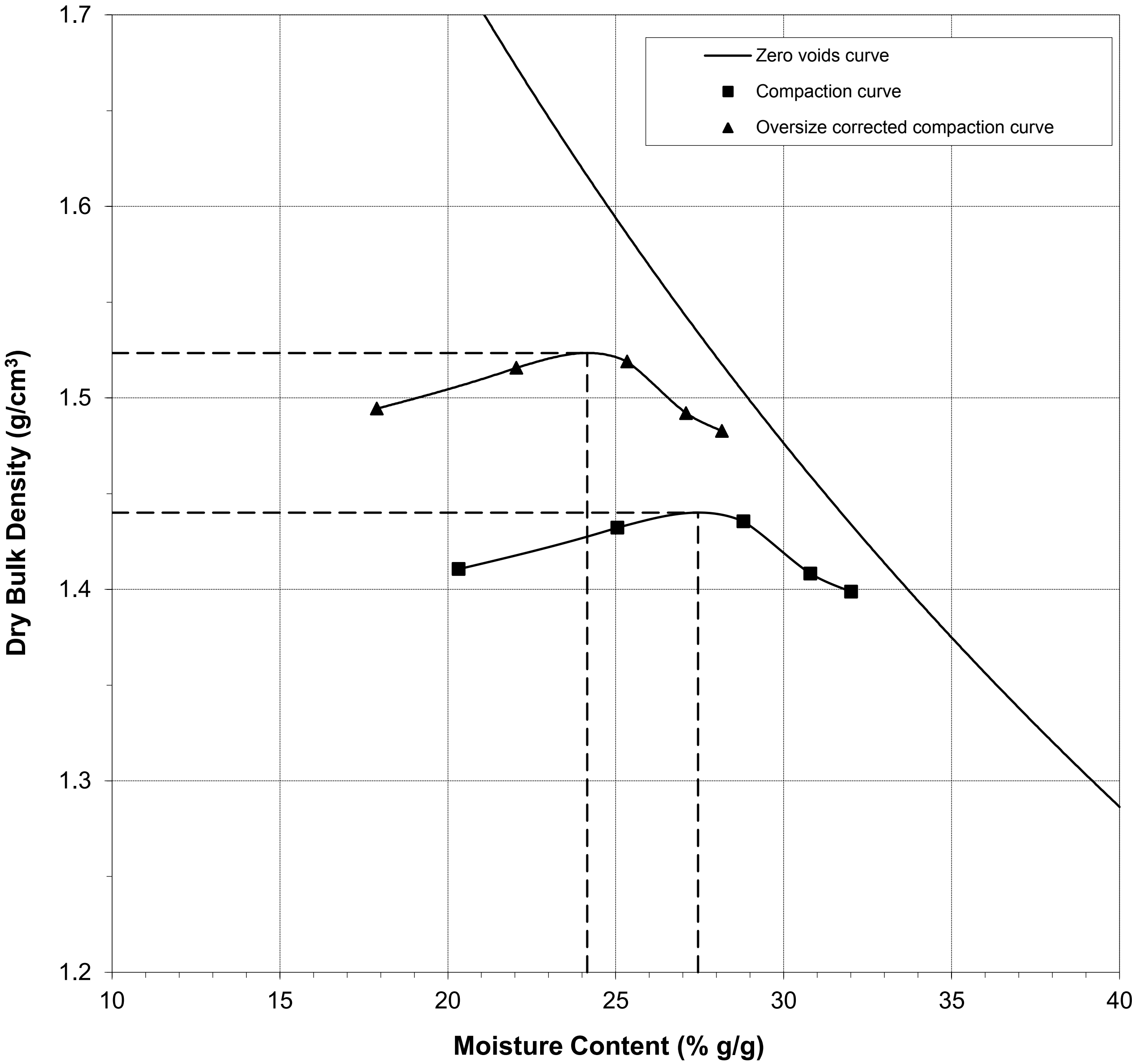
Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite 31+

	Measured	Corrected
Optimum Moisture Content (% g/g):	27.5	24.2
Maximum Dry Bulk Density (g/cm^3):	1.44	1.52

Test Date: 25-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-10
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 25-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): 3/4
Mass of coarse material (g): 21.58382813
Mass of fines material (g): 78.41617187
Mold weight (g): 5573
Mold volume (cm^3): 2123.94

Compaction Method: Standard C
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9738	877.42	815.53	297.96	1.75	11.96
2	9860	872.01	795.83	284.26	1.76	14.89
3	9963	881.31	792.81	268.40	1.77	16.88
4	9903	889.17	792.26	287.76	1.71	19.21
5	9826	897.08	792.53	283.37	1.66	20.53

Soil Fractions

Coarse Fraction (% g/g): 21.6
Fines Fraction (% g/g): 78.4

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.89	9.38
2	1.89	11.68
3	1.90	13.23
4	1.85	15.06
5	1.81	16.10

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

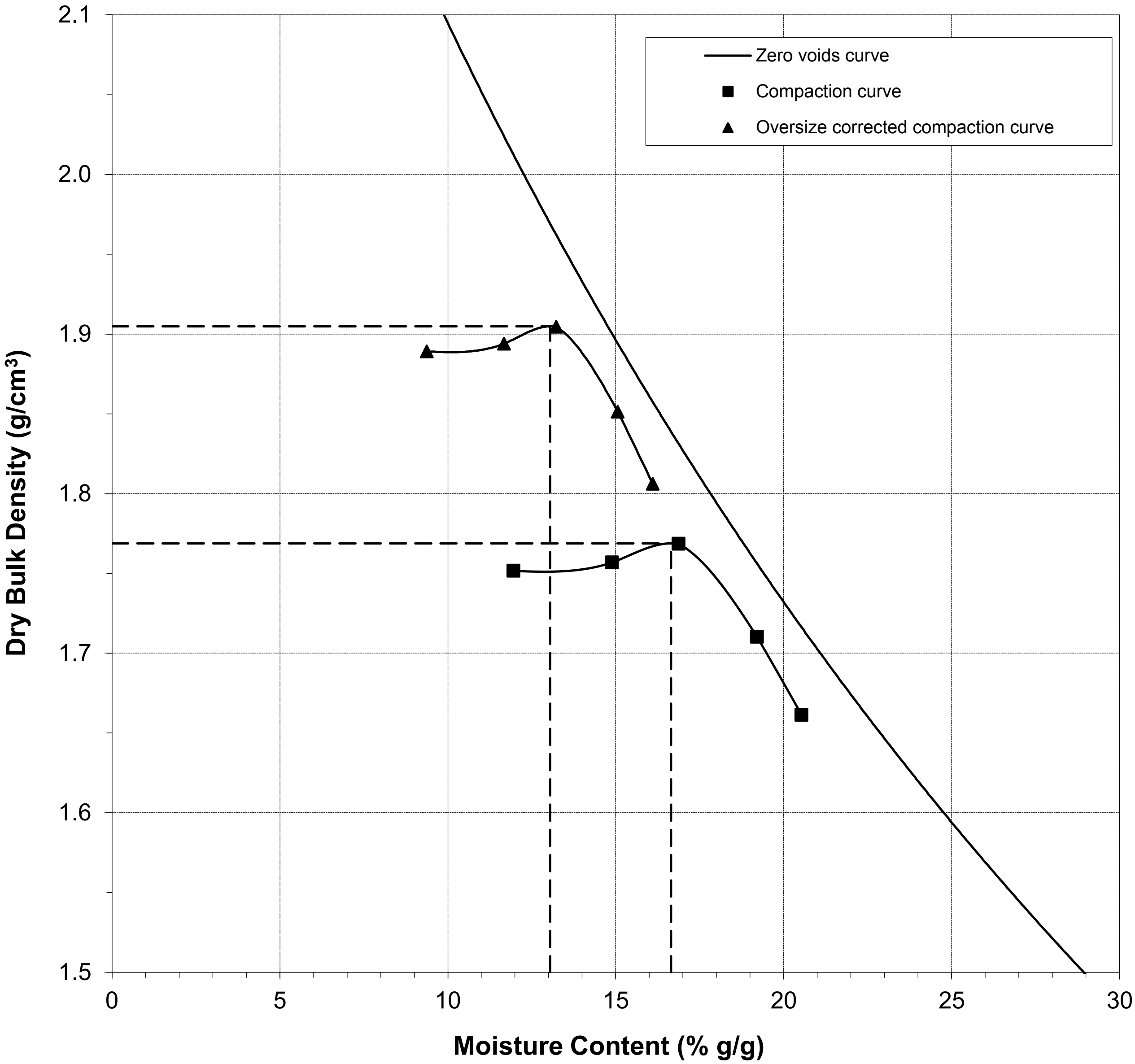
Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite TP-10

	Measured	Corrected
Optimum Moisture Content (% g/g):	16.7	13.1
Maximum Dry Bulk Density (g/cm^3):	1.77	1.90

Test Date: 25-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-12
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 25-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): 3/4
Mass of coarse material (g): 19.61353072
Mass of fines material (g): 80.38646928
Mold weight (g): 5573
Mold volume (cm^3): 2123.94

Compaction Method: Standard C
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9492	915.22	834.08	292.88	1.60	14.99
2	9609	824.82	742.57	269.39	1.62	17.38
3	9757	838.90	748.21	282.26	1.65	19.46
4	9764	785.82	693.99	282.98	1.61	22.34
5	9741	792.02	697.66	298.97	1.59	23.67

Soil Fractions

Coarse Fraction (% g/g): 19.6
Fines Fraction (% g/g): 80.4

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.74	12.05
2	1.75	13.97
3	1.78	15.65
4	1.75	17.96
5	1.72	19.03

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

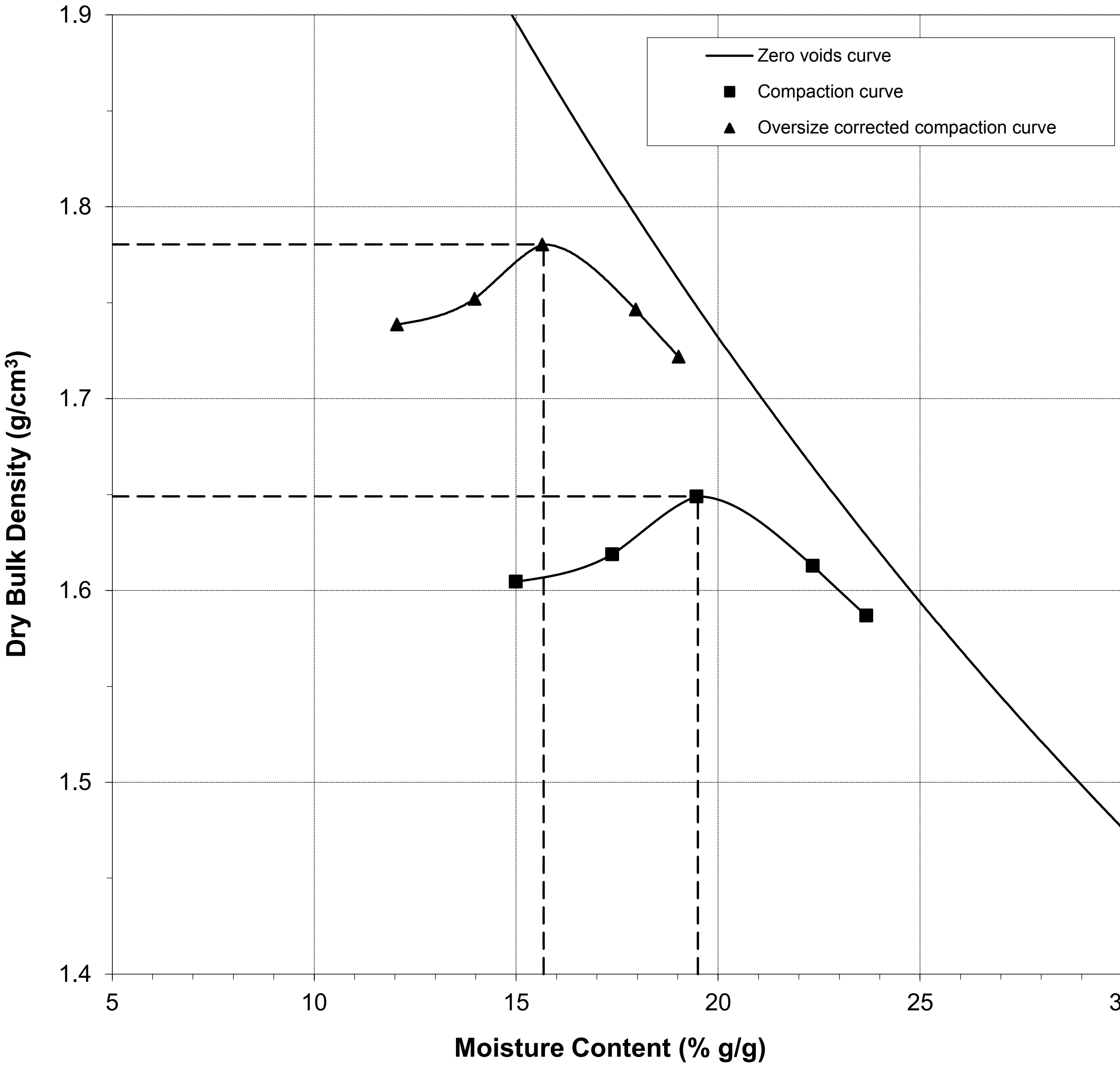
Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite TP-12

	Measured	Corrected
Optimum Moisture Content (% g/g):	19.5	15.7
Maximum Dry Bulk Density (g/cm^3):	1.65	1.78

Test Date: 25-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: VVL Composite TP-13
Project Name: VVL Composite Samples
PO Number: 12015
Test Date: 28-Aug-14
As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): 3/4
Mass of coarse material (g): 13.13755554
Mass of fines material (g): 86.86244446
Mold weight (g): 5573
Mold volume (cm^3): 2123.94
Compaction Method: Standard C
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	9411	861.24	774.20	291.07	1.53	18.02
2	9561	803.80	713.95	269.71	1.56	20.23
3	9740	702.11	628.21	294.40	1.61	22.14
4	9728	816.59	710.13	267.89	1.58	24.07
5	9686	677.50	583.39	210.09	1.55	25.21

Soil Fractions

Coarse Fraction (% g/g): 13.1
Fines Fraction (% g/g): 86.9

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.62	15.65
2	1.65	17.57
3	1.69	19.23
4	1.66	20.91
5	1.64	21.90

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

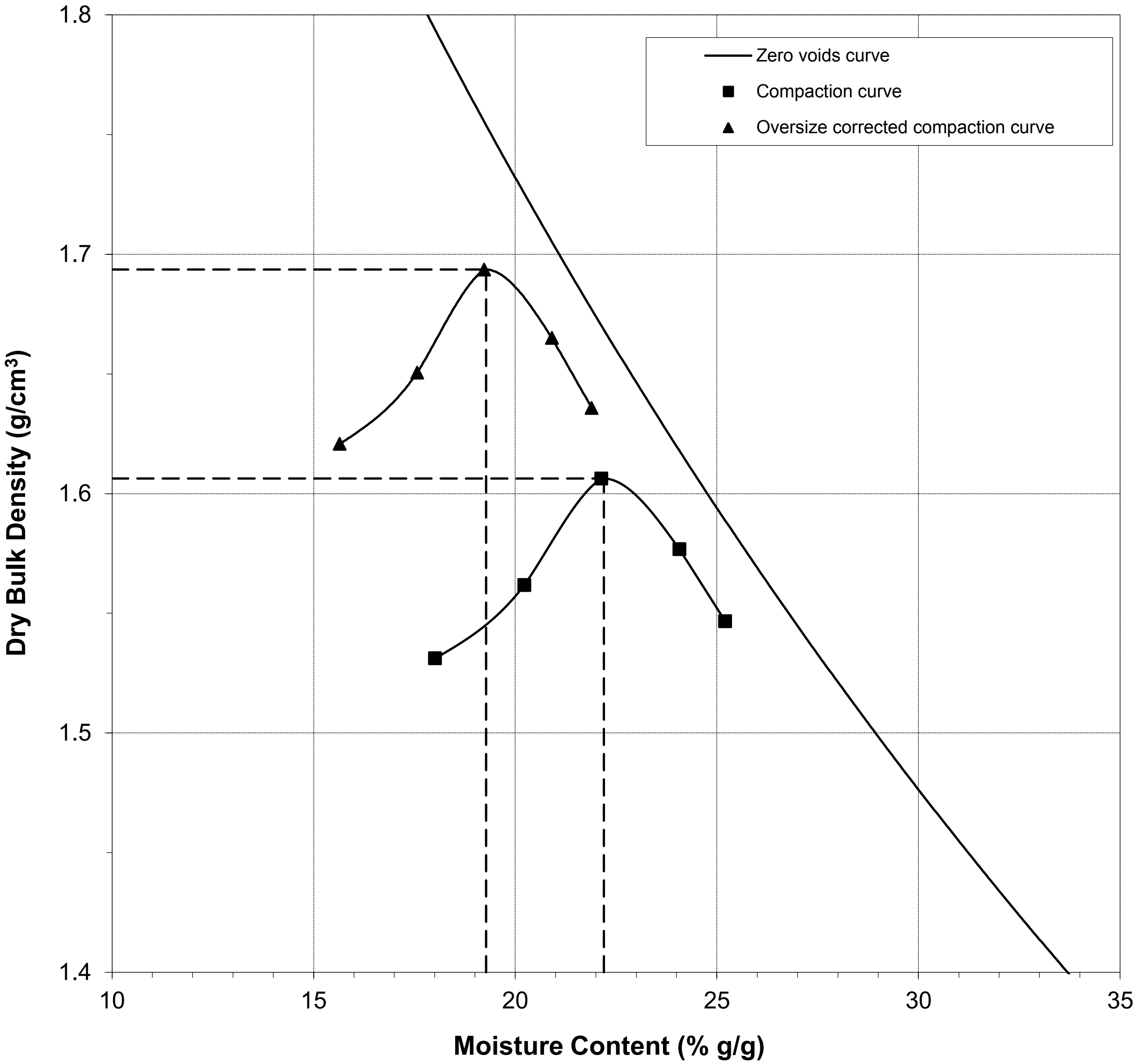
Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: VVL Composite TP-13

	Measured	Corrected
Optimum Moisture Content (% g/g):	22.2	19.3
Maximum Dry Bulk Density (g/cm^3):	1.61	1.69

Test Date: 28-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Candelaria
Data entered by: D. O'Dowd
Checked by: J. Hines

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Borrow-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 18-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 12.36129352
Mass of fines material (g): 87.63870648
Mold weight (g): 4202
Mold volume (cm^3): 943.95

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	5957	893.63	815.95	298.92	1.62	15.02
2	6023	869.88	785.66	283.53	1.65	16.77
3	6081	946.46	841.82	289.70	1.67	18.95
4	6073	896.77	789.99	284.53	1.64	21.13
5	6057	859.69	749.87	268.23	1.60	22.80

Soil Fractions

Coarse Fraction (% g/g): 12.4
Fines Fraction (% g/g): 87.6

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.70	13.17
2	1.73	14.70
3	1.75	16.61
4	1.72	18.51
5	1.68	19.98

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

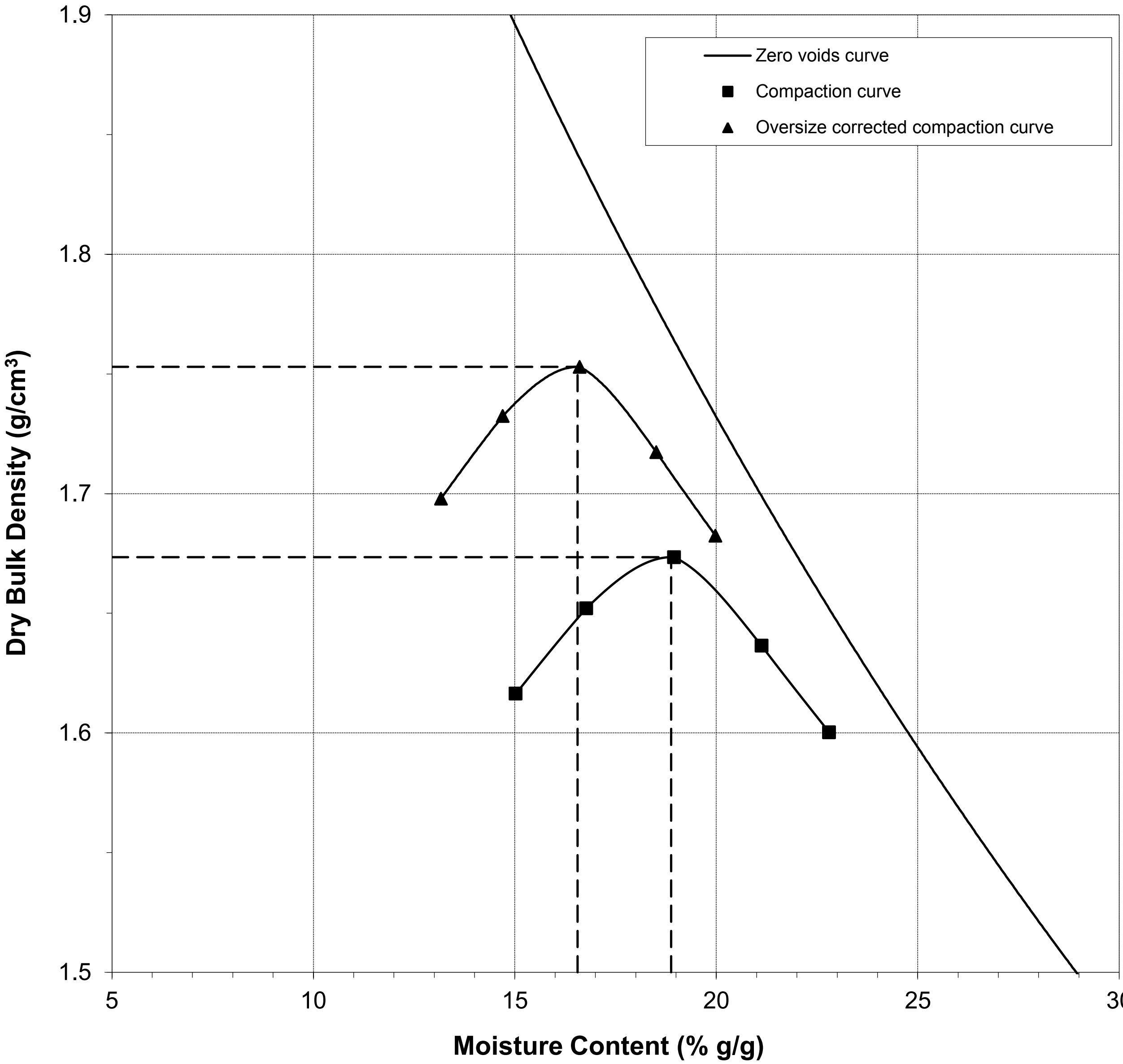
Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data Points with Fitted Curve

Sample Number: WB Borrow-1

	Measured	Corrected
Optimum Moisture Content (% g/g):	18.9	16.6
Maximum Dry Bulk Density (g/cm^3):	1.67	1.75

Test Date: 18-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 18-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 8.732531931
Mass of fines material (g): 91.26746807
Mold weight (g): 4202
Mold volume (cm^3): 943.95

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	5931	899.16	837.35	268.45	1.65	10.86
2	6063	890.36	818.88	291.60	1.74	13.56
3	6152	975.79	884.42	292.25	1.79	15.43
4	6163	911.60	816.97	269.40	1.77	17.28
5	6124	828.59	741.84	284.28	1.71	18.96

Soil Fractions

Coarse Fraction (% g/g): 8.7
Fines Fraction (% g/g): 91.3

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.71	9.92
2	1.79	12.37
3	1.84	14.08
4	1.82	15.77
5	1.77	17.30

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

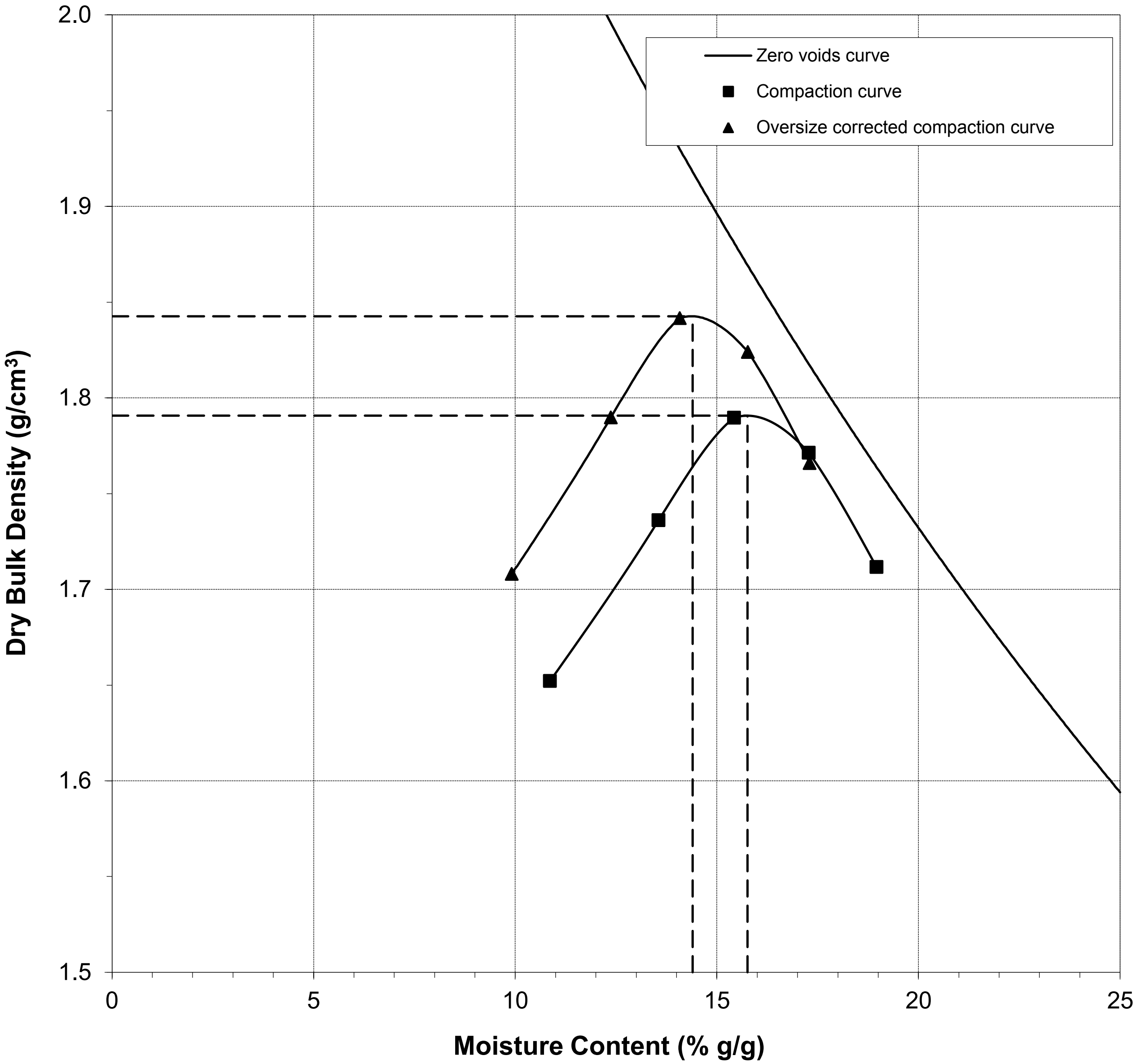
Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data Points with Fitted Curve

Sample Number: WB Stockpile-1

	Measured	Corrected
Optimum Moisture Content (% g/g):	15.8	14.4
Maximum Dry Bulk Density (g/cm^3):	1.79	1.84

Test Date: 18-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: WB Stockpile-2
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 18-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 24.41850569
Mass of fines material (g): 75.58149431
Mold weight (g): 4202
Mold volume (cm^3): 943.95

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	5947	915.75	844.89	282.91	1.64	12.61
2	6012	870.38	795.77	296.98	1.67	14.96
3	6115	901.64	809.03	260.81	1.73	16.89
4	6123	885.81	788.45	269.39	1.71	18.76
5	6082	901.93	795.56	286.96	1.65	20.91

Soil Fractions

Coarse Fraction (% g/g): 24.4
Fines Fraction (% g/g): 75.6

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.81	9.53
2	1.83	11.31
3	1.89	12.77
4	1.87	14.18
5	1.81	15.81

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

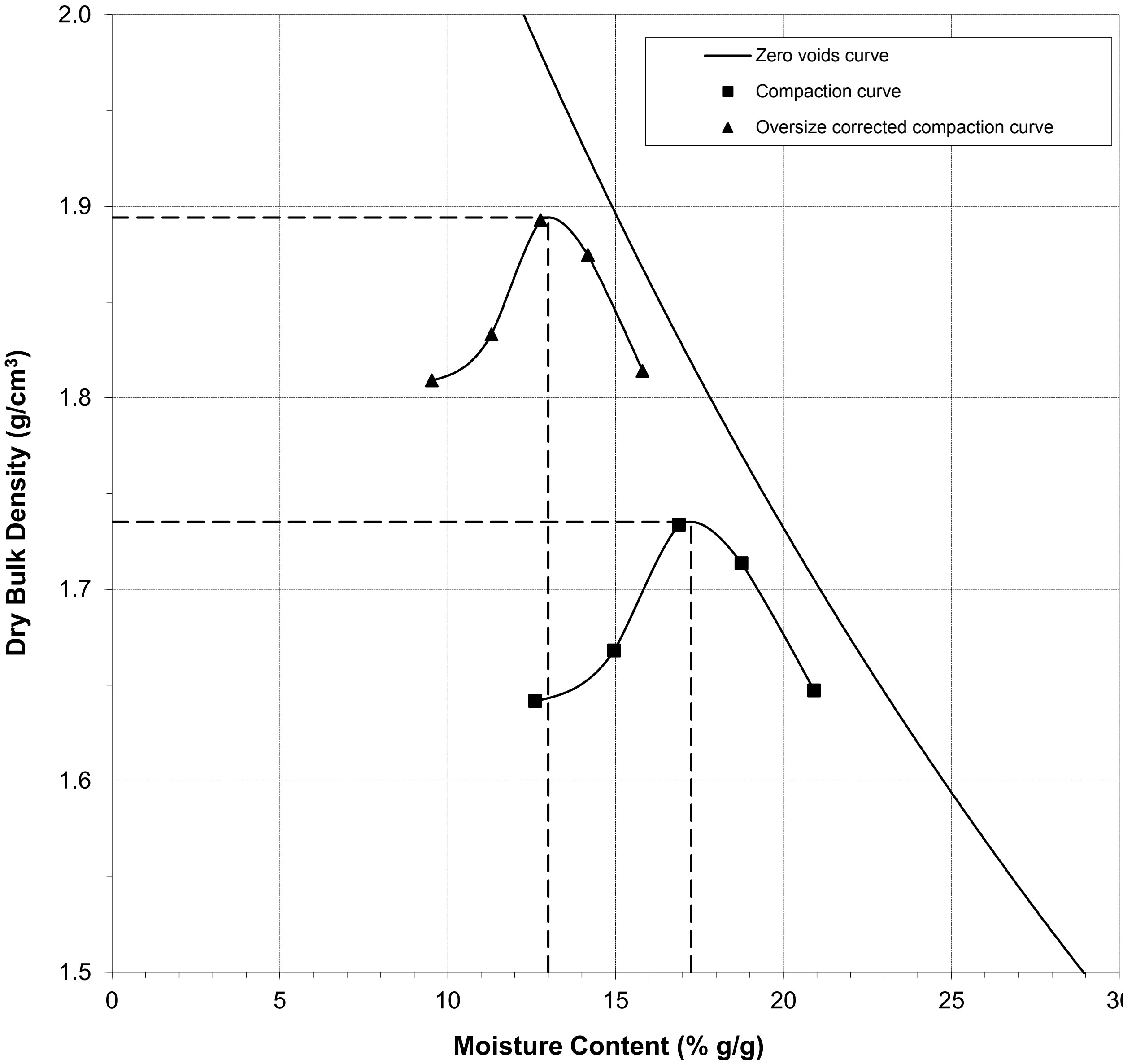
Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: WB Stockpile-2

	Measured	Corrected
Optimum Moisture Content (% g/g):	17.3	13.0
Maximum Dry Bulk Density (g/cm^3):	1.74	1.89

Test Date: 18-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Hydrometrics, Inc.
Job Number: LB14.0168.00
Sample Number: Topsoil-1
Project Name: VVL Composite Samples
PO Number: 12015

Test Date: 18-Aug-14

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 0.448258848
Mass of fines material (g): 99.55174115
Mold weight (g): 4202
Mold volume (cm^3): 943.95

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	5647	694.32	610.48	267.63	1.23	24.45
2	5692	722.05	629.50	284.32	1.24	26.81
3	5785	729.90	629.86	284.77	1.30	28.99
4	5786	693.11	593.03	271.92	1.28	31.17
5	5803	772.55	644.43	269.55	1.26	34.18

Soil Fractions

Coarse Fraction (% g/g): 0.4
Fines Fraction (% g/g): 99.6

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

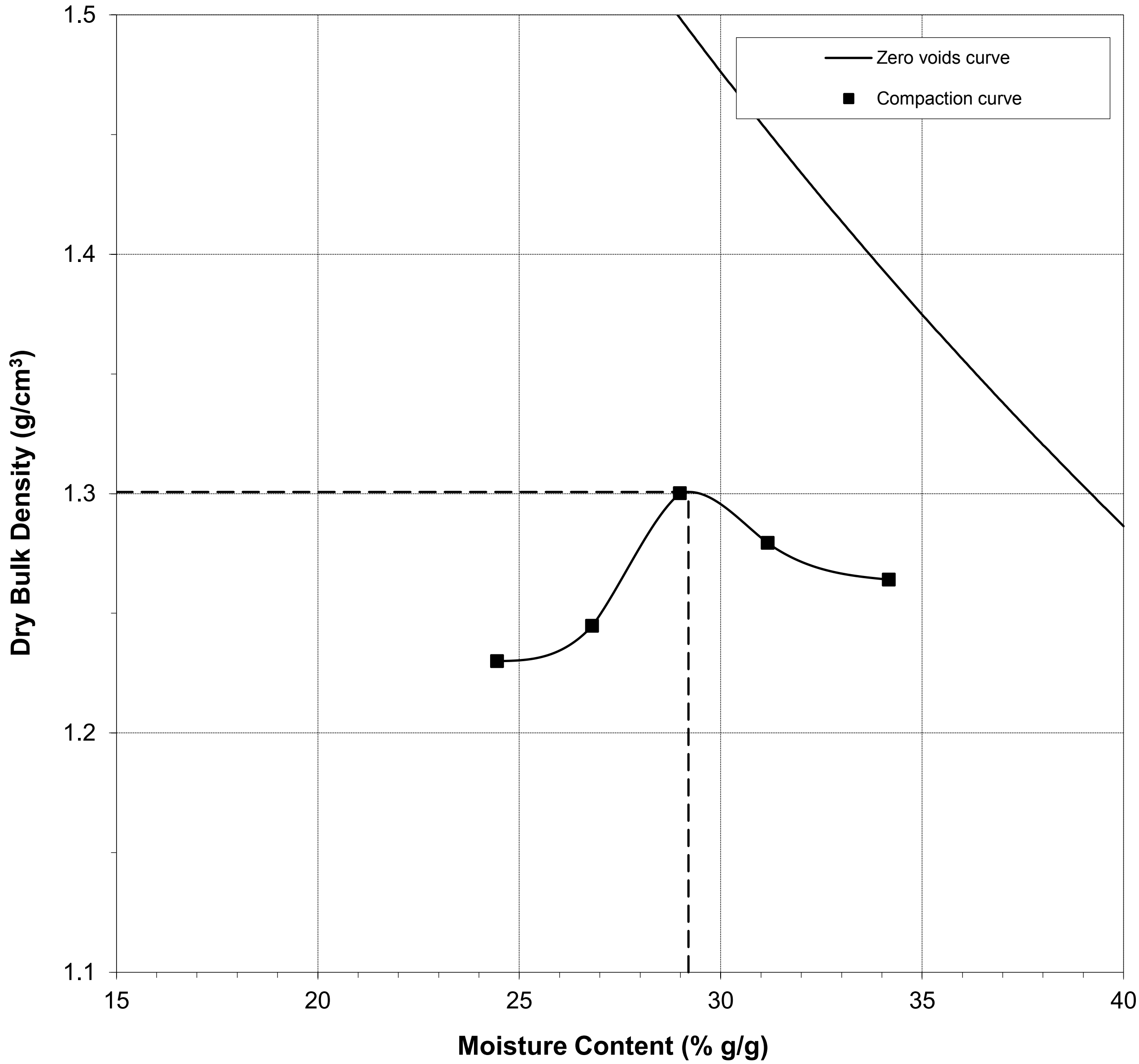
Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: Topsoil-1

	Measured	Corrected
Optimum Moisture Content (% g/g):	29.2	---
Maximum Dry Bulk Density (g/cm^3):	1.30	---

Test Date: 18-Aug-14



--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: N. Canelaria
Data entered by: C. Krous
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity: Constant Head: (Rigid Wall)	ASTM D 2434 (modified apparatus)
Hanging Column Method:	ASTM D6836 (modified apparatus)
Pressure Plate Method:	ASTM D6836 (modified apparatus)
Water Potential (Dewpoint Potentiometer) Method:	ASTM D6836
Relative Humidity (Box) Method:	Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis. Part 1. American Society of Agronomy, Madison, WI; Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Particle Size Analysis:	ASTM D422
USCS (ASTM) Classification:	ASTM D422, ASTM D2487
USDA Classification:	ASTM D422, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Visual-Manual Description:	ASTM D2488
Standard Proctor Compaction:	ASTM D698
Coarse Fraction (Gravel) Correction (calc):	ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose Zones. Groundwater Vol. 22, No. 6
Water Holding Capacity (calc):	ASTM D6836; Stephens, D. B. 1996, pp.11-12, Vadose Zone Hydrology. CRC Press, Inc., Boca Raton, FL

Attachment 2
Estimated Performance of an Evapotranspiration Cover for the Former ASARCO Smelter Site

Estimated performance of an evapotranspiration cover for the Former ASARCO Smelter Site

William H Albright, PhD

This report summarizes estimates of required and available water storage relative to design of an evapotranspiration final cover for the Former ASARCO Smelter Site near East Helena, MT.

Evapotranspiration (ET), or water balance, covers for final closure of waste sites function by providing water storage in the cover soils for periods when precipitation exceeds evapotranspiration. The available storage capacity in a soil profile can be calculated and is a product of the soil hydraulic properties and the cover thickness. The required storage capacity for an effective ET cover for a specific site can be difficult to estimate and requires consideration of temporal variation in precipitation, evaporation, and transpiration. The required storage method employed in this technical memorandum provides a preliminary calculation of storage required and required layer thickness to provide adequate available storage based on empirical results from large-scale field tests, monthly summaries of precipitation, evaporation, and transpiration, and soil properties of selected borrow soils.

The required storage is based on results from the Alternative Cover Assessment Program (ACAP) funded by the USEPA and is described in *Water Balance Covers for Waste Containment: Principles and Practice* (Albright, Benson, Waugh, ASTM Press, 2010). Estimates of required storage by the ACAP method are based on methods and coefficients derived from data collected in a nation-wide network of large-scale field tests of covers. Although semi-empirical, the required storage method has general applicability because of the large database (28 final cover test sections in 11 states monitored for 4-8 years) used to create the method.

Required Storage: Method

The required storage (S_r) is the design amount of water to be stored in the cover profile for a given site. Regression analysis of the ACAP data was used to identify two important factors: (1) monthly thresholds for the ratio of precipitation (P) to potential evapotranspiration (PET) beyond which water accumulates in an ET cover; and (2) the amount of water that accumulates in the soil profile in months with threshold exceedance. The ACAP data were segregated for sites with snow and frozen ground vs. sites without freezing conditions and by the warm and cool seasons in North America (fall-winter vs. spring-summer). At “cold” sites water accumulates when the monthly threshold for P/PET exceeds 0.51 (fall/winter) and 0.32 (spring/summer). The method assumes that during months when P/PET falls below these thresholds, water does not accumulate.

When the monthly threshold is exceeded the monthly accumulation of soil water storage (ΔS) can be computed using the water balance equation:

$$\Delta S = P - R - ET - L - P_r \qquad (1)$$

where P is monthly precipitation, R is monthly runoff, ET is monthly evapotranspiration, L is monthly internal lateral drainage, and P_r is monthly percolation. Of the quantities on the right-hand side of Eq. 1, only P is available for design. However, ET can be assumed to be a fraction (β) of PET, L is usually very small and can be ignored (Albright et al. 2004). The remaining components, R and P_r, are combined into a loss term (Λ) to simplify Eq. 1 as:

$$\Delta S = P - \beta\, PET - \Lambda \qquad (2)$$

Values for β and Λ were obtained by fitting Eq. 2 to the ACAP data set (Apiwantragoon 2007). Thus, given defined values for β and Λ, Eq. 2 can be used to estimate the monthly accumulation in soil water storage using precipitation and PET data which are available for the former ASARCO site. For Montana ("cold" sites) β = 0.37 (fall/winter) and 1.00 (spring/summer) and Λ = 0.0 mm (fall/winter) and 167.8 mm (spring/summer).

Using the monthly thresholds for water accumulation and the β and Λ parameters for "cold sites", the required storage (S_r) in a design year can be estimated by summing the monthly ΔS for all fall/winter months and all spring/summer months:

$$S_r = \sum_{i=1}^{6} \Delta S_{i,FW} + \sum_{i=7}^{12} \Delta S_{i,SS} \qquad (3)$$

where $\Delta S_{i,FW}$ is the change in storage during the i^{th} month of fall and winter and $\Delta S_{i,SS}$ is the change in storage during the i^{th} month of spring and summer. Both $\Delta S_{i,FW}$ and $\Delta S_{i,SS}$ are computed with Eq. 2 using monthly data and the β and Λ parameters. The terms $\Delta S_{i,FW}$ and $\Delta S_{i,SS}$ are included in Eq. 3 only for those months when the monthly P/PET exceeds the thresholds, and in only those cases where either term is greater than or equal to zero (i.e., terms less than zero are not included). Additional detail of this method is in (Albright et al. 2010).

Available storage: Method

Available storage is the product of the plant-available water storage capacity of the soil and the thickness of the cover. The plant-available water storage capacity of a cover can be calculated from the soil water characteristic curve (SWCC). The SWCC is typically analyzed in the lab (ASTM D6836) and produces data which may be fit with a least-squares method to the van Genuchten equation to describe a continuous relationship between soil water suction and volumetric soil water content. From that relationship two important points are calculated - the water contents of the soil at field capacity (33 kPa) and at wilting point (1500 kPa). The difference between these two points is called the "plant-available water holding capacity". This inherent storage characteristic of the soil (given in mm of stored water per unit depth of soil) multiplied by the thickness of the cover gives the storage capacity of a cover soil profile.

Results for Former ASARCO Smelter Site

Required storage for the Former ASARCO Smelter Site

Required storage was computed using P and PET data from the Western Regional Climate Center (WRCC), results are shown in Table 1. Free access to the National Land Data Assimilation System (NLDAS) (Mitchell et al., 2004) gridded weather data on the Google Earth Engine (GEE) cloud computing platform, has provided a unique opportunity to develop a complete historical time series of reference evapotranspiration (ETo) from 1979 to present. The Desert Research Institute has developed Python and JavaScript programs that are executed on the GEE cloud computing platform to rapidly process NLDAS gridded weather data for estimating ETo. Bias corrected and spatially disaggregated (BCSD) NLDAS gridded weather data of daily maximum and minimum air temperature (Tmax and Tmin), daily maximum and minimum relative humidity (RHmax and RHmin), solar radiation (Rs) and daily average windspeed at 2m height (u2) were utilized to estimate daily and monthly ETo. Daily NLDAS weather data available on the GEE were spatially disaggregated to a 4 km spatial resolution by Abatzoglou (2011) based on Parameter Regression on Independent Slopes Model (PRISM) (Daly, 2008) 4 km spatial resolution monthly temperature and precipitation data. Because a finer spatial resolution (<12 km) product of Rs and u2 does not exist, simple bilinear interpolation was performed to resample from 12 km to 4 km (Abatzoglou, 2011).

Available storage for the Former ASARCO Smelter Site

The soil thickness required to store the maximum required storage (49 mm, Table 1) is shown in Table 2 and was calculated for each soil sample using soil hydraulic property data supplied by Daniel B Stephens and Associates. The required soil layer thickness ranges between 0.21 and 0.80 m for as constructed conditions. The laboratory soil hydraulic property data were modified to reflect anticipated changes due to natural pedogenic processes including wet-dry and freeze-thaw cycles and biointrusion and required soil layer thickness ranges between 0.24 and 1.17 m. These natural processes typically increase porosity and introduce larger pores resulting in changes to soil storage properties. The effects of these processes were investigated at the ACAP research sites, results are reported in Benson et al. (2011) along with recommendations for adjustment factors for laboratory data. Soil layer thicknesses reflecting these recommendations required for storage of the maximum required storage value (49 mm) are also reported in Table 2. These required and available storage figures provide sufficient basis for a preliminary design of an ET cover for the smelter site. The calculated soil layer thicknesses to provide adequate soil water storage should be evaluated with regard to the thickness required to support the vegetative cover.

Table 1. Annual precipitation, PET, winter precipitation and required storage estimated from climate data for the Former ASARCO Smelter Site.

Year	Annual Precipitation (mm)	Annual PET (mm)	Annual Winter* Precipitation (mm)	Annual Required Storage (mm)
1979-80	335	1167	62	17
1980-81	393	1126	112	0
1981-82	310	1136	90	6
1982-83	265	1128	103	27
1983-84	364	1149	85	5
1984-85	168	1213	70	4
1985-86	304	1155	132	49
1986-87	301	1144	83	27
1987-88	269	1210	39	0
1988-89	262	1163	128	28
1989-90	276	1145	73	0
1990-91	287	1204	32	0
1991-92	230	1253	82	9
1992-93	331	1080	99	40
1992-94	372	1080	76	0
1994-95	266	1107	61	0
1995-96	297	1076	100	7
1996-97	264	1110	71	27
1997-98	353	1046	77	17
1998-99	268	1122	71	18
1999-00	202	1224	47	0
2000-01	249	1172	98	35
2001-02	36	201	60	0
2002-03	307	1130	79	0
2003-04	227	1241	53	0
2004-05	380	1129	78	0
2005-06	315	1288	93	16
2006-07	278	1283	107	20
2007-08	248	1258	96	0
2008-09	223	1232	84	8
2009-10	325	1179	71	4
2010-11	432	1148	111	41

* Winter precipitation is defined for this method as September through February.

Table 2. Unsaturated soil hydraulic parameters and the thickness of a layer of each soil required to store the maximum required storage (49 mm of water). Numbers in parentheses are corrected by the method described in the NRC report (Benson et al. 2011).

Soil sample	α (cm^{-1})	N	Volumetric water content (%)					Soil thickness (m) required to store 49 mm of water
			Residual	Saturated	Field capacity	Wilting point	Plant available	
EB-ET-1	0.0441 (0.0573)	1.29 (1.42)	0	20.2	9.1 (5.8)	3.0 (1.2)	6.1 (4.6)	0.80 (1.07)
EB-ET-2	0.0164 (0.0213)	1.34 (1.48)	0	25.2	13.6 (9.6)	3.8 (1.6)	9.8 (8.0)	0.50 (0.61)
EB-ET-3	0.0155 (0.0202)	1.31 (1.45)	1.42	39.9	23.8 (17.4)	8.4 (4.3)	15.4 (13.1)	0.32 (0.37)
VV-ET-1	0.0090 (0.0117)	1.20 (1.33)	0	45.2	34.7 (27.8)	16.5 (8.2)	18.2 (19.6)	0.27 (0.25)
VV-ET-2	0.0095 (0.0124)	1.23 (1.36)	1.81	38.8	28.9 (23.2)	13.4 (7.4)	15.5 (15.8)	0.32 (0.31)
VV-ET-3	0.0121 (0.0157)	1.28 (1.41)	1.83	35.6	23.9 (18.5)	9.6 (5.4	14.3 (13.1)	0.34 (0.37)
VVL Comp 0-10	0.0061 (0.0079)	1.30 (1.43)	1.12	44.6	28.9 (24.1)	10.5 (5.8)	18.4 (18.3)	0.27 (0.27)
VVL Comp 11-15	0.0140 (0.0181)	1.32 (1.45)	0.27	43.0	22.7 (16.7)	7.2 (3.3)	15.5 (13.4)	0.32 (0.37)
VVL Comp 16-20	0.0094 (0.0123)	1.26 (1.39	0.00	46.9	30.3 (23.9)	11.6 (5.6)	18.7 (18.3)	0.26 (0.27)
VVL Comp 21-30	0.0089 (0.0116)	1.26 (1.39)	0.00	48.7	30.7 (24.4)	11.8 (5.7)	18.9 (18.7)	0.26 (0.26)
VVL Comp 31+	0.0065 (0.0837)	1.21 (1.46)	0.00	57.4	43.2 (11.7)	20.3 (2.0)	22.9 (9.7)	0.21 (0.51)
VVL Comp TP-10	0.0231 (0.0300)	1.31 (1.44)	1.43	43.9	20.4 (14.4)	7.2 (3.7)	13.2 (10.7)	0.37 (0.46)
VVL Comp TP-12	0.0059 (0.0077)	1.30 (1.43)	3.43	46.8	32.0 (26.9)	13.0 (8.0)	19.0 (18.9)	0.26 (0.26)
VVL Comp TP-13	0.0083 (0.0108)	1.25 (1.37)	0.00	49.4	34.0 (27.3)	14.0 (7.0)	20.0 (20.3)	0.25 (0.24)
WB Borrow-1	0.0179 (0.0233)	1.29 (1.42)	1.94	47.4	26.6 (19.4)	10.3 (5.4)	16.3 (14.0)	0.30 (0.35)
WB Stockpile-1	0.0118 (0.1522)	1.29 (1.54)	1.45	44.3	27.8 (6.2	10.6 (2.0)	17.3 (4.2)	0.28 (1.17)
WB Stockpile-2	0.0153 (0.0199)	1.36 (1.50)	3.35	47.1	22.7 (17.0)	7.9 (5.0)	14.8 (12.0)	0.33 (0.41)
Topsoil-1	0.0137 (0.0177)	1.39 (1.52)	3.92	59.7	34.0 (25.6)	11.1 (7.0)	22.9 (18.6)	0.21 (0.26)

References

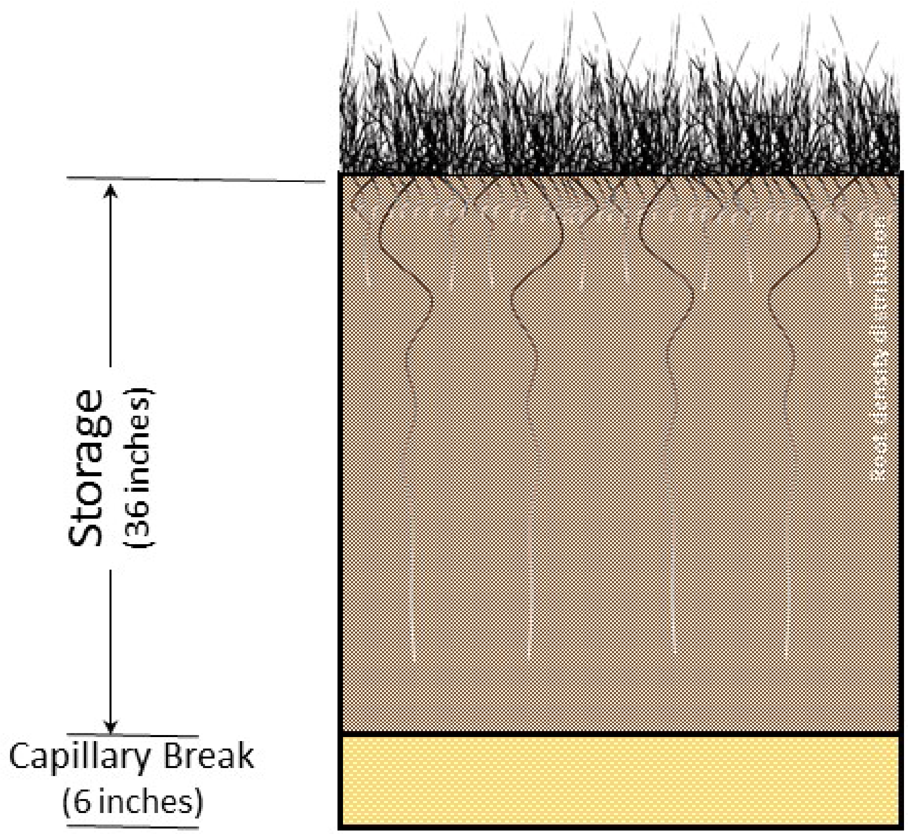
Albright, W.H., Benson, C.H., and Waugh, W.J., 2010. Water Balance Covers for Waste Containment: Principles and Practice. ASCE Press, Reston VA.

Albright, W., Benson, C., Gee, G., Roesler, A., Abichou, T., Apiwantragoon, P., Lyles, B., and Rock, S. (2004). “Field water balance of landfill final covers”. *J. Environ. Qual*. 33(6), 2317-2332.

Apiwantragoon, P. (2007). “Field hydrologic evaluation of final covers for waste containment.” Ph.D. dissertation, University of Wisconsin, Madison, Wisc.

Benson, C., Albright, W., Fratta, D., Tinjum, J., Kucukkirca, E., Lee, S., Scalia, J., Schlicht, P., Wang, X. 2011. Engineered Covers for Waste Containment: Changes in Engineering Properties & Implications for Long-Term Performance Assessment, NUREG/CR-7028, Office of Research, U.S. Nuclear Regulatory Commission, Washington.

Attachment 3
HYDRUS Model Inputs Conceptual Diagram



Upper Boundary - Atmospheric Conditions

Daily Precipitation 1979 – 2013 Helena Airport Station
Meteorological data from Helena, MT AgriMet station and NLDAS data used to develop reference evapotranspiration.

Vegetation – PET Conditions

Total potential evapotranspiration calculated using grass as a reference crop and the reference evapotranspiration.
End of month average leaf area index values used for western wheatgrass to calculate potential transpiration and remainder potential evaporation.
Rooting depth distribution 32 inches and based on grassland plant communities test site near Helena, MT.
Plant water stress parameters used for wheatgrass-dominated vegetation community.

Storage Layer – Soil Hydraulic Model

Single porosity model, van Genuchten – Mualem water retention curve without hysteresis.
Soil type specific parameters including van Genuchten soil parameters, saturated hydraulic conductivity, residual and saturated soil water content.

Capillary Break – Soil Hydraulic Model

Coarse grained soil type used for every simulation

Lower Boundary – Free Drainage

Free draining below capillary break layer considered percolation

Attachment 4
HYDRUS Model Results Summary

Sim9 VV-ET-3

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	107.6	198.5	-0.0044	-16.0070	-1.6007	303.2	30.3	0	Sim9	10/22/14	36" - VV-ET-3; Corrected	6" - EB-ET-2; Corrected	0.490	
2nd	7306	79-88	214.3	645.8	105.1	195.9	-0.0001	-0.3270	-0.0327	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	92.2	197.4	-0.0001	-0.2660	-0.0266	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	88.5	179.3	0.0000	-0.0040	-0.0004	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	46.3	95.6	0.0000	-0.0410	-0.0086	144.1	30.3	0						

Sim10 VV-ET-2

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	106.4	201.9	-0.0039	-14.4110	-1.4411	303.2	30.3	0	Sim10	10/22/14	36" - VV-ET-2; Corrected	6" - EB-ET-2; Corrected	0.429	
2nd	7306	79-88	214.3	645.8	102.3	199.2	0.0000	-0.0450	-0.0045	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	89.0	201.1	0.0000	-0.0440	-0.0044	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	85.2	182.9	0.0000	-0.0020	-0.0002	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	44.9	97.3	0.0000	-0.0030	-0.0006	144.1	30.3	0						

Sim11 VV-ET-1

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.1	111.0	201.5	-0.0036	-13.3220	-1.3322	302.5	30.2	0.53859	Sim11	10/23/14	36" - VV-ET-1; Corrected	6" - EB-ET-2; UnCorrected	0.340	Would not converge with water content & pressure head tolerance at 0.001 & 0.1 respecti
2nd	7306	79-88	214.3	645.1	102.4	199.1	0.0000	-0.0020	-0.0002	302.5	30.3	0.52401						
3rd	10958	89-98	203.0	626.1	88.2	202.1	0.0000	-0.0020	-0.0002	288.9	28.9	0.53859						
4th	14611	99-08	217.7	698.9	85.5	183.1	0.0000	-0.0020	-0.0002	270.4	27.0	0.52401						
<5th	16345	09-13	107.7	336.5	45.5	97.1	0.0000	-0.0010	-0.0002	144.1	30.3	0.53869						

Sim12 WB Borrow-1

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	112.8	197.1	-0.0049	-17.7950	-1.7795	303.2	30.3	0	Sim12	10/22/14	36" - WB Borrow 1; Corrected	6" - EB-ET-2; Corrected	0.318	
2nd	7306	79-88	214.3	645.8	107.1	194.9	0.0000	-0.0030	-0.0003	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	93.2	197.2	0.0000	-0.0030	-0.0003	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	89.9	178.8	0.0000	0.0000	0.0000	270.4	27.0	0						
<5th	16345	09-13	107.6	336.5	47.7	95.1	0.0000	0.0000	0.0000	144.1	30.3	0						

Sim23 WB Borrow-1 (uncorrected K for Cap Break)

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	112.6	197.0	-0.0049	-18.0590	-1.8059	303.2	30.3	0	Sim23	10/22/14	36" - WB Borrow 1; Corrected	6" - EB-ET-2; Uncorrected	0.316	Same as Sim12 but with uncorrected K for CB.
2nd	7306	79-88	214.3	645.8	107.1	194.9	0.0000	-0.0030	-0.0003	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	93.2	197.2	0.0000	-0.0040	-0.0004	288.9	28.9	0						
4th	14611	99-08	217.7	698.9	89.9	178.8	0.0000	-0.0030	-0.0003	270.4	27.0	0						
<5th	16345	09-13	107.6	336.5	47.7	95.1	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim13 WB Stockpile-1

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	109.6	199.9	-0.0048	-17.5460	-1.7546	303.2	30.3	0	Sim13	10/22/14	36" - WB Stockpile-1; Corrected	6" - EB-ET-2; Corrected	0.388	
2nd	7306	79-88	214.3	645.8	104.4	197.3	0.0000	-0.0110	-0.0011	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	91.1	199.1	0.0000	-0.0170	-0.0017	288.8	28.9	0						
4th	14611	99-08	217.7	698.8	87.4	181.0	0.0000	0.0000	0.0000	270.4	27.0	0						
<5th	16345	09-13	107.6	336.6	46.2	96.2	0.0000	0.0000	0.0000	144.1	30.3	0						

Sim24 WB Stockpile-1 (uncorrected K for Cap. Break)

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	109.4	199.8	-0.0049	-17.9180	-1.7918	303.2	30.3	0	Sim24	10/22/14	36" - WB Stockpile-1; Corrected	6" - EB-ET-2; Uncorrected	0.389	Same as Sim13 but with uncorrected K for CB.
2nd	7306	79-88	214.3	645.8	104.4	197.3	0.0000	-0.0140	-0.0014	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	91.1	199.1	0.0000	-0.0210	-0.0021	288.8	28.9	0						
4th	14611	99-08	217.7	698.8	87.4	181.0	0.0000	-0.0040	-0.0004	270.4	27.0	0						
<5th	16345	09-13	107.6	336.6	46.2	96.2	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim14 WB Stockpile-2

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	114.2	193.0	-0.0051	-18.4720	-1.8472	303.2	30.3	0	Sim14	10/22/14	36" - WB Stockpile-2; Corrected	6" - EB-ET-2; Corrected	0.379	
2nd	7306	79-88	214.3	645.8	110.5	191.3	0.0000	-0.0220	-0.0022	303.2	30.3	0						

3rd	10958	89-98	203.0	626.1	97.0	193.3	0.0000	-0.0520	-0.0052	288.8	28.9	0
4th	14611	99-08	217.7	698.8	93.4	175.1	0.0000	-0.0030	-0.0003	270.4	27.0	0
<5th	16345	09-13	107.6	336.6	49.3	93.3	0.0000	0.0000	0.0000	144.1	30.3	0

Sim25 WB Stockpile-2 (uncorrected K for Cap. Break)

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	113.9	193.0	-0.0051	-18.7450	-1.8745	303.2	30.3	0	Sim25	10/22/14	36" - WB Stockpile-2; Corrected	6" - EB-ET-2; Uncorrected	0.382	Same as Sim14 but with uncorrected K for CB.
2nd	7306	79-88	214.3	645.8	110.5	191.3	0.0000	-0.0280	-0.0028	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	97.0	193.3	0.0000	-0.0660	-0.0066	288.8	28.9	0						
4th	14611	99-08	217.7	698.8	93.4	175.1	0.0000	-0.0030	-0.0003	270.4	27.0	0						
<5th	16345	09-13	107.6	336.6	49.3	93.3	0.0000	-0.0020	-0.0004	144.1	30.3	0						

Sim15 VV-L Comp 0-10

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	104.3	206.0	-0.0043	-15.5410	-1.5541	303.2	30.3	0	Sim15	10/22/14	36" - VV-L Comp 0-10; Corrected	6" - EB-ET-2; Corrected	0.431	
2nd	7306	79-88	214.3	645.8	99.6	201.9	0.0000	-0.0610	-0.0061	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	86.7	203.1	0.0000	-0.0510	-0.0051	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	82.9	185.2	0.0000	-0.0030	-0.0003	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	43.6	98.4	0.0000	-0.0070	-0.0015	144.1	30.3	0						

Sim16 VV-L Comp 11-15

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	108.9	198.0	-0.0051	-18.5130	-1.8513	303.2	30.3	0	Sim16	10/22/14	36" - VV-L Comp 11-15; Corrected	6" - EB-ET-2; Corrected	0.472	
2nd	7306	79-88	214.3	645.8	106.0	195.2	-0.0001	-0.2300	-0.0230	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	93.1	196.6	-0.0001	-0.2020	-0.0202	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	89.2	178.6	0.0000	-0.0030	-0.0003	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	46.8	95.2	0.0000	-0.0240	-0.0051	144.1	30.3	0						

Sim17 VV-L Comp 16-20

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	104.6	206.3	-0.0047	-17.2050	-1.7205	303.2	30.3	0	Sim17	10/22/14	36" - VV-L Comp 16-20; Corrected	6" - EB-ET-2; Corrected	0.395	
2nd	7306	79-88	214.3	645.8	99.1	202.6	0.0000	-0.0220	-0.0022	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	86.0	204.0	0.0000	-0.0200	-0.0020	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	82.2	186.1	0.0000	-0.0010	-0.0001	270.4	27.0	0						
<5th	16345	09-13	107.6	336.5	43.4	98.8	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim18 VV-L Comp 21-30

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	106.6	204.8	-0.0046	-16.7980	-1.6798	303.2	30.3	0	Sim18	10/22/14	36" - VV-L Comp 21-30; Corrected	6" - EB-ET-2; Corrected	0.369	
2nd	7306	79-88	214.3	645.8	100.4	201.5	0.0000	-0.0070	-0.0007	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	87.0	203.2	0.0000	-0.0080	-0.0008	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	83.4	185.0	0.0000	0.0000	0.0000	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	44.2	98.3	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim 19 VV-L Comp 31+

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	104.4	212.1	-0.0043	-15.7130	-1.5713	303.2	30.3	0	Sim19	10/22/14	36" - VV-L Comp 31+; Corrected	6" - EB-ET-2; Corrected	0.285	
2nd	7306	79-88	214.3	645.8	94.0	208.2	0.0000	-0.0020	-0.0002	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	80.3	210.0	0.0000	-0.0020	-0.0002	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	77.3	191.5	0.0000	-0.0020	-0.0002	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	41.2	101.4	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim20 VV-L Comp TP-10

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	112.0	192.8	-0.0050	-18.2410	-1.8241	303.2	30.3	0	Sim20	10/22/14	36" - VV-L Comp TP-10; Corrected	6" - EB-ET-2; Corrected	0.476	
2nd	7306	79-88	214.3	645.8	109.9	191.1	-0.0001	-0.4040	-0.0404	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	96.9	192.8	-0.0001	-0.3750	-0.0375	288.9	28.9	0						
4th	14611	99-08	217.7	698.8	93.2	174.8	0.0000	-0.0030	-0.0003	270.3	27.0	0						
<5th	16345	09-13	107.7	336.5	48.6	93.2	0.0000	-0.0240	-0.0051	144.1	30.3	0						

Sim21 VV-L Comp TP-12

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes

1st	3653	79-88	214.3	645.8	107.7	203.5	-0.0042	-15.3380	-1.5338	303.2	30.3	0	Sim21	10/22/14	36" - VV-L Comp TP-12; Corrected	6" - EB-ET-2; Corrected	0.370	
2nd	7306	79-88	214.3	645.8	101.6	200.1	0.0000	-0.0100	-0.0010	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	88.5	201.8	0.0000	-0.0120	-0.0012	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	84.8	183.7	0.0000	-0.0020	-0.0002	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	44.8	97.6	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim22 VV-L Comp TP-13

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	105.0	207.6	-0.0045	-16.5740	-1.6574	303.2	30.3	0	Sim22	10/22/14	36" - VV-L Comp TP-13; Corrected	6" - EB-ET-2; Corrected	0.348	
2nd	7306	79-88	214.3	645.8	97.9	204.0	0.0000	-0.0050	-0.0005	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	84.6	205.7	0.0000	-0.0040	-0.0004	288.8	28.9	0						
4th	14611	99-08	217.7	698.9	81.0	187.5	0.0000	0.0000	0.0000	270.4	27.0	0						
<5th	16345	09-13	107.7	336.5	43.0	99.5	0.0000	-0.0010	-0.0002	144.1	30.3	0						

Sim26 SENSITIVITY RUN - CAPILLARY BREAK VALUES USED FOR BOTH ET LAYER AND CAP BREAK FULL PROFILE THICKNESS

decade	days	year	decadal sum pot. Transp. (cm)	decadal sum pot. Evap (cm)	decadal sum actual transp. (cm)	decadal sum actual evap. (cm)	avg. daily bottom percolation rate (cm/day)	Total decadal bottom percolation (cm)	average annual bottom percoloation rate (cm/year)	decadal precip. (cm)	average annual precip (cm/year)	Decadal Runoff (cm)	Sim#	Date	ET Thick & K	CB Thick & K	Water Balance (%)	Notes
1st	3653	79-88	214.3	645.8	96.9	201.7	-0.0048	-17.6640	-1.7664	303.2	30.3	0	Sim26	10/22/14	36" - EB-ET-2; UnCorrected	6" - EB-ET-2; UnCorrected	0.340	Trial run - used soil values for Cap. Break for entire 42" profile
2nd	7306	79-88	214.3	645.8	96.7	200.3	-0.0009	-3.4670	-0.3467	303.2	30.3	0						
3rd	10958	89-98	203.0	626.1	88.6	197.4	-0.0007	-2.5570	-0.2557	288.9	28.9	0						
4th	14611	99-08	217.7	698.8	90.3	176.3	-0.0001	-0.5300	-0.0530	270.4	27.0	0						
<5th	16345	09-13	107.7	336.6	45.0	96.2	-0.0006	-1.1130	-0.2343	144.1	30.3	0						

Note: last "period" only represents 4.75 years (09 to 2013); others are decades

Appendix C
Public Comments Received on the 2015/2016 Interim Measures Work Plan with U.S. Environmental Protection Agency Responses and Conditional Letter of Approval

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 10 West 15th Street, Suite 3200
HELENA, MT 59626-0096
Phone 866-457-2690
http://www.epa.gov/region08

Ref: 8MO

SENT VIA E-MAIL

May 1, 2015

Ms. Cynthia Brooks
Montana Environmental Trust Group
Trustee of the Montana Environmental Custodial Trust
100 Smelter Road
P. O. Box 1230
East Helena, MT 59635

Re: Conditional Approval of the Draft *Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016*, dated February 2015.

Dear Ms. Brooks,

On February 4, 2015, EPA submitted the Draft *Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016,* dated February 2015, for public review and comment as required in paragraph 72 of the First Modification to the 1998 USA v. ASARCO Consent Decree. EPA received five comments on the Work Plan and has provided responses to the comments (see attached).

Today, EPA is approving the proposed work for 2015-2016, as detailed in the Draft *Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016*, with the following conditions:

- The Montana Environmental Trust Group (METG) will incorporate modifications as requested in the EPA Response to Comments (see attachment);
- The comments submitted, along with the EPA responses, will be incorporated as an appendix into the 2014 Final Work Plan;
- The Montana Environmental Trust Group (METG) will incorporate the editorial and non-material changes detailed in the April 29, 2015 letter, from the Trust to EPA; and
- An Addenda to the Draft IMWP, referencing ongoing and planned source area investigations and source control IMs, will be provided to EPA later this year and submitted for public comment and review.

Please provide the Final 2015 and 2016 Work Plan with the requested changes to EPA within thirty days. If you have any questions on this letter or any related matter, please contact me directly at (406) 457-5013.

Sincerely,

Betsy Burns

Betsy Burns
Project Manager

Attachment

04/30/2015 – EPA RESPONSE TO MONTANA DEPARTMENT OF JUSTICE AND DEPARTMENT OF ENVIRONMENTAL QUALITY COMMENTS ON THE *DRAFT EAST HELENA INTERIM MEASURES WORK PLAN 2015 AND 2016*, DATED FEBRUARY 2015

Betsy Burns
Remedial Project Manager
US Environmental Protection Agency
10W 15th Street, Suite 3200
Helena, MT 59601

RE: Montana's Comments on Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016

Dear Ms. Burns:

The State of Montana, Through the Montana Department of Justice and Department of Environmental Quality, submit the following comments on the Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016 (2015 IMWP), submitted by the Montana Environmental Trust Group (METG).

EPA Response: EPA acknowledges that many of the comments below reflect the State's previously stated position on the Interim Measures and the Corrective Measures Study processes. In this response EPA reiterates our previous responses[1] and our position that the IM approach proposed for and being implemented at the East Helena Facility is protective of human health and the environment, and already is making significant, tangible early progress towards reducing exposure to contaminants at and from the former Smelter site while evaluations of potential final corrective measures are being conducted as part of the Corrective Measures Study. Further, this approach is consistent with all applicable regulations, RCRA guidance and the First Modification to the 1998 Consent Decree (1998 CD).

EPA is providing these responses independently of the Custodial Trust, however, EPA agrees with the Custodial Trust Response to Comments received from the Montana Department of Justice (MDOJ) on the Draft 2015-2016 Interim Measures Work Plan (IMWP), dated March 23, 2015. The Custodial Trust's response is included as Appendix D of the Work Plan

1. The State continues to maintain that the breadth of the proposed interim measures (IMs), which include plans through 2016, requires that those measures be developed through a conventional RCRA Corrective Measures Study (CMS). The State maintains that the present IM implementation schedule will likely lead to a CMS analysis that is non-substantive in nature and merely endorses the IMs that are already in place or on the table, as the IMs will already be implemented to a large degree by that time, and are of a permanent nature. Clearly, if the CMS analysis had been performed several years ago, as repeatedly requested by the State and initially planned by METG, cleanup actions at the

[1] (see, for example, EPA Response to [State] Comments on *Final Draft Former ASARCO East Helena Facility Interim Measures Work Plan – Conceptual Overview of Proposed Interim Measures and Details of 2012 Activities – dated August 27, 2012*, EPA Response to [State] Comments on the *Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2013* and EPA Response to Comments on the *Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2014*).

site could be proceeding in a comprehensive, more deliberate fashion, and achieving significant cost savings. Taking the IM path for the East Helena site remains problematic, as many final remedies are being put in place without a final remedy investigation and analysis components.

EPA Response – EPA responded to this comment in correspondence to the State dated April 28, 2014. A copy of the correspondence was included in Appendix B to the final *Former ASARCO East Helena Facility Interim Measures Work Plan – 2014*, dated May 2014. Additional clarification is provided below:

a. The State comment that “the IM implementation schedule will lead to a CMS analysis that is non- substantive in nature and merely endorses the IMs that are already in place or on the table, as the IMs will already be implemented, at least to a large degree, by that time, and are of a permanent nature” is noted, again. The performance of the IMs will continue to be evaluated as part of the CMS process, and the need for and scope of final corrective measures will be identified based on monitoring results and actual environmental quality data. The technical evaluations of the IMs will meet all the requirements for remedy evaluation specified in the 1998 CD and the First Modification and all other RCRA requirements. EPA will ensure that the CMS process maintains the integrity of its intended purpose.
b. From the beginning, the Custodial Trust’s clearly and unambiguously stated intent has been that the proposed IMs become part of the final corrective measures if they work as intended. After extensive review and consideration of the conceptual framework, including consideration of comments from the State of Montana and other stakeholders, EPA approved this conceptual approach. EPA continuously monitors all site information and conditions and is continuously assessing whether adjustment to the conceptual approach, or modifications to existing work plans need to be made to ensure that the short and long term cleanup objectives expressed in the 1998 CD are met.
c. EPA does not agree with the State’s unsupported assertion that “if the CMS analysis had been performed several years ago, as repeatedly requested by the State and initially planned by METG, cleanup actions at the site could be proceeding in a comprehensive, more deliberate fashion, and achieving significant cost savings”. First, EPA is confident that investigations and clean-up actions at the facility are proceeding in a comprehensive and deliberate fashion. We cannot respond to your second point because no information is provided to support the assertion that significant cost savings would be achieved if an alternate path had been chosen.
d. See Custodial Trust response dated March 23, 2015.

2. The State continues to have significant issue with METG's IMWP process, which has led to cleanup decisions with questionable technical justifications and sometimes excessive or unjustifiable costs.

The State maintains that an independent, technically sound CMS should be developed that fully analyzes all potential RCRA alternatives. Given the enormous cost, the uncertainty about what contaminated soil will be removed, and the lack of analysis of the effectiveness of the proposed IMs, the State believes that implementing these corrective actions without further consideration is imprudent and needlessly wastes limited Trust resources. The State encourages a thoughtful and deliberative approach to the RCRA corrective action process. The State continues to advocate that a CMS be developed at this time.

EPA Response –

a. EPA requests that the State provide any data and/or specific examples to support the assertion that cleanup decisions are made "with questionable technical justifications and sometimes excessive or unjustifiable costs". EPA thoroughly reviews the supporting documentation for recommendations, requests adjustments as appropriate, and consults with stakeholders before providing approval. EPA is satisfied with the detailed technical justifications to date and believes that the cleanup costs are appropriate for the work being accomplished.

b. EPA requires that a CMS develop the technical information to show that the proposed final remedy(ies) will be protective and meet site-specific remedy performance standards. A CMS analyzing "all potential RCRA alternatives" is not a requirement of RCRA, does not ensure a greater environmental benefit or cost savings, and can waste time and resources by comparing theoretical alternatives that likely have no practical application at a particular facility. EPA supports the Custodial Trust's approach to focus CMS and IM evaluations on remedies that have been demonstrated to be effective, have the ability to meet remedial action objectives and remedy performance standards, can be implemented with finite Trust funds, and are compliant and consistent with RCRA regulation, guidance and practice.

c. See Custodial Trust response dated March 23, 2015.

3. METG has been working on the Corrective Measures Study Work Plan (CMS Work Plan), which is the primary outline for analyzing cleanup, for five years, but has not produced an adequate draft to the State, or to the public for review or comment. The CMS Work Plan and the CMS are required components of the RCRA consent decree. The CMS is to direct the analysis, design, and cleanup of the site. Once a CMS Work Plan is adopted, the next step is to perform a CMS study and then choose the corrective measures to be implemented from among the alternatives presented. These corrective measure alternatives would examine an alternative's effectiveness at cleaning up groundwater relative to its costs. The Trust contains a finite amount of money. It is therefore necessary to rely on a comprehensive cleanup plan to determine the best use of the funds, rather than EPA and METG's sweeping reliance on interim measures (IM). It appears that substantial Trust resources are being spent on activities that show no or little tangible effect on cleaning up the groundwater contamination problem. This may result, in part, from METG's failure to have an onsite manager, and that the project is being managed by out of state contractors, whose multi-state

priorities may not align with State and local needs for site cleanup. An evaluation of the effectiveness of these IMs on specifically cleaning up groundwater, the primary problem at the site, has not been performed.

EPA Response –

a. The Custodial Trust is preparing a CMS and has been conducting technical evaluations outlined in the draft CMS Work Plan first presented to and reviewed by EPA and the Beneficiaries in 2011, and again in 2014. The technical evaluations are shared with the State at routine working group meetings or via e-mail.

b. The assertion that little or no tangible effect on groundwater has occurred to date, is incorrect. Evaluations of the IMs with respect to their impact on groundwater are ongoing, have been provided to the State, and will be incorporated into the CMS and remedy selection process. These evaluations show that the IM's in place already are starting to achieve their intended effect on the groundwater regime.

c. As noted in Section 3 of the IMWP, the Custodial Trust has been conducting hydrologic monitoring since before the onset of IM activities to plan and document the hydrologic system response to the IMs. To date, plant site groundwater levels have declined from about two feet beneath the slag pile, to more than 10 feet in the south plant area. Lowering groundwater levels is one key objective of the SPHC IM intended to help attain the ultimate goal of improving downgradient groundwater quality. Groundwater quality monitoring to date has shown varying results across and downgradient of the plant site, with the most pronounced effects being an overall westward shift of the groundwater plumes (almost certainly due to elimination of seasonal recharge from Wilson Ditch), and expansion of the low concentration "gap" between the east and west selenium plume lobes north of the plant site. As anticipated and explained in the numerous workplans and reports generated to date regarding the IM's, the geochemical response to the SPHC and other IMs is quite complex and it will take some time for the full benefits to groundwater quality to be realized. The effects to groundwater quality to date, however, are quite encouraging, and are summarized in Section 3.2.

d. Information on the observed groundwater improvements and the results of the Fate & Transport modeling with the evaluation of the IM effectiveness was provided to the State on February 23, 2015 at the Technical Groundwater Team Meeting (4 State employees attended). Copies of the detailed slides were provided to the State on March 3, 2015 via the Montana File Transfer System.

e. EPA believes that the team that has been assembled by the Trust, with three on-site local Trust representatives has proven to be very effective and efficient.

4. The State again advocates a clear analysis and discussion of the measurable impacts to the current off-site plumes from the proposed IMs. Both the State and EPA based a significant part of their claims against ASARCO in the bankruptcy proceeding on the perceived need to remediate and restore the off-site groundwater plumes, yet there has

been no consideration of such an action by METG at this point in time. Implementation of the IMs presently considered, with their large projected costs, will in effect foreclose the possibility of remediating and restoring the groundwater under the City of East Helena due to the finite monetary amount of the Trust.

EPA Response – As discussed in the various public documents the State of Montana has reviewed and commented on, and as discussed in many meetings with representatives of the State of Montana, the proposed IMs are expected to have significant beneficial effects on the current off-site groundwater plumes, primarily by containing and isolating a significant percentage of contaminated soils (which represent one of most significant sources of contamination to groundwater). Reducing contaminant loading to groundwater is the primary goal of the IMs with the intent of a long-term improvement in downgradient groundwater quality. Starting in 2014 and continuing in 2015, the Custodial Trust has undertaken development of a contaminant fate and transport model for the specific purpose of evaluating effects of the currently proposed (Tier I) IMs and potential additional Tier II IMs on groundwater concentrations and plume extent. The model results, presented at the February 23rd, 2015 Groundwater Work Group meeting, suggest an approximate 70 percent reduction in groundwater arsenic mass and 40 percent reduction in groundwater selenium mass as a result of the Tier I IMs, and a 45 percent reduction in the volume of the selenium plume and minimal reduction in plume volume for arsenic (see 2/23/15 presentation slides distributed to the Groundwater Work Group). The groundwater modeling efforts and results represent a rigorous evaluation of predicted groundwater quality response to the proposed Tier I IMs, and possible additional Tier II IMs, as requested in the comment.

Additional evaluations are being planned to look at the overall combined effectiveness of IMs and evaluate the need for supplementary remedial options (i.e., to develop the final remedy). The Custodial Trust has revised the objectives and scope of the annual groundwater monitoring program for 2015 and beyond, placing less emphasis on general groundwater characterization and more emphasis on groundwater remedy (i.e., Tier I IMs) performance evaluation.

As part of the ongoing CMS evaluations, the Custodial Trust also continues to evaluate the need for and scope of additional groundwater remedies in the event that the projected or actual performance of the IMs does not adequately meet remedy performance standards. Your assertion that the project IM costs are staggering is noted. But because the State does not provide any supporting data or information and EPA cannot effectively respond other than to state that EPA, by reviewing the budgets, commenting on work plans, taking public comment on the work plans, and then approving the modified work plans, is of the opinion that significant environmental value is being obtained in exchange for the IM costs.

5. METG's failure to initially prepare the CMS, which would provide a comprehensive cleanup plan, has resulted in significant expenditures on engineering designs that have not or are not likely to be implemented, resulting in significant monetary losses for the Trust. Instead, the site is proceeding with a view toward the short-term, rather than employing a strategy that seeks to expend Trust money over a longer time span in a cost

effective manner to meet the goals of site cleanup.

EPA Response –

a. As previously noted, the Custodial Trust began preparing the CMS Work Plan in 2011, and the initial CMS evaluations were the basis for recommending the IMs.

b. We reiterate the request we made to the State in the January response to the State's comments on the 2015 East Helena Cleanup Budget to provide factual basis for the statement "METG's failure to initially prepare the CMS, which would provide a comprehensive cleanup plan, has resulted in significant expenditures on engineering designs that have not or are not likely to be implemented, resulting in significant monetary losses for the Trust."

c. Virtually all of the designs prepared by the Custodial Trust have been or are being implemented, except, where through initial development, EPA or the Trust have identified a more cost-effective approach (e.g., the CAMU #3 cell which was discontinued in favor of consolidation under an AOC boundary in conjunction with the ET cover IM).

d. Each iteration of the Interim Measures schedule details activities related to the implementation of IMs as Tier I measures, in conjunction with the evaluation and potential implementation of additional groundwater remedies as Tier II measures. The SPHC IM which culminates in the PPC Realignment is slated to be substantively completed in 2016 and finally completed around 2022, which is eight years from now and up to twelve years after the Custodial Trust was established.

e. EPA does not agree that slowing the pace of cleanup saves money over the long term. The approach to interim measures has been to address the sources of contamination first to reduce the further spread of contamination. It is well-documented that the cost of cleanup increases over time, and that allowing the further spread of contamination also increases the difficulty and cost of cleanup. EPA's highest priority for cleanup is protection of human health and the environment.

6. METG has not adequately analyzed the effectiveness of the IMs and compared that effectiveness to their costs, as is standard practice in RCRA and CERCLA cleanup projects. This lack of analysis has led to unnecessary IM components, conflicting and questionable cleanup rationale, questionable IM analyses and design quality, and excessive management and administrative costs.

EPA Response – See response to comments numbered 1 through 5 above, previous EPA responses to similar State comments on draft work plans in previous years, and the Custodial Trust response dated March 23, 2015.

7. METG proposes to cover the majority of the site with an interim cover system and the final ET Cover System. There has been no rigorously vetted analysis of the effectiveness of source removal, which is typically the most cost-effective remedial activity. It appears that METG has arbitrarily concluded not to perform source removal, and then developed an analysis to support that decision. METG has been

planning for an ET cover for several years, prior to any serious acknowledgement of the potential for source removal. Here, IM implementation will preclude or dramatically increase the cost of the most viable corrective action, source removal, which seems inconsistent with RCRA requirements and METG's RCRA consent decree obligations. The result is the lack of removal of groundwater saturated sources, coupled with implementation of IMs to help ensure that the sources won't be removed in the future.

EPA Response – The State's assertion that a rigorous analysis of source removal has not been conducted is incorrect. Preliminary source removal evaluations began in October 2012 and have been a continuous part of the CMS development process ever since. Several presentations detailing these source removal evaluations (MVS modeling presentations; Tito Park Area removal options evaluations; CMS Work Plan draft reviews; numerous technical work group sessions) were made by the Custodial Trust and attended by representatives of the State. In the past year, the Custodial Trust has prepared a Source Area Investigation Work Plan which includes an inventory and prioritization of groundwater contaminant source areas (Hydrometrics, November 2014), completed a field investigation of high priority contaminant source areas (Fall 2014), and prepared a 2014 Source Area Investigation report (Hydrometrics, February 2015). All of this material has been presented and reports provided to the Groundwater Technical Work Group which includes personnel from the State. Based on the 2014 investigation results, as well as prior data, the groundwater fate and transport model and Tier II Groundwater Remedy Evaluations have included an evaluation of various groundwater remedies including source removal, with source removal retained as one potential Tier II remedy in the West Selenium Source Area.

The statement that the IMs will preclude source removal is incorrect. The 2011 CMS schedule showed that the 2nd and 3rd phases of the ET Cover were originally proposed in 2014. However, the schedule was moved back, in part to allow for completion of the Tier II evaluations and cost-effective implementation if an additional (Tier II) source removal/control measure was found to have the necessary/appropriate cost-to-benefit for the West Selenium or North Plant Site Arsenic source areas, or other areas identified in the 2014 Source Inventory.

The State's assertion that the IMs have resulted in a lack of or inability to conduct source removal ignores the work completed to-date, including the TPA removal which disposed of thousands of yards of contaminated soils, buried drums and other metallic debris, buried Speiss material and building debris (follow-on Speiss removal planned in 2015 as part of ET cover construction), and the highly contaminated Acid Plant Sediment Drying (APSD) area soils (inside and outside of the APSD slurry wall). Ongoing Tier II evaluations will develop supplemental groundwater remedy options, including potential additional source removal/control actions, which will be planned for implementation prior to or after final construction of the ET Cover as appropriate.

8. There are continuing unanswered questions about the environmental benefits and

therefore the necessity of certain work. For example, there is no clear direct benefit to improvement of groundwater quality related to the removal of Tito Park, and there is the potential to further contaminate groundwater with movement of this waste source. METG has not quantified the effectiveness of the interim cover system at protecting groundwater, plus the interim cover system has not been permitted by DEQ as it is typically done. There were also flaws in the Prickly Pear Creek bypass channel design, pointed out by the State prior to construction. This, coupled with less than appropriate construction oversight management, led to inadequate adequate protection of the Yellowstone Pipeline underlying the Prickly Pear Creek, and the stability of the creek, which led to a costly change order to address the problem.

EPA Response –

a. The Custodial Trust has evaluated the benefits of removing Tito Park, and first presented its analysis to the beneficiaries in a meeting on April 17, 2013. The design basis for this source removal action also was presented in the 2014 IMWP. See also, our responses to comments 3, 4 and 7 above which also describe some of the tangible benefits currently observed from this action.

b. All permits needed to construct the ICS 1 cover were obtained from MDEQ. This temporary cover has been evaluated for effectiveness in preventing erosion and the effects of infiltration through underlying subgrade soils to groundwater as part of the design. Effects of the ICS 1 on infiltration and groundwater quality were considered appropriate for its expected approximate one-year design life (before the final ET cover is placed over it). Detailed design information on the ICS 1&2 have been shared with the State and MDEQ representatives were onsite to evaluate construction of ICS 1 during 2014.

c. The PPC Bypass construction was completed in November 2013, and the Bypass has been functioning as designed over the past two years of operation (including a March 2014 flooding event), conveying flows around the site, protecting smelter dam, and reducing groundwater levels beneath contaminated areas of the site. The design was developed (with review and input by MDOJ) and implemented as planned, and the cost of the project was completed within 1% of the bid price for the work.

d. The State's assertion regarding inadequate protection of the Yellowstone Pipeline is incorrect. Beginning in late 2013, the Custodial Trust communicated with the Yellowstone Pipeline Company (YPLC) with respect to bank stabilization. After waiting over a year for the YPLC to address their responsibilities in the matter, the Custodial Trust decided to proceed with the necessary remedial actions to ensure that the Bypass construction and operation does not impact this critical utility. Additional costs are due to the Custodial Trust's initiative and response in addressing the matter without the YPLC. For additional information, see the communications with YPLC provided as attachments to the Custodial Trust response dated March 23, 2015.

9. Paragraph 15 of the RCRA consent decree requires that, "Each IM Work Plan shall ensure that the interim measure is designed to mitigate immediate or potential threat(s) to human health and/or the environment, prevent or minimize the spread of hazardous waste

or hazardous substances, and is consistent with the objectives of and contribute to the performance of any long-term remedies which may be required at the ASARCO Properties." In the absence of the development of a CMS, the IMWP needs to document the connection to the CMS and the final remedy in each section. Please provide this information in the 2015 IMWP.

EPA Response – This question was previously answered in the 2014 response to State comments as the response to question #8. As we have stated numerous times, nothing is being done in "absence of the development of a Corrective Measures Study", as the CMS has been underway since 2011, and its relationship to the IMs has been documented in the draft CMS Work Plans (which have been submitted and reviewed by both EPA and the Beneficiaries) and will be further documented in the CMS Report.

10. The State strongly maintains that the public must be informed of the costs of each proposed interim measure and other elements of the budget for the 2015 IMWP, and that such cost estimates should be included in the IM work plan. These estimated costs are essential for full and meaningful public input on the 2015 IMWP, and the IMs planned for 2015 and 2016. In addition, the State has not received cost projections.

EPA Response – As previously stated in the response to comments for the 2012, 2013, and 2014 Interim Measures Work Plans, EPA disagrees. Cost information is not properly or appropriately included in a RCRA corrective action IMWP. Including such cost information would inaccurately suggest that EPA is seeking public comment on the estimated costs for the IMs. The purpose of an IMWP is to describe the objectives, scope and components of a proposed IM in a manner that can allow the public to provide informed comment, and the lead agency its informed decision on the proposal.

11. Similar to previous IMWPs, much of the discussion regarding IM regulatory requirements is general. Please provide substantive details so that the State, as well as the public, can provide meaningful input.

EPA Response – This question was previously answered in the 2014 response to State comments as the response to question #10. All work being conducted at the East Helena Facility is being performed in accordance with applicable regulations, and the appropriate agencies will be given the necessary information and documentation to support their required review and approval processes. In fact, unlike a CERCLA site, because the work is being performed under the RCRA Corrective Action program, the Custodial Trust is obligated to obtain permits when required by law. Information on permitting requirements is provided in great detail throughout the IMWP and specifically in Section 7 of the Draft Final IMWP 2015/2016.

12. Given the level of IM complexity, an overview of the site and contamination history is needed at the beginning of the IMWP so the reader can relate the IMs within the site itself.

EPA Response – This question was previously answered in the 2014 response to State comments as the response to question #11. In an effort to ensure work is delivered efficiently and cost-effectively, EPA has requested that the Custodial Trust's work plans and reports provide summaries of relevant information that has been presented in other documents, and reference those documents and discussions extensively, rather than repeat the details again and again. For example, a historical overview of smelter operations and site conditions has been presented in multiple documents, including the Corrective Measures Study Work Plan (CH2M HILL, 2014) and the Phase II RFI (METG, 2014). These documents have been provided to the Beneficiaries, and are available in the document repository at the East Helena Public Library and on the Custodial Trust's website. Additionally, EPA has ensured that representatives with Lewis and Clark County and the City of Helena have received copies of the above documents.

13. The IMWP should set forth how the 2015 IMWP actions relate to the CERCLA work, particularly the Process Ponds (OU 1) ROD.

EPA Response – This question was previously answered in the 2014 response to State comments as the response to question #12. The relationship of the IMs proposed for 2015/2016 to previous CERCLA actions is not information needed to evaluate and approve the proposed interim measures.

Specific Comments:

14. The 2015 IMWP states, "The soil was removed to eliminate the potential inundation and erosion from potential PPC flooding, meet the function needs of the PPC Realignment, support the development of wetland habitat in the PPC floodplain and reduce the overall footprint of the ET Cover System." Several aspects warrant comment.

a. "soil was removed to eliminate the potential inundation and erosion from potential PPC flooding"- The HEC-RAS surface water modeling performed for the permitting of the PPC activities does not indicate inundation or erosion of Tito Park during regulated flooding events(< or =100 year event). These wastes have been saturated for more than 80 years without any indication of surface water contaminant impacts. The SPHC lowered these wastes out of groundwater and the removal of the PPC dam eliminates backwater around Tito Park.

EPA Response – FEMA maps show the TPA area to be within the 100-year floodplain of the PPC. At completion of the PPC realignment flooding at the 100-year level is expected to be fully contained within the development area of the creek, which includes a portion of the former TPA area (refer to Figure 2-3 of the 2015/2016 IMWP for PPC development areas within the former TPA area). Flooding beyond the 100 year event likely will temporarily inundate additional portions of the former TPA. Further, stormwater runoff from portions of the ET cover, and from a large area of the west bench (above the existing CAMUs) discharge to this area of the facility. These flows will be beneficial to proposed wetland development for the former TPA area.

b. "meet the function needs of the PPC Realignment"- Figure 1.2 of the 2015 IMWP clearly contradicts this statement. The active channel and floodway do not intersect with the Tito Park removal area.

EPA Response –See response to a. above. In addition, the current design provides a much wider area for flood storage, creating a more stable transition from the area to the PPC corridor. This is also adjacent to the portion of the flood plain that narrows and transitions from the deformable stream reach to the steep reach below the dam. This area may be subject to considerable shear stresses along the toes of the slopes and EPA believes that it is better overall to have removed the material and so reduce the floodplain constriction in this area.

c. "support the development of wetland habitat in in the PPC flood plain" –The documentation submitted to support the permit applications to the ACE and other agencies shows most of the Tito Park removal areas as uplands not wetlands. Lower Lake is shown as wetlands. However, there was only minor removal from that area, and that would be a wetland under any scenario.

EPA Response – See response to a. above. Regarding Lower Lake, the statement in the comment is incorrect. After PPC realignment is complete the elevation of the creek adjacent the current Lower Lake area will be much lower than the current elevation. As a result the entire former Lower Lake would likely become upland habitat without additional excavation.

d. "reduce the overall footprint of the ET Cover System" - This statement is correct. The real consideration is one of cost. Did removal of Tito Park and construction of the interim cover system, which is only needed to protect this new on site groundwater source of Tito Park wastes, cost less than the ET cover for this less than 9 acre areas. The analysis described above "Tito Park Grading Options Evaluation" (May 9, 2013) clearly did not demonstrate this.

EPA Response – Cost is one factor in the decision to remove the TPA area, and it is considered along with environmental benefit achieved. Given the very competitive IM construction costs that have been obtained during previous (2012, 2013, and 2014) construction seasons and forecasted for 2015/2016 construction activities, the cost-to-environmental-benefit ratio of the removal of the TPA and its benefit to the remediated habitat of the PPC realignment and to risk reduction/contamination control on site remain positive and consistent with the results and conclusions of the original evaluation. See response to #7 above, for additional clarification.

The State's comment that the ICS is only needed to protect the Tito Park soils is incorrect. The ICS and subgrade material is needed as a foundation/bio-barrier layer for the ET Cover and provides protection from direct contact, infiltration, and stormwater contact with impacted soil as part of the final ET Cover.

15. Page 1-2; Section 1.3.2 Performance Evaluation:

A technical evaluation of the effectiveness of improving groundwater quality with the identified IMs has not been provided to the State or the public. Section 3.2 provides groundwater elevation decreases from implementing SPHC. However, this does not address its impact on groundwater quality.

EPA Response – Section 3.1 of the IMWP presents changes in groundwater elevations to date and 3.2 discusses changes in water quality. The references in Section 1.3.2 have been corrected. Additionally, see EPA response in 3.d. above for a response to the State's assertion that such information has not been provided to the State or public.

16. Page 1-3; Section 1.4 Proposed Activities:

METG took the Tito Park wastes and transported them onsite, creating a further waste source. The Tito Park wastes were spread around onsite, exposing them to atmospheric and other geochemical leaching processes. METG constructed a cover system (the interim cover system) to limit leaching to groundwater; however METG has not provided the design specifics to the State, nor provided the HELP model. METG has also not provided an interim cover system groundwater monitoring or performance plan, as is typically required for cover systems.

EPA Response – First, moving TPA wastes on site did not create another source. The measure consolidated existing sources into a smaller footprint and put them under a protective cover. Second, see response to comment 8.b. above, which outlines the evaluations that were conducted on the ICS. Given the short-term expected duration of the ICS, and the fact that it is not a permanent cover system (again, it is a temporary cover that is part of the subgrade for the final ET Cover System), the need for extensive detailed modeling on long-term performance is not warranted or justified. EPA has verified with MDEQ that an interim cover system groundwater monitoring or performance plan is not be required.

In addition, it appears that METG has not investigated the applicability of Montana Ground Water Pollution Control System permit (MGWPCS) for this interim cover system cover system or the final ET over system. Lewis and Clark County, along with Jamie Schell (Mayor of East Helena), have submitted comments on the 2014 IMWP with similar interim cover system groundwater protection concerns.

EPA Response – See response to 8.b. above. All construction was completed within applicable and appropriate permits. These permits were developed through numerous discussions with State, County, and local officials. Further, representatives of the MDOJ, MDEQ, Lewis and Clark County, and the City of East Helena have been provided numerous tours of construction activities over the execution of this work.

17. Page 2-3; Section 2.2.1.2 interim cover system 2 Construction:

The Objectives section states "The primary purpose of the interim cover system 2 is to protectively manage materials excavated during the PPC Realignment until the ET cover east can be constructed." However, the PPC realignment materials have not been identified as contaminated. The purpose is protecting groundwater from the existing contamination sources that will now be exposed to infiltration because the current liner system is being removed. Please provide a quantitative analysis as to the effectiveness of eliminating infiltration for the interim cover system in general and the interim cover system 2.

EPA Response – EPA will request that the text be modified to state that '*The primary purpose of the ICS is to function as the subgrade and biobarrier portion of the final ET Cover System*.' In the interim condition, the ICS functions to stabilize the surface soils from erosion, and to promote shedding of non-contact stormwater to clean discharge. One benefit of the ET Cover System is protecting groundwater through reduced infiltration. The ICS is expected to operate as the primary cover for approximately one year before the final ET Cover is constructed over it.

18. Page 2-5; Section 2.2.2 Monitoring Network Modification:

METG proposes decommissioning monitoring wells based on "30 years of monitoring and evaluation experience." However, METG is implementing IMs in an attempt to dramatically change the hydrogeological system. If so, METG's knowledge of the last 30 years seems to have little bearing on future conditions. Decommissioning monitoring wells without analysis in this circumstance is not appropriate.

EPA Response –Any proposed well adjustments (either decommissioning or new wells) will be based on an analysis of the extensive facility historical knowledge base, and of existing well performance, coupled with the forecasted flow conditions developed from detailed flow modeling performed as part of ongoing CMS evaluations. It is agreed that prior to abandoning any monitoring wells, an analysis will first be conducted to ensure that the well is not needed for evaluating ongoing water quantity and quality changes.

The section states "The overall plan and strategy for monitoring the performance of the IMs and their effect on groundwater quality contamination will be developed as part of the final remedy selection." METG should not delay IM performance monitoring until after the final remedy is selected. Performance monitoring of IM components should be begin when IMs are implemented.

EPA Response –Studies of IM performance impacts relative to groundwater began in November, 2011 with the initiation of the Upper Lake drawdown test, and continued with the development of the detailed groundwater flow model beginning in August, 2012 and the groundwater fate and transport model in August, 2014. The objectives of the Corrective Action Monitoring Plan (CAMP), are not only continuing to provide information on the nature and extent of contamination but also to support the ongoing remedy evaluations as part of the CMS process. They are now assisting the Trust in evaluating the effects on groundwater flow and quality resulting from IM implementation. Further, the CAMP will be modified in the future to require performance monitoring of all remedy components developed and implemented as part of the CMS. EPA will request that the language in the IMWP will be revised to reflect the current and future objectives of the CAMP. Also see responses to Comments 3.d. and 4.

19. Page 3-4; Section 3.2 Arsenic and Selenium in Groundwater:

This brief description focuses on water elevation. However, improvement of water quality should be the focus. This section acknowledges that the IMs have substantially altered the flow system and that the plumes are moving more to the west. It states "A western shift observed in both the arsenic and selenium plumes since 2011 is attributable to SPHC IM." If the IMs had been analyzed prior to implementation, this shift may have been predicted and an adequate monitoring plan would be in place to ensure the IM is not contaminating groundwater areas not previously impacted. This section also acknowledges that the hydrogeological system is changing and needs to be monitored, but does not include a monitoring plan to collect data as part of the activities.

EPA Response – As indicated in response to comment #18, efficacy studies have been underway since 2011 regarding evaluating potential future impacts of the IMs (and future additional remedy components) and the protective benefits of the IMs were identified prior to their implementation. The CAMP has been prepared to verify the impacts on groundwater from the IMs.

The State's implication that the plume shift and changes in the hydrogeological system were not anticipated is unfounded. Extensive groundwater monitoring studies and groundwater modeling all confirm that a plume shift resulting from elimination of seasonal irrigation flow within Wilson Ditch would occur. The westward shift of the plume is slight, and not anticipated to impact significant previously un-impacted areas. Of course, it also is being monitored by the existing monitoring well network.

20. Page 4-1; Section 4.1 Data Sufficiency:

The groundwater flow model was not used to predict the performance of SPHC IM. This Flow model was used to predict water elevation and flow field changes rather than improvement of groundwater quality. Under the Groundwater F&T Model bullet, METG acknowledges that it has not evaluated the IMs for effectiveness in reducing arsenic and selenium contamination. This evaluation should have occurred prior to implementation of IM cleanup actions.

EPA Response – The performance objective of the SPHC IM is to reduce groundwater levels and gradient flux beneath contaminated portions of the site to help attain the overall goal of improving downgradient groundwater quality. The reduction in water levels contributes to the improvement of groundwater quality by taking significant contaminant mass (located within pre-SPHC IM saturated zones) out of contact with groundwater, thereby reducing the mass flux of contaminants to groundwater. The primary performance metric for the SPHC is therefore a reduction in groundwater elevation levels. As such, the groundwater flow model is the appropriate evaluation tool. In fact, it was used to evaluate attainment of the SPHC performance objective. As previously mentioned in comment responses above, analyses evaluating these benefits have been ongoing as part of the CMS process. These analyses (including groundwater flow and fate and transport modeling) have been developed (beginning in 2011) to support the planning, design, and implementation of IMs. Further, ongoing evaluation of additional remedial alternatives are occurring to support development of the final remedy as part of the CMS process.

21. Page 5-6; Section 5.3.1 Key Design Objectives:

The key design objective for the interim cover system and interim cover system 2 is to eliminate infiltration through left in place contaminated soils and groundwater, and to shed off water. However, for the interim cover system 2, this section states that it is only to protect clean soils and sediments from the PPC realignment removals. This seems like a fundamental misunderstanding of cover systems and vadose zone wastes.

<u>EPA Response</u> – All of the bullets within Section 5.3.1 describe the design objectives for the ICS 2. The State's comment references only one of the bullets in that list. The 8th bullet already addresses reducing infiltration as follows: "*Provide a native cover soil layer that <u>prevents direct contact with the consolidated soil, protects the soil from erosion, reduces infiltration in advance of ET Cover construction</u>, and minimizes ET Cover System construction costs.*" EPA will recommend that this bullet be moved to the first bullet in the list for clarity.

22. Page 5-8; Section 5.4.1 Key Design Objectives:

This section states that the ET cover needs only to " ... reduc[e] percolation through contaminated media." Montana regulations require ET cover performance to reduce infiltration so that State groundwater is not impacted above regulatory levels. In addition, there should be a monitoring plan to ensure that the ET covers predicted performance is achieved (i.e., performance monitoring) as part of the design.

<u>EPA Response</u> –Given that the groundwater beneath the site is already "…impacted above regulatory levels…", the ET cover can only serve to protect groundwater quality by reducing long-term infiltration and preventing continued migration of COPCs from the unsaturated zone to the underlying groundwater. It is expected that this will prevent further degradation of groundwater quality and contribute to the improvement in downgradient groundwater quality over time.

The ET cover serves additional important functions, including preventing human and ecological receptors and storm water from direct contact with contaminated soils, and facilitating the consolidation and long-term sustainable protection of buried contaminated soils and sediments against infiltration by surface water.

As indicated in response to comment #18, efficacy studies for IMs are ongoing and a CAMP has been prepared to support remedy evaluations and IM performance. In addition, the CMS Report will include a description of performance monitoring requirements for all selected remedies.

23. Page 5-9; Section 5.5 Cleanup Standards for Surface Soil:

METG proposes final exposure surface values for the PPC realignment and ET cover systems. The proposed values are 794 mg/kg for arsenic and 650 mg/kg for lead. The arsenic value's source is referenced as the East Helena Superfund Site Operable Unit Record of Decision. METG does not propose values for other hazardous constituents but is relying on these values to ensure other constituents will be below risk levels based on a statement referenced from the ROD. The State did not concur with these standards when EPA issued the ROD. The State maintains its position here.

The final values for hazardous constituents in the surface soil are an important component of long term impacts to human health and the environment. The State believes an explanation of the rationale for the cleanup values should be presented in the IM Work Plan. For example, the IM Work Plan should explain why the arsenic value references recreational land use criteria (presumably human receptors) and the lead value references ecological receptors. For clarity, METG should explain if the proposed arsenic value is protective of ecological receptors. In addition, the manner that the risk assessments conducted under the RCRA program support the arsenic value should be addressed.

EPA Response – EPA understands that the State did not concur with the statements made in the ROD; however, the document has been approved as final and is consistent with two nearby USEPA Superfund sites: 1) Anaconda Co. Smelter (Deer Lodge County, MT), and 2) Milltown Reservoir/Clark Fork River (Milltown, MT).

As described in Section 5.5 of the IMWP 2015/2016, the anticipated future use of the for Smelter facility covered by the ET Cover System and PPC Realignment and its floodplain is recreational and therefore the arsenic value is based on recreational land use. The anticipated future use has been identified with consideration of overall facility conditions at the start of the corrective action process, to market conditions, community goals and objectives, and other stakeholder interests. Regarding the lead value, in the Draft CMS Work Plan, the Custodial Trust indicated that if an ecological screening criterion is more conservative, then the ecological–derived value should be used in place of the recreational-derived standard. As such, the lead value is derived based on the ecological criterion, and is consistent with the criteria at the above USEPA Superfund sites. For clarity, EPA will request that the text in the IMWP 2015/2016 be modified to provide additional explanation for the selection of the criteria.

24. Page 7-1; Section 7.1.3 Montana Dam Safety Act:

Please reference and attach the DNRC determination letter.

EPA Response – See attached email from Michele Lemieux, DNRC on May 28, 2013.

25. Page 7 -3; Section 7.2.4 Floodplain Development Permit:

Please reference and attach the City of East Helena approval letter.

EPA Response – The City of East Helena floodplain permit was signed and delivered on Monday, March 23, 2015. EPA will request that the text be revised to indicate that the permit was issued in April 2015.

Thank you for your consideration of the above.

Lewis and Clark County
Water Quality Protection District

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(406) 447-8351 Fax: (406) 447-8398

MEMORANDUM

Date: March 6, 2015

To: Betsy Burns, EPA

From: James Swierc, P.G.
Lewis & Clark Water Quality Protection District

Re: 2015-2016 Interim Measures Work Plan (Work Plan) Comments

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The following comments represent concerns identified by Lewis and Clark Water Quality Protection District (LCWQPD) staff after reviewing the Work Plan. The comments include general comments which relate to conceptual issues, and specific comments corresponding to individual components of the document.

General Comments

1. The Work Plan represents the primary document prepared for public review (and comment) on site conditions and ongoing remedial actions completed at the site. Since this represents the standard mechanism to transfer and present information about the site to the public, it seems warranted to include additional information about site activities which may not be specific to the IM actions. An example would be to present summary overviews of the surface and ground water monitoring programs so that the general public can be aware of the frequency and locations of sample and data collection efforts. In some cases these activities are indirectly referenced; however, there is insufficient information for the reader to understand the magnitude of such activities.

EPA Response – As stated in Section 1 of the Interim Measures Work Plans (IMWPs), the purpose of these plans is to present sufficient information to support EPA's approval of the proposed IMs. The IMWPs are not intended to be the primary documents for communication to the public about site conditions and ongoing remedial actions, and therefore only a brief summary of activities such as ongoing groundwater monitoring has been provided.

Information on site conditions has been provided in the Phase II RFI Report, a copy of which is available for Public viewing at the East Helena Public Library (16 East Main Street, East Helena) and at the Lead Education and Abatement Program (LEAP) Office at City Hall (306 East Main Street, Room 201, East Helena). Information on groundwater monitoring and ongoing remedial actions has been presented to the Public in Town Hall meetings and will also be documented in the final report on the Corrective Measures Study, currently underway. Each of these documents will be presented to beneficiaries and stakeholders (including the East Helena Groundwater Technical Working Group that meets with representatives from the state and federal government, the Water Quality Protection District and the City of East Helena), and made available for public review. However, to provide a better understanding of the process of conducting the CMS, including ongoing monitoring, investigations and evaluations, EPA is requesting that a Section 1.3.3 will be added to the IM Work Plan to provide additional information.

2. The Work Plan does reference the need for closure sampling of soil excavations, ground water sampling, and other field activities. A reference to Sampling and Analysis Plan (SAP) components, the Field Sampling Plans (FSP) and Quality Assurance Project Plan (QAPP), which provide information on field and laboratory methods for specific data collection activities should be included. Even as the approach changes with the Adaptive Management Strategy, there should still be quality assurance provided for field and laboratory activities to ensure that data collected is representative of media sampled, and usable for intended purposes.

EPA Response – Environmental sampling being conducted as part of the RCRA Corrective Action work in East Helena is being done in accordance with appropriate sampling and quality assurance plans. All groundwater sampling conducted for site monitoring or IM performance monitoring as described in the IM Work Plan was completed to meet quality assurance and quality control (QA/QC) requirements documented in the Corrective Action Monitoring Plan (CAMP). Environmental sampling performed during construction of the IMs (primarily associated with topsoil metals concentrations) will also be performed in accordance with these protocols. For clarification, within each appropriate subsection in Section 5 of the IM Work Plan, the QA/QC document will be referenced.

For geotechnical sampling and analyses, the technical specifications establish the appropriate QA/QC testing requirements and methods, to be performed by an independent qualified testing laboratory. Geotechnical testing will follow ASTM procedures.

3. The intent of the Work Plan to provide information to the public for review and comment is unclear. The document is marked "For Public Review", but does not directly indicate that the public can provide comment on the provided information. This extends to the METG website where it may be downloaded. A statement of a deadline for public comment, and how/where to transmit them, should be included, and highlighted, to ensure that the reader is aware. While the deadline to transmit comments to EPA was announced at the public meeting, this information should be made available to parties who were not able to attend the meeting, but still demonstrate sufficient interest in the site to obtain and review the *draft* Work Plan.

EPA Response – Future documents that are provided for public review will include information on the document regarding the duration of the public comment time period and the process by which the public may provide comments. This information will be included on the METG website and in the notices filed in the local media. Public notices were published by EPA and METG in the Helena Independent Record on February 15, 2015 and February 23, 2015 announcing the public meeting, the locations available for review of the 2015-2016 Interim Measure Work Plan, and describing the process to provide public comment on the document.

4. The discussion of the South Plant Hydraulic Control (SPHC) repeatedly notes that the objective is

to lower ground water levels at the facility. For public understanding, a statement indicating that lowering the Prickly Pear Creek base elevation in the upgradient area will change the stream from a losing stream to a gaining stream would help clarify rationale for the work.

EPA Response – EPA will request that the Custodial Trust provide clarification of the hydrogeologic benefit of lowering the Prickly Pear Creek base elevation as part of the SPHC IM in Section 2.1.1 of the IMWP. To further clarify, the primary benefit of SPHC on groundwater quality is the reduction of the amount of groundwater in direct contact with contaminated soils. This is achieved in part by the lowering of the PPC profile, particularly in the southern portion of PPC, and removal of the historic surface water bodies (Upper Lake and Lower Lake). The intended result is to lower groundwater levels and reduce groundwater flow rates under the former Smelter site and ultimately to reduce contaminant leaching from soils to groundwater and reduce downgradient groundwater contaminant concentrations. This design alters groundwater/surface water interaction in the south portion of the realigned PPC (south of the former smelter dam) where the creek elevation will be reduced from pre-SPHC conditions by more than 10 feet in places; resulting in reduced leakage to groundwater from the creek and a transition from a losing to gaining stream in some PPC segments. With elimination of the Smelter Dam/Upper Lake complex, and realigning the creek both laterally and vertically to more closely approximate a natural configuration, the creek will better contribute to wetland habitat while not re-raising groundwater elevations to pre-implementation of SPHC.

5. Efficacy studies on the IMs are indirectly referenced with discussions on ground water monitoring, and that the performance of the IMs will be reviewed with the future and ongoing Corrective Measures Study. The information specific information on the efficacy studies should be integrated with the ground and surface water monitoring, sampling and analysis programs. These studies represent part of the IMs, and the data collection program for monitoring their effectiveness should be included with the Work Plan. A direct discussion of this would be useful for the public, as discussed in the first general comment. An important component of the efficacy studies will be how water levels fluctuate seasonally with spring recharge once the majority of dewatering from the SPHC are present. This concern was raised by a local resident during the February 2015 public meeting.

EPA Response –As previously noted, the purpose of the IM Work Plan is to provide information to support EPA's approval of the IMs. The performance of the IMs is being evaluated as part of the CMS process and the results will be documented in the CMS Report. To date, groundwater modeling has been done to estimate the performance of the IMs with respect to groundwater elevations and quality. These evaluations are ongoing. In addition, the performance of the IM components installed to date have been, and will continue to be monitored and evaluated as part of the ongoing groundwater monitoring program. The objectives and methods for the monitoring are set forth in the Corrective Action Monitoring Program (CAMP). As part of this program, the Custodial Trust will compare the current groundwater data to over 20 years of groundwater data collected at and around the former Smelter Site to evaluate seasonal fluctuations, as well as the effects of the changes made during SPHC implementation. Finally, long-term monitoring of the IMs and any other corrective measures implemented as part of the final remedy will be conducted to evaluate performance over time and ensure that conditions remain protective of human health and the environment.

6. The discussion of Data Sufficiency combines the discussion of available data with applications of

the data. This review should indicate if there are known data gaps in the site characterization datasets. For example, the groundwater flow model(s) requires data for calibration and completion to demonstrate representativeness during transient conditions. This approach is somewhat misleading, as the question arises whether there are gaps in datasets that limit calibration of the model that need to be addressed with further data collection activities.

The discussion of additional data requirements for future work does not note the work to be completed to characterize residual soil contamination present after completion of the excavations. This information was presented to the ground water work group as necessary for completion in the next year; however, it is not referenced in this report. This also represents a data gap that should be identified with the discussion of soil chemistry.

EPA Response – The intent of the IMWP section is to discuss the data needs specifically related to the design and implementation of the IMs. The identification of data needs to complete corrective measures evaluations of source areas and surface soil contamination on portions of the East Helena Facility surrounding the former Smelter site are being addressed and documented in the CMS and the final sampling associated with the Phase II RFI, respectively.

Specific Comments

p. 1-1, Introduction. The stated purpose of the Work Plan document is to provide information to support USEPA approval of remaining IM phases yet to be completed. While this is true, the introduction provides opportunity to explain some important concepts about the cleanup activities to the public. The ultimate goal of the remedial actions is to mitigate the risk to human health and the environment posed by the contamination present at the former Asarco facility. From a risk perspective, the remedial actions are designed to break any exposure pathways for contaminants to the potentially impacted population or environment proximal to the site. While the IMs represent engineered actions designed to meet the objectives, the presence and development of the East Helena Valley Controlled Ground Water Area (CGWA) as a management method of protecting exposure should be presented in summary form. The CGWA is referenced on Page 8-1 but not discussed or presented elsewhere in the Work Plan.

EPA Response – As noted in this comment and previous responses, the IM Work Plan has a specific purpose and was not developed to provide general information. EPA acknowledges the Water Quality Protection District's significant commitment to the protection of public health as evidenced by the County's submittal of the CGWA petition and its interest in providing additional information on the overall East Helena Cleanup Program to the public expressed in most of these comments. Accordingly, EPA will request that the Custodial Trust add a paragraph describing the CGWA and contact information for the WQPD so that the public can follow-up directly with the County on the petition. EPA also notes that the primary purpose of the Groundwater Technical Work Group and Town Hall meetings held by EPA and the Custodial Trust has been to present the current information to the public on cleanup activities. To address the point raised in this comment, a brief summary of the status of CMS activities, including risk mitigation, will be included in a new Section 1.3.3 to be added to the IM Work Plan. The CMS Report, which will be provided for public review and comment, will integrate risk, performance objectives, the IMs, and the CGWA into a comprehensive evaluation and subsequent recommendation of a final remedy.

p. 1-1, Section 1.1. The Summary of Interim Measures in the Introduction (and later in the document) refers to the Interim Measures as proposed actions. Moving forward with the IM actions were approved by EPA several years ago. The current document provides information on the status and additional work needed to complete their implementation. The construction activities completed to date for the IM actions are significant, ongoing, and will be part of the final remedial measures for the site. The text discussion(s) should reflect the status that they are approved and currently being implemented, and not proposed.

EPA Response – The "Former ASARCO East Helena Facility Interim Measures Work Plan – Conceptual Overview of Proposed Interim Measures and Details of 2012 Activities (CH2M HILL, June, 2012)" requested and received EPA's *conceptual* approval of the overall IMs, recognizing that important details of the IM components were yet to be developed and would be presented in subsequent work plans. The current work plan refers to specific IM component work to be completed as "proposed" to acknowledge that the initial approval for proceeding with the overall IM approach was conceptual.

p. 1-1, Section 1.2. The discussion of the work completed for the South Plant Hydraulic Control (SPHC) indicates that ground water levels were lowered "substantially" by previous actions. Rather than using a relative term, presenting the actual decline in water levels would provide the reader with a clearer picture regarding the effects of this IM.

EPA Response – Because the change in water levels vary at different locations at the site, the reader will be referred to Section 3.1 "Groundwater Levels". The word "substantially" will be removed.

Part of the SPHC IM included removing Wilson Ditch from use, thus eliminating this as a pathway for current and future discharges of any contaminants into the ground water downgradient from the site. Since this was implemented as part of the SPHC IM, it should be presented so that residents who live near the ditch (e.g. Seaver Park) are aware of the change in status.

EPA Response – EPA agrees with this comment and the work plan text will be clarified to state that the ditch has been decommissioned as an irrigation ditch, but continues to serve a role for stormwater control. Wilson Ditch does collect runoff from hillside areas upgradient (south) of the ditch during spring runoff, providing some measure of runoff protection to existing roads and residences in the area.

p. 1-2, Section 1.3.2. The performance evaluation to date provides a review of some of the impacts of the interim actions. A statement noting if the actions are meeting design objectives would be useful to demonstrate the efficacy of the work.

EPA Response – EPA agrees, and a statement will be added to Section 1.3.2.

p. 1-3, Section 1.5. The introduction to the Work Plan Summary references the Phase II RFI and the 2014 Groundwater Conditions Status report. Since the work presented expands on these data sources, they should be made available to the interested public for review, as should any document referenced in the Work Plan as providing supporting information for how a specific approach or issue was addressed. The text should indicate where these may be found in both hard and electronic format. The groundwater report is not listed in the references.

EPA Response – The reference to the 2014 Groundwater Conditions Status Report to be presented by Hydrometrics will be deleted from the text of Section 1.5. The report was not complete at the time the IM Work Plan was issued. Key groundwater results relevant to the IM Work Plan are summarized in Section 3.0. The last sentence of Section 1.5 will be revised to state, "A complete list of references is provided in Section 9 of this IM Work Plan 2015/2016. Relevant documents are located at the METG website http://www.mtenvironmentaltrust.org/."

The Phase II RFI appears to have been "finalized" since the last Work Plan, since GSI Water Solutions is now identified as the author. Any changes from the "draft" version should be identified in Section 3 which presents the updated conceptual site model

EPA Response – The Phase II RFI is now referenced as "final" rather than "draft" to acknowledge EPA's conditional approval of the Phase II RFI, which was received by the Custodial Trust on April 29, 2014. No substantive changes were made to the Phase II RFI. Please note that the updated conceptual site models presented in the IM Work Plans have built on the Phase II RFI data, and incorporate new information relevant to the IM work.

Figure 3-2. The legend is incomplete and does not identify data point locations.

EPA Response – Data point locations (wells/piezometers) are shown in Figure 3-1. A note will be added to Figures 3-2 and 3-3 indicating that "*Data locations are shown in Figure 3-1*".

Figure 3-4. The figure, and additional figures are referenced from the Groundwater Status Report, December 2014; however, this report is not included in the references.

EPA Response – As previously noted, at the time of the Work Plan production, the groundwater monitoring report had not been completed and therefore, was not included in the references. The figures are complete as presented, and all reference to the Groundwater Status Report will be deleted from the IM Work Plan.

p. 8-1, Section 8.2. The discussion of public participation indicates how the public is updated on ongoing activities. The section should indicate how interested parties may be able to comment on the work as active participation of the public in the project. Providing opportunities for communities to comment and offer their input on site cleanup plans represents the second goal of the Superfund community involvement program as presented on the EPA website for the East Helena Site (http://www2.epa.gov/region8/east-helena-site#12)

EPA Response – Please see the response to #3 above. In addition to the formal public review of the IM Work Plans, EPA and the Custodial Trust have held, and will continue to hold, periodic "Town Hall" meetings with the stated purpose of informing the public and getting feedback from the public.

04/30/2015 – EPA RESPONSE TO JAMES SCHELL, EAST HELENA, MONTANA COMMENTS ON THE *DRAFT EAST HELENA INTERIM MEASURES WORK PLAN 2015 AND 2016*, DATED FEBRUARY 2015

Date: March 6, 2015

Subject: Public Comments – Draft EH Interim Measures Work Plan 2015 and 2016

To: Betsy Burns
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10 W. 15th St. -Suite 3200
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From: James Schell
Box 1610
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Thank you for the opportunity to comment on the very comprehensive East Helena Draft Interim Measures Work Plan – 2015 and 2016.

These comments were produced using the Draft for Public Review - Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016 document dated February 2015. (source)

The following comments are my own and may not represent the opinions or comments of the City of East Helena or the East Helena City Council.

Comment #1

Section 1.3.2, Performance Evaluation to Date, contains reference in the first paragraph to a sustained drop in groundwater elevations with parenthetical reference as: "(more detail is provided in Section 3.2)". Section 3.2 is titled Arsenic and Selenium in Groundwater and the above parenthetical reference may likely need to be to Section 3.1 titled "Groundwater Levels" instead of Section 3.2.

EPA Response – EPA agrees and will request that the Custodial Trust edit the text to state that "… more detail is provided in Section 3.1"

Comment #2

Section 1.3.2, Performance Evaluation to Date, contains reference in the first paragraph decreases in arsenic and selenium concentrations with parenthetical reference as "(a summary is provided in Section 3.2.1)". There is no Section 3.2.1 and the above parenthetical reference may likely need to be to Section 3.2 titled "Arsenic and Selenium in Groundwater".

EPA Response – EPA agrees and will request that the Custodial Trust edit the text to reference Section 3.2.

Comment #3

Slag Pile Access

Contained in Section 2.2.1.1, Phase 3 Demolition, is reference to future slag pile access: "As proposed in 2015, functionality and vehicle access for groundwater monitoring and asset recovery operations at the slag pile will be maintained during construction and after 2016 construction is complete." Statements regarding future slag pile access are also contained in Section 2.2.1.2, with regards to the "access road" along the eastern boarder of ICS 2/ET Cover East, also used for 69-kV transmission line relocation.

Contained in Appendix A, section Selective Evapotranspiration Cover System, Interim Cover System 2, and Demolition Phase 3 Design Drawings, is drawing sheet 3 of 38 titled "OVERALL SITE PLAN" which contains two smaller roads joining the perimeter road which are marked "SLAG PILE ACCESS ROADS".

The METG are to be commended for including reference to "asset recovery operations at the slag pile" in various formats and drawings within the Draft IMWP 2015 and 2016 and I hope that access to the slag pile for current and future removal remains an important aspect to the overall scope and plans of the METG.

(See my related "Comment #3", submitted January 7, 2014, contained in IMWP 2014.)

EPA Response – EPA and the Custodial Trust have been and continue to be committed to recovering value that may be derived from the reprocessing and/or sale of material from the East Helena Slag Pile. These efforts help to achieve the twin goals of (i) reducing the magnitude of the Slag Pile and (ii) contributing funds to help pay for the cleanup of the East Helena Site. EPA and the Custodial Trust also recognize that many citizens of East Helena would like to see the Slag Pile eliminated entirely. While it is unlikely that the estimated 14 million tons of slag will be significantly reduced any time in the near future, we are committed to taking all reasonable, available steps to reduce the size of the slag pile as much as possible over time.

Comment #4

Groundwater Levels

Section 3.1, Groundwater Levels, contains reference to areas within the plant site and areas around the plant site with historical statistics and graphical representations. Included in this are the Upper Lake Marsh Area (Section 3.1.1) and Main Plant Site area (Section 3.1.2).

Not contained in the Draft IMWP 2015 and 2016 are groundwater level historical statistics and graphical representations in the northeast area of the plant site, under and to the east of the slag pile.

I have serious concerns about an increased amount of groundwater and potential contaminants being diverted (from a northwestern flow under the plant site) under the slag pile, because of the SPHC measures being implemented, and toward and under the City of East Helena. Primary concerns include groundwater increases which could potentially cause increased basement flooding in areas of the City of East Helena. In my opinion, including groundwater historical and graphical representations of the northeast area of the plant site should be included in the final IMWP 2015 and 2016.

EPA Response – EPA notes the expressed concern. The data and evaluations presented in the Interim Measures (IM) Work Plan refer only to those portions of the site impacted by IM activities during 2015 and 2016. The representations you suggest are beyond the scope of information needed for consideration of IM work for 2015 and 2016. As part of the ongoing groundwater modeling efforts for the CMS, groundwater data is being gathered and evaluated for all portions of the former Smelter Site and all potential offsite migration pathways.

Comment #5
Stormwater Runoff
Draft IMWP 2015 and 2016 contains many short, incidental references to stormwater and a few references to existing stormwater infrastructure. One such reference is Section 5.2.2, Design and Construction Features of Phase 3 demolition, which includes a dot point "Demolition of the Rodeo Tank will include protecting the existing stormwater piping entering the tank to allow future use."

In my opinion, because of the importance of potential volume and contamination transport both on and off of the former Smelter site from sotrmwater, more information should be included in IMWP 2015 and 2016 regarding the interim and future (final) designs of any on and offsite alterations of the stormwater system.

EPA Response – EPA will request the Custodial Trust to add additional text to Section 5.2.2 that further describes the basis of design for the stormwater infiltration basin area that will replace the Rodeo Tank system. It should be noted that stormwater volumes generated by the ET cover is predicted to be substantially smaller than runoff volumes that were previously generated from the existing site to the Rodeo Tank due to the grass cover and storage capability of the ET cover, once the grass cover is established.

Comment #6
ET Cover Long Term O&M and Access
Appendix A, section and document Technical Memorandum: Evapotranspiration Cover System Design, Construction, Operation, and Maintenance Criteria, Former ASARCO Smelter Site, East Helena Montana contains a section titled "Monitoring and Maintenance Phase". This section and its associated table describes objectives, criteria, and very rough demonstration elements of (long term) monitoring and maintenance.

One aspect of the entire ET cover system being implemented on the former ASARCO plant site that has not been discussed to any great extent, are the long term requirement for O&M, mid and long term costs and administration of the O&M, and mid and long term plans for site access.

I look forward to future discussions with the METG and USEPA on this (and other) important subjects and appreciate the open approach both agencies have taken in dealing with the public and public officials in the City of East Helena and surrounding area.

EPA Response – EPA agrees with your comments regarding the importance of the long-term O&M requirements and notes that an ET Cover is protective and requires less maintenance over time when compared to other cover systems that incorporate synthetic materials, geotextiles or asphalt. EPA appreciates your comments and looks forward to future discussions with you and the City of East Helena. EPA also notes that an evaluation of all remedy O&M considerations is being done as part of the CMS and information will be presented to the public in the CMS Report.

Eastgate Village Water & Sewer Association, Inc.
P.O. Box 1220 – East Helena, MT 59635
Phone (406) 449-1015 or (406) 227-7033

March 2, 2015

Betsy Burns
U.S. EPA Region 8
10 W. 15th Street - Suite 3200
Helena MT 59626

Subject: Former ASARCO East Helena Facility Interim Measures Work Plan - 2015 & 2016

Dear Ms. Burns,

This letter is being advanced in response to information presented at the Public Meeting (held on 2/24/15) and should be considered as formal comment on the 2015/2016 Interim Measures Work Plan.

The Custodial Trust (and EPA) continue to be dismissive of the Eastgate Water & Sewer Association's rights relating to the conveyance (Company Ditch) and point of diversion (Smelter Dam) associated with its Prickly Pear Creek water rights. To date, there has been no effort to obtain written consent relating to encroachments (or impairments) on the Company Ditch and the Smelter Dam (as required by MCA 70- 17-112).

Additionally, the Custodial Trust (and EPA) have made no effort to mitigate the long-term effects (of their remediation efforts) on the Association. At present, the Company Ditch is severed and usable. In the future, the point of diversion for the Company Ditch will be removed. It is clear that the remediation effort has created these issues - yet there has been no effort to accommodate the Association in the short-term or the long-term. This omission seems especially glaring when accommodations have already been made for Wilson Ditch users and affected utility operators (such as the City of East Helena and Century Link).

As mentioned previously, the Eastgate Water & Sewer Association views this course of action as unacceptable. Moving forward, the Association expects the Custodial Trust (and EPA) to adhere to state law and obtain written consent for encroachments and impairments on the Company Ditch and Smelter Dam. Further, the Association expects the Custodial Trust (and EPA) to mitigate the short-term and long- term effects (of their remediation efforts) on those entities possessing water rights associated with the Company Ditch and Smelter Dam.

EPA Response – Please see attached legal analysis from the METG Water Attorney dated March 20, 2015.

Sincerely,

Paul Johnson
President – Eastgate Water & Sewer Association.

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March 20, 2015

Betsy Burns
U.S. Environmental Protection Agency
Region 8
10 West 15th Street, Suite 3200
Helena, MT 59626

RE: Draft 2015-16 Interim Measures Work Plan Comments Regarding Company Ditch

Dear Betsy:

This letter is in reference to two comments that were sent to the Environmental Protection Agency ("EPA") in response to the Draft 2015-16 Interim Measures Work Plan that recently was released for public comment. The first letter is dated March 2, 2015, and is from Paul Johnson on behalf of the Eastgate Village Water & Sewer Association, Inc. ("Eastgate"). The second letter is dated March 6, 2015, and is from Jerry Hamlin, Trustee for the Hamlin Family Revocable Trust ("Hamlin Trust"). Both letters raise issues as to the effect the Prickly Pear Creek temporary bypass channel interim measure ("IM") has on the diversions to the irrigation ditch known as the "Company Ditch."

On behalf of the Custodial Trust we provide the following background, and responses to each letter.

A. BACKGROUND

Eastgate and the Hamlin Trust jointly own three water rights that list Prickly Pear Creek as the source of supply. The point of diversion for each of the three water rights is in Section 36, Township 10 North, Range 3 West in Lewis & Clark County. The Company Ditch is the name for an irrigation ditch that is shown on some maps as having a point of diversion on Prickly Pear Creek at a point near Smelter Dam. The Custodial Trust owns the property where the point of diversion is depicted on the maps.

According to records maintained in the Montana Department of Natural Resources and Conservation ("DNRC") online database, Eastgate and the Hamlin Trust jointly own the following three water rights:

Water Right No.	Priority	Flow Rate	Acres[1]
41I 89277-00	11/24/1866	1.25 CFS	63.00
41I 89278-00	2/10/1869	1.69 CFS	63.00
41I 89279-00	10/15/1866	421.87 GPM	63.00

When the predecessors of the current owners filed their water right claims with the DNRC in 1981, they described the point of diversion as a headgate located on the east bank of "Smelter Pond" on Prickly Pear Creek. The water right claim files do not indicate how long the diversion point had been at that particular location. At the time the water right claims were filed, water evidently flowed 400 feet through an 18 inch diameter pipeline, then into an open ditch that conveyed water northeast across what is now Custodial Trust property. The records indicate that ditch then passed under U.S. Highway 12 through a 36 inch pipeline, and then further north and east to reach its ultimate place of use on property now owned by either Eastgate, the Hamlin Trust or others.

Several years ago, Eastgate applied to the DNRC for a permit to install a new well. On July 21, 2009, DNRC granted the application and issued Beneficial Water Use Permit No. 41I 30026328. This permit was granted with the condition that Eastgate obtain approval to use three Prickly Pear water rights as mitigation in an amount of not less than 185 acre feet. Obtaining approval for mitigation required a separate application. The mitigation application was approved in an authorization (Authorization No. 41I-30050020) dated June 5, 2014. The authorization states that portions of acres formerly authorized for irrigation "will be retired." The DNRC order granting the change authorization indicates that the water historically diverted from the Company Ditch headgate on Prickly Pear Creek now will be left in the creek and not diverted.

B. RESPONSE TO LETTERS

1. Eastgate Water and Sewer

When the IMs were proposed last year, Eastgate submitted comments objecting to the effect of the bypass channel on its Company Ditch diversion. The Custodial Trust held several conference calls with Eastgate to discuss its concerns, but understood that Eastgate's change application would make Eastgate's concerns moot because the mitigation requirements would require it to leave water in Prickly Pear Creek and would prohibit any diversions. Until receiving Eastgate's March 2, 2015 letter, the Custodial Trust had assumed that Eastgate's issues were resolved because there no longer were any diversions, nor had there been for many years. The June 5, 2014 approval order approved the condition that Eastgate no longer divert water from Prickly Pear Creek, but instead leave it instream.

The Custodial Trust remains willing to listen to any remaining concerns that Eastgate might have. However, in light of the mitigation conditions on its water rights that appear to prohibit diversions,

[1] Note that these acreage figures are overlapping, not cumulative, which means a total of up to 63 acres can be irrigated with all three water rights.

Eastgate's letter does not provide sufficient information for a response. It does not appear to be consistent with Eastgate's current water rights to provide and maintain a diversion point that Eastgate cannot use without violating the mitigation conditions under which it now must operate. The Custodial Trust is, however, willing to work directly with Eastgate to reconcile these positions.

2. Hamlin Trust

The Hamlin Trust does not appear to be part of the Eastgate water rights change authorization mitigation conditions. Mr. Hamlin's March 10 letter makes several assumptions that do not appear to be accurate. First, the letter states that the Custodial Trust has caused a loss of the Hamlin Trust water right. That statement is not accurate. Under Montana law, a water right and a ditch right are separate property rights. The Custodial Trust has not taken any public position, filed any objections, nor made any public statements concerning the validity of the Hamlin Trust water rights. The validity of those rights is a matter between the Hamlin Trust, DNRC and the Montana Water Court.

As to the Hamlin Trust rights to the Company Ditch, the Custodial Trust does not believe that any improper interference has occurred. As part of the process for implementing the Prickly Pear Creek temporary bypass, the Custodial Trust interviewed the Water Commissioner to ensure that the work would not interfere with any active water use. The Water Commissioner assured us that no diversion has occurred since 1999. The records submitted in the Eastgate change authorization proceeding appear to support this statement. We also collected the filings that the Water Commissioner makes with the state district court. Our review of those filings confirmed the Water Commissioner's reports.

The Custodial Trust remains open to meeting with Mr. Hamlin to better understand his plans for continued use of the Company Ditch now that the Eastgate water rights have been carved out of the joint Eastgate-Hamlin Trust water right. Until receiving this letter, however, the Custodial Trust was not aware that the Hamlin Trust had concerns distinct from Eastgate. Because the vast majority of the Company Ditch on the Custodial Trust property remains intact, addressing whatever legitimate concerns Mr. Hamlin can discuss should not be difficult. However, based upon the review that has been done, the Custodial Trust does not agree that any unreasonable interference with the Hamlin Trust diversion and ditch rights has occurred. The Custodial Trust will reach out to Mr. Hamlin and offer to work with him and the Hamlin Trust to determine any necessary steps to restore a diversion structure on the Prickly Pear Creek, similar to what was in place prior to the implementation of the bypass project.

Please let us know if you have any questions about this letter.

Very truly yours,

GARLINGTON, LOHN & ROBINSON, PLLP

Stephen R. Brown

C: Chuck Figur
Lauri Gorton
Dean Brockbank
Marc Weinreich
Cindy Brooks

SRB:srb

MDT

Montana Department of Transportation
2701 Prospect Avenue
PO Box 201001
Helena MT 59620-1001

Michael *T. Tooley,* Director
Steve Bullock, Governor

March 5, 2015

Betsy Burns
U.S. EPA Region 8
10 West 15th Street, Suite 3200
Helena MT 59626

Subject: Former ASARCO East Helena Facility Interim Measures Work Plan 2015 & 2016
Montana Department of Transportation Comments

Dear Betsy,

The Montana Department of Transportation Staff (MDT} staff has reviewed the Former ASARCO East Helena Facility Interim Measures Work Plan 2015 and 2016 and has the following comments.

1. Thank you acknowledging that any work within MDT right-of-way will require an encroachment permit from MDT.

   EPA Response - Thank you for providing comments on behalf of the Montana Department of Transportation (MDT) and for your support of the efforts to remediate the former Asarco smelter in East Helena.

2. If there is a change in use of existing approaches onto MDT roadways (US 12/287, MT 518, Lane Ave, or Main Street in East Helena) a change in use Driveway Approach application may be required.

   EPA Response – The comment is noted.

3. The report indicates stormwater from the site will be contained. Understanding there may still be outfall, stormwater runoff from the Former ASACRO East Helena Facility cannot add additional flows into the MDT right-of-way beyond pre-existing conditions. Please contact MDT if additional flow is anticipated.

   EPA Response – The comment is noted. MDT will be contacted if additional flow is anticipated.

4. MDT understands that the flows within Prickly Pear Creek will change from historic flows with the proposed work. MDT as a downstream owner of property and structures is putting the Trust on notice if the changes to Prickly Pear Creek flows result in adverse impacts to MDT facilities and/or structures the Trust will be responsible for mitigation/repair for the adverse impacts at no cost to MDT.

   EPA Response – The comment is noted.

If there are planned encroachments into MDT right-of-way or know impacts to MDT facilities and/or structures, please contact Kevin Millhouse, Helena Maintenance Superintendent (406-444-6399) for the proper clearances.

Thank you for the opportunity to comment on the Interim Measures Work Plan 2015 and 2016. If you have any questions concerning these comments, please contact me at (46)444-9456 or email at jriley@mt.gov.

Sincerely,

Jean A.Riley, P.E.
Transportation Planning Engineer
Policy, Program & Performance Analysis Bureau

Copies: Jeff Ebert, P.E. - Butte District Administrator
Kam Wrigg - Butte Maintenance Chief
Kevin Millhouse - Helena Maintenance Superintendent
Jim Skinner - Policy, Program & Performance Analysis Bureau Chief
Mike Tierney - Policy, Program & Performance Analysis Bureau
File

Appendix D
Custodial Trust Response to Comments from the Montana Department of Justice on the 2015/2016 Interim Measures Work Plan

Montana Environmental Trust Group, LLC
Trustee of the Montana Environmental Custodial Trust
PO Box 1230, East Helena, Montana 59635
Telephone (1): (617) 448-9762
Telephone (2): (406) 227-4098

By Electronic Mail

TO: Mary Capdeville, MDOJ
Rob Collins, MDOJ
Greg Mullen, MDOJ

FROM: Cynthia Brooks and Marc Weinreich
Montana Environmental Trust Group, LLC,
Trustee of the Montana Environmental Custodial Trust

RE: Custodial Trust Response to Comments from the Montana Department of Justice (MDOJ) on the Draft 2015—2016 Interim Measures Work Plan (IMWP)

DATE: March 23, 2015

By way of this memorandum, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (the Custodial Trust), is hereby responding to certain comments contained in the attached March 6, 2015, letter from the Montana Department of Justice (MDOJ) to the US Environmental Protection Agency (EPA) regarding the draft 2015—2016 Interim Measures Work Plan (the Draft IMWP) for the East Helena Facility. This communication is not a substitute for the EPA's formal response to MDOJ's and other comments that were submitted as part of the public review and comment process for the Draft IMWP. Rather, this memo seeks to achieve the following specific goals:

- ✓ Correct misinformation contained in MDOJ's letter that MDOJ has relied on in reaching certain inaccurate conclusions in its letter;

- ✓ Provide MDOJ with more accurate information to help address its concerns (many of which are based on misinformation) and more constructively and efficiently participate in technical discussions related to the Resource Conservation and Recovery Act (RCRA) Corrective Action (CA) activities at the East Helena facility; and

- ✓ Request that MDOJ consult with the Custodial Trust and/or EPA on further communications instead of relying on misinformation that must then be corrected in writing by the Custodial Trust and/or EPA at significant time and expense.

The Custodial Trust's comments are detailed below. After you have had the opportunity to review this information, the Custodial Trust proposes scheduling a meeting with representatives from the Montana Department of Environmental Quality (MDEQ), MDOJ and EPA to follow-up on any outstanding questions.

1. In ¶1, ¶2, ¶3, ¶5 and ¶9 (on multiple pages), MDOJ repeatedly objects to the East Helena RCRA CA process, including implementation of Interim Measures (IMs) prior to completion of the Corrective Measures Study (CMS). These objections reflect a lack of knowledge about and/or agreement with EPA's established RCRA CA guidance and/or the Custodial Trust's obligations under the First Modification to the 1998 RCRA Consent Decree (the RCRA CD). Both issues are addressed more fully in Section 6.D below. The Custodial Trust also notes **MDOJ's objections are also inconsistent with MDEQ's own guidelines for RCRA** cleanups in the State of Montana, which state that:

   A. The State's own RCRA CA process need not follow a linear process: "…[c]orrective action *activities* ***are not always undertaken as a linear progression towards final facility cleanup, but can be implemented flexibly to most effectively meet site-specific corrective action needs."*** See Attachments A.[1]

   B. A CMS is not necessarily required by MDEQ for RCRA CA activities: *"After the RFI is completed and the regulatory agency determines that cleanup is necessary, the regulatory agency* ***may*** *(emphasis added) require the owner/operator to conduct a CMS."*

   C. IMs can be implemented at any time during the MDEQ RCRA CA process: *"**Interim/Stabilization Measures**. Stabilization measures **can be implemented at any time in the corrective action process** to address ongoing releases and environmental threats in the near-term. Stabilization measures are established in an effort to control or abate immediate threats to human health and the environment and prevent or minimize the further spread of contamination."*

   Consistent with Montana's own RCRA CA guidance, under MDEQ oversight, MDEQ required Asarco to perform numerous IMs, including: demolition of numerous structures on site; placement of extensive covers over demolition work areas; construction of two permanent Corrective Action Management Units (CAMUs), including closure of CAMU-1; and installation of two permanent slurry walls to address arsenic contamination in groundwater. MDOJ might be more familiar with and prefer that the Custodial Trust follow a more linear process (such as is the case with MDEQ's CECRA process). However, under EPA's and the State's own RCRA CA process, cleanup of the East Helena Facility need not be "undertaken as a linear progression." For ease of reference, MDEQ's CECRA investigation and cleanup process[2] is included here as Attachment B.

[1] See MDEQ website at: http://www.deq.mt.gov/StateSuperfund/Cecra.mcpx.
[2] See MDEQ website at: http://www.deq.mt.gov/StateSuperfund/Cecra.mcpx.

2. In ¶2 on page 1, MDOJ states that the IMWP process has led to, *"questionable technical justifications and sometimes excessive or unjustifiable costs."* Respectfully, the Custodial Trust disagrees with and denies MDOJ's unsubstantiated allegations. Please provide the Custodial Trust with the detailed technical analysis and engineering opinion that supports MDOJ's statement that one or more of the IMs are based on *"questionable technical justification"* and why those particular IMs are unjustified. In responding, please provide specific information, including actual dollar amounts, for those costs that MDOJ claims are *"excessive"* or *"unjustifiable."* Since the appropriateness of the IMs and associated costs are technical, not legal, determinations, the opinion should be issued by a licensed engineer and/or other qualified scientist familiar and experienced with EPA's RCRA requirements. The IM technical evaluations and deliverables were prepared by licensed, certified engineers and hydrogeologists. Therefore, any assessment of IM technical issues should also be performed by equally qualified professionals. Pending receipt of a duly issued opinion, the Custodial Trust requests that MDOJ cite the source of its current information, since so many of MDOJ's comments in its letter appear to be based on misinformation and a lack of technical expertise and familiarity with the complex clean-up of a RCRA facility. While professionals and experts can disagree, to label work-product from licensed technical professionals as "questionable" and their costs as "unjustifiable" without such supporting documentation seems unfair and prejudicial.

3. In ¶3 on page 2, MDOJ claims that, METG's fails *"to have an onsite manager, and that the project is being managed by out of state contractors, whose multi-state priorities may not align with State and local needs for site cleanup."* Respectfully, the Custodial Trust disagrees with and denies MDOJ's statement about its lack of a strong Montana presence. Once again, MDOJ appears misinformed about, or is disregarding, the Custodial Trust's strong project team in East Helena. Please find enclosed: a copy of the most recent Custodial Trust team organization plan dated April of 2014. (<u>See Attachment C-1</u>.) The Custodial Trust has also included <u>Attachment C-2</u>, which identifies the members of the Custodial Trust East Helena team who are permanent residents of the State of Montana. (See boxes highlighted in blue on <u>Attachment C-2</u>.) As indicated on <u>Attachment C-2</u>, with one exception, <u>all members of the Custodial Trust team in East Helena reside in the State of Montana</u>. Therefore, MDOJ's assertion that, *"the project is being managed by out of state contractors, whose multi-state priorities may not align with State and local needs for site cleanup,"* is simply not correct and (again) seems based on misinformation.

4. In ¶3 on page 2, MDOJ claims that, *"substantial Trust resources are being spent on activities that show no or little tangible effect on cleaning up the groundwater contamination problem."*
   a. Again, respectfully, the Custodial Trust must question the basis for MDOJ's claim. MDOJ is misinformed about the clear benefits to groundwater contamination that have been documented in numerous technical deliverables and reviews with the beneficiaries (including MDOJ) and interested stakeholders. Rather than enumerate each instance when that information has been presented to MDOJ (including the most recent review,

which was held on February 23, 2015 and was attended by Greg Mullen from MDOJ), the Custodial Trust suggests scheduling another review of the results of our analyses in a working meeting with MDOJ and MDEQ. If after such a meeting, MDOJ continues to issue written communications that criticize and misrepresent the Custodial Trust's demonstrable and productive groundwater clean-up work in East Helena, the Custodial Trust may request that a factual determination made through a formal hearing before the US Bankruptcy Court as the most efficient path forward.

b. Unlike many groundwater cleanup efforts, the East Helena cleanup being conducted by the Custodial Trust is uniquely able to objectively demonstrate the groundwater contamination cleanup benefits of its work to date at the Site. The Custodial Trust respectfully requests that MDOJ describe those hazardous waste sites where MDOJ or MDEQ has implemented cleanup plans that have demonstrated the benefits to groundwater contamination in a span of three years or less, especially for sites where construction activities are still underway.

5. In ¶6 on page 3, MDOJ alleges that, "*METG has not adequately analyzed the effectiveness of the IMs and compared that effectiveness to their costs, as is standard practice in RCRA and CERCLA cleanup projects. This lack of analysis has led to unnecessary IM components, conflicting and questionable cleanup rationale, questionable IM analyses and design quality, and excessive management and administrative costs.*"
   a. Respectfully, the Custodial Trust disagrees with and denies MDOJ's allegations. MDOJ again appears to be relying on misinformation. The Custodial Trust has been monitoring, analyzing and modeling IMs since November of 2011, including but not limited to: the Upper Lake drawdown and pump tests; monitoring and analysis of water quality and water levels before and after diversion of the Prickly Pear Creek (PPC) into the Temporary Bypass Chanel (TBC); draining Lower Lake and removal of Tito Park; the Corrective Action Monitoring Plans; the numerical groundwater flow model results; the predictive fate and transport modeling results; and the Tier II study results. The results of all of these efforts have been presented and provided to the beneficiaries (including MDOJ) and stakeholders on numerous occasions.

   b. MDOJ's assertion that the Custodial Trust has not compared the costs of the IMs to the environmental benefits is simply not correct. Since 2012, the Custodial Trust has been developing and updating its cost estimates for environmental actions in East Helena and analyzing the costs and environmental benefits associated with the current IMs, potential additional IMs and potential final Corrective Measures (CMs). Last year the Custodial Trust developed a comprehensive financial planning tool that models past and projected expenditures for various RCRA CA scenarios.

   c. The Custodial Trust requests that MDOJ clarify which IM component are *"unnecessary"* and the basis for MDOJ's conclusion that any of the IMs are unnecessary. If MDOJ believes certain IMs are not required, please advise how the contaminant issues being addressed by that IM should be addressed.

d. Please specify the cleanup rationale that MDOJ believes is *"conflicting and questionable"* and explain why.

e. The Custodial Trust is surprised to learn that MDOJ is claiming that there are *"design quality"* issues with the IMs and therefore we are requesting specific feedback about which IM design efforts are inconsistent with industry standards for design quality. (Again, any such feedback should be based on the opinion and analysis of a qualified, certified technical expert.) We are particularly surprised given the track record and expertise of the Custodial Trust's IM technical team, which includes, but is not limited to: Karen Boyd (Applied Geomorphology) for the PPC realignment project **as suggested by MDOJ**; William Albright (Desert Research Institute) for the Evapotranspirative Cover (ET Cover) design **as supported by MDEQ**; the US Army Corps of Engineers to perform an independent peer review of the PPC realignment project **as specifically requested by MDOJ**; Kirk Eakin (AMEC), as suggested by the USFWS, to assist with compliance with the Migratory Bird Treaty Act and preparation of an Avian Bird Protection Plan; Pioneer Technical Services to design, permit and construct the PPC realignment project **as supported by MDEQ and MDOJ**. The Custodial Trust is therefore requesting specific feedback from MDOJ as to what aspects or components of the IMs design efforts have serious quality issues. If MDOJ genuinely believes there are "design quality" concerns, by this letter, the Custodial Trust is seeking specific instructions from MDOJ as to what actions, if any, MDOJ wants the Custodial Trust to pursue against these consultants, or others, for the "design quality" issues that MDOJ will separately and specifically identify to the Custodial Trust. If so, MDOJ's support and analysis are critical for addressing and rectifying the substance of any such claims. Please specify exactly which management and administrative costs are "excessive" and what level of expenditures, with specific amounts would not be excessive in the opinion of MDOJ. MDOJ should also provide an analysis of these costs including how these costs compare to the costs of other environmental response and custodial trustees in the US.

6. In ¶7 on page 3, MDOJ maintains that, *"There has been no rigorously vetted analysis of the effectiveness of source removal, which is typically the most cost-effective remedial activity. It appears that METG has arbitrarily concluded not to perform source removal, and then developed an analysis to support that decision. METG has been planning for an ET cover for several years, prior to any serious acknowledgement of the potential for source removal. Here, IM implementation will preclude or dramatically increase the cost of the most viable corrective action, source removal, which seems inconsistent with RCRA requirements and METG's RCRA consent decree obligations. The result is the lack of removal of groundwater saturated sources, coupled with implementation of IMs to help ensure that the sources won't be removed in the future."*

a. Respectfully, MDOJ again clearly misunderstands the Custodial Trust's scope of work, results to date, and plans for source removal and control activities. The Custodial Trust started preliminary source removal evaluations in 2013 and presented the details of its most recent source removal activities to the beneficiaries and stakeholders on November 20, 2014 and again on February 23, 2015. Greg Mullen from MDOJ attended both technical meetings. The Custodial Trust's source removal technical analysis was distributed to the beneficiaries, including MDOJ, and East Helena stakeholders on February 17, 2015, prior to the issuance of your letter.
b. MDOJ is correct in stating that an ET Cover System has been planned for several years. An ET Cover has been proposed because it is a sustainable, cost-effective CM able to meet several of the Remedial Action Objectives for the East Helena Facility, including: eliminating the potential for human and ecological receptors and stormwater to contact contaminated soils; and minimizing infiltration of precipitation through contaminated soils, thereby preventing future contaminant loading to groundwater. ET Covers are also a remedial technology proven to be effective in the Helena Valley.

c. MDOJ appears to be entirely misinformed about the Custodial Trust's source removal and source control plans. Specifically, the Custodial Trust has and is evaluating the scope, costs and potential benefits of source control or source removal measures at multiple areas of the Site, including, but not limited to, the west selenium hot spot, the north plant area, the acid plant area and the speiss dross area.

d. MDOJ's contention that the Custodial Trust's actions are, "inconsistent with RCRA requirements and METG's RCRA consent decree obligations," reflects a lack of familiarity with EPA's RCRA CA program and the First Modification of the RCRA CD. As outlined below, the environmental actions being performed at the East Helena Facility meet and/or exceed the requirements of the RCRA CA guidance and the RCRA CD. If MDOJ has issues with the Custodial Trust's performance and compliance with the RCRA CD, those concerns should be specifically spelled out and addressed directly to EPA and USDOJ, who oversee and approve the Custodial Trust's RCRA CA and RCRA CD activities, and for whom such activities clearly are in compliance.
   i. The Custodial Trust has met or exceeded the RCRA CD requirements for implementation of IMs at the East Helena Facility.
      (1) ¶10.a. of the RCRA CD, which requires that the Custodial Trust, *"Perform interim measures where possible and appropriate, at the ASARCO properties."*
      (2) ¶12 states that, *"Interim measures, in addition to those which may already be in place, shall be used whenever possible and appropriate to achieve the goal of stabilization (emphasis added), which is defined to mean the control or abatement of imminent threats to human health and/or the environment (including, without limitation, actions in support of an interim measure), and prevention or minimization of the spread of hazardous waste or hazardous constituents while long-term corrective measure alternatives are being evaluated."* As demonstrated by the technical studies (provided to MODJ), IMs implemented to date have

already contributed to the stabilization of the Site and reduced the spread of hazardous constituents by removing groundwater from contact with thousands of tons of contaminants that would otherwise remain saturated.

(3) ¶12 to ¶18 set forth the requirements for implementing IMs, including the requirements for an IMWP. The Custodial Trust has exceeded the RCRA CD requirements, as evidenced by the four (4) IMWPs that have been submitted to date for work in 2012, 2013, 2014 and 2015—2016.

(4) Pursuant to ¶72 of the RCRA CD, EPA has made all such IMWPs available to the public for review and comment.

ii. The Custodial Trust has met or exceeded the RCRA CD requirements for a CMS for the East Helena Facility.

(1) The CMS, which has been under development since 2011, is consistent with ¶10.c. of the RCRA CD, under which the Custodial Trust is to *"Perform a Corrective Measure Study ("CMS") to identify and evaluate alternatives which will prevent or mitigate the continuing migration of or future release of hazardous waste or hazardous constituents at and/or from the ASARCO Properties, and to restore contaminated media to standards that are acceptable to EPA…"*

(2) ¶34 states that, *"…the Custodial Trust shall prepare and submit to EPA a corrective measures study Work Plan…"* As summarized in Table 1 (attached), the Custodial Trust has prepared multiple drafts of the CMS WP, and has also invested significant time and resources into the CMS WP, the CMS and accommodating and incorporating comments from the beneficiaries.

(3) Neither the EPA nor the RCRA CD requires an EPA-approved CMS WP prior to proceeding with the CMS.

(4) The RCRA CD does not afford MDOJ approval rights over the CMS WP**.**

(5) The RCRA CD does not require issuance of the CMS WP for public review and comment.

The Custodial Trust requests MDOJ clarification and documentation that describes the specific provisions of the RCRA CD that have been breached by the Custodial Trust.

7. In ¶8 on page 3, MDOJ claims that the Custodial Trust's, "*less than appropriate construction oversight management, led to inadequate adequate protection of the Yellowstone Pipeline underlying the Prickly Pear Creek, and the stability of the creek, which led to a costly change order to address the problem."*

   a. The Custodial Trust is not sure what is meant by *"less than appropriate construction oversight management,"* and therefore assumes that MDOJ is misinformed about the construction management team in East Helena. For your information and for the record, the construction management and oversight team consists of Mark Rhodes (Hydrometrics), Randy Rose (CH2M Hill) and Tyler Deeds (CH2M Hill), who have 15, 35 and 15 years of experience managing remediation construction activities. All three gentlemen are permanent residents of the State of Montana.

b. MDOJ's comments about the Yellowstone Pipeline (YPL) reflect a complete lack of understanding or misinformation about the issues. To address MDOJ's misinformation, the facts related to the YPL are summarized below:

   i. The YPL crosses the PPC south of the TBC diversion and is owned and operated by the Yellowstone Pipeline Company (YPLC). YPLC has sole responsibility for maintaining the pipeline.

   ii. Prior to starting construction of the TBC, the Custodial Trust observed sloughing in the area of the YPL crossing PPC and notified the YPLC on numerous occasions about its concern that, in the event of a high flow, the pipeline could be exposed and damaged, resulting in a release of oil into the PPC. Some of the written communications between the Custodial Trust and the YPLC documenting the Custodial Trust's concerns are included in Attachment D. Because of the Custodial Trust's plans to divert the PPC into the TBC, the Custodial Trust was also concerned that, if the pipeline was damaged, notwithstanding the fact that responsibility for the YPL resides solely and exclusively with the YPLC, downstream owners and stakeholders would nevertheless attribute any such problem to the Custodial Trust. In fact, the Custodial Trust placed additional sandbags near the area where erosion was occurring precisely because the YPLC was unable to address the issue in a timely manner, notwithstanding the months of prior communications and notices to the YPLC (as indicated in Attachment D). Please note that it took the YPLC almost one year to temporarily address this maintenance problem. At this time, YPLC has not finalized arrangements to permanently address the erosion problem by realigning the pipeline at the PPC crossing.

   iii. Additional grade control structures and bank stabilization measures were implemented after the TBC was diverted into the PPC because of YPLC's failure to properly maintain the pipeline. Specifically, minor head-cutting of less than one (1) foot was observed in an area near the TBC point of diversion (POD) where the pipeline is buried more than nine (9) feet below the channel. This occurred because of a change in conditions in PPC near the POD and is not unusual given the dynamic nature of rivers and streams. As indicated in Attachment D, the Custodial Trust made numerous attempts to coordinate the work with the YPLC and share the costs of those measures for the benefit of both parties. However, once it became clear that the YPL maintenance was not going to occur in a timely fashion, after consulting with EPA, the Custodial Trust made the decision to proceed with the grade control and bank stabilization measures without the involvement of the YPLC. Overall, the Custodial Trust incurred net change order costs totaling $30,000 for the TBC, including the grade control and bank stabilization measures, although the Custodial Trust notes that the total costs for TBC construction came in $1.6 million less than the EPA-approved budget. The Custodial Trust elected to implement and fund 100% of the bank stabilization and grade control costs for this effort to avoid potential risk of further bank erosion at the YPL crossing. MDOJ may disagree with the Custodial Trust's decision to proceed with this effort, which could have been avoided if YPLC had properly and timely maintained their pipeline. However, MDOJ is clearly misinformed about the Custodial Trust's efforts to ensure adequate protection of the YPL. The Custodial Trust's actions, including the decision to incur change order costs, were specifically designed to protect the YPL. Clearly MDOJ was misinformed about the issues and is again encouraged by the Custodial Trust to ensure it is relying on credible sources of information.

As indicated above, the Custodial Trust can only assume that MDOJ has relied on a persistent string of misinformation and untested hypotheses as the basis for many of the claims and allegations contained in its March 6, 2015 letter to EPA. The Custodial Trust respectfully asks MDOJ not to take as true and correct information that has not been independently corroborated by a professional third-party with current, specific knowledge of environmental actions at the Site and substantive, successful experience with EPA-led projects. The Custodial Trust continues to be willing to sit with representatives of MDOJ to correct these misimpressions and to work to forge a productive relationship that aligns interests and builds success for the people of East Helena and the State of Montana.

Please do not hesitate to contact me with any questions pertaining to this transmittal.

Attachments

cc: Steve Brown—GLR
Betsy Burns—EPA
Julie DalSoglio—EPA
Chuck Figur—EPA
Lauri Gorton—Custodial Trust
Mark Hall—MDEQ
Bill Kirley—MDEQ
Denise Kirkpatrick—MDEQ
Tom Livers—MDEQ
Tim Stepp—MDEQ
Jim Stimson—MDEQ
Elliot Rockler—USDOJ
Alan Tenenbaum—USDOJ
Joe Vranka—EPA

DEPARTMENT OF JUSTICE
NATURAL RESOURCE DAMAGE PROGRAM

TIM FOX
ATTORNEY GENERAL

1301 EAST LOCKEY AVENUE

STATE OF MONTANA

(406) 444-0205 (OFFICE)
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PO BOX 201425
HELENA, MONTANA 59620-1425

March 6, 2015

Betsy Burns
Remedial Project Manager
US Environmental Protection Agency
10W 15th Street, Suite 3200
Helena, MT 59601

RE: Montana's Comments on Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016

Dear Ms. Burns:

The State of Montana, through the Montana Department of Justice and Department of Environmental Quality, submit the following comments on the Draft Former ASARCO East Helena Facility Interim Measures Work Plan – 2015 and 2016 (2015 IMWP), submitted by the Montana Environmental Trust Group (METG).

1. The State continues to maintain that the breadth of the proposed interim measures (IMs), which include plans through 2016, requires that those measures be developed through a conventional RCRA Corrective Measures Study (CMS). The State maintains that the present IM implementation schedule will likely lead to a CMS analysis that is non-substantive in nature and merely endorses the IMs that are already in place or on the table, as the IMs will already be implemented to a large degree by that time, and are of a permanent nature. Clearly, if the CMS analysis had been performed several years ago, as repeatedly requested by the State and initially planned by METG, cleanup actions at the site could be proceeding in a comprehensive, more deliberate fashion, and achieving significant cost savings. Taking the IM path for the East Helena site remains problematic, as many final remedies are being put in place without a final remedy investigation and analysis components.

2. The State continues to have significant issue with METG's IMWP process, which has led to cleanup decisions with questionable technical justifications and sometimes excessive or unjustifiable costs.

The State maintains that an independent, technically sound CMS should be developed that fully analyzes all potential RCRA alternatives. Given the enormous cost, the uncertainty about what contaminated soil will be removed, and the lack of analysis of the effectiveness of the proposed IMs, the State believes that implementing these corrective actions without further consideration is imprudent and needlessly wastes limited Trust resources. The State encourages a thoughtful and deliberative approach to the RCRA corrective action process. The State continues to advocate that a CMS be developed at this time.

3. METG has been working on the Corrective Measures Study Work Plan (CMS Work Plan), which is the primary outline for analyzing cleanup, for five years, but has not produced an adequate draft to the State, or to the public for review or comment. The CMS Work Plan and the CMS are required components of the RCRA consent decree. The CMS is to direct the analysis, design, and cleanup of the site. Once a CMS Work Plan is adopted, the next step is to perform a CMS study and then choose the corrective measures to be implemented from among the alternatives presented. These corrective measure alternatives would examine an alternative's effectiveness at cleaning up groundwater relative to its costs. The Trust contains a finite amount of money. It is therefore necessary to rely on a comprehensive cleanup plan to determine the best use of the funds, rather than EPA and METG's sweeping reliance on interim measures (IM). It appears that substantial Trust resources are being spent on activities that show no or little tangible effect on cleaning up the groundwater contamination problem. This may result, in part, from METG's failure to have an onsite manager, and that the project is being managed by out of state contractors, whose multi-state priorities may not align with State and local needs for site cleanup. An evaluation of the effectiveness of these IMs on specifically cleaning up groundwater, the primary problem at the site, has not been performed.

4. The State again advocates a clear analysis and discussion of the measurable impacts to the current off-site plumes from the proposed IMs. Both the State and EPA based a significant part of their claims against ASARCO in the bankruptcy proceeding on the perceived need to remediate and restore the off-site groundwater plumes, yet there has been no consideration of such an action by METG at this point in time.

   Implementation of the IMs presently considered, with their large projected costs, will in effect foreclose the possibility of remediating and restoring the groundwater under the City of East Helena due to the finite monetary amount of the Trust.

5. METG's failure to initially prepare the CMS, which would provide a comprehensive cleanup plan, has resulted in significant expenditures on engineering designs that have not or are not likely to be implemented, resulting in significant monetary losses for the Trust. Instead, the site is proceeding with a view toward the short-term, rather than employing a strategy that seeks to expend Trust money over a longer time span in a cost-effective manner to meet the goals of site cleanup.

6. METG has not adequately analyzed the effectiveness of the IMs and compared that effectiveness to their costs, as is standard practice in RCRA and CERCLA cleanup projects. This lack of analysis has led to unnecessary IM components, conflicting and questionable cleanup rationale, questionable IM analyses and design quality, and excessive management and administrative costs.

7. METG proposes to cover the majority of the site with an interim cover system and the final ET Cover System. There has been no rigorously vetted analysis of the effectiveness of source removal, which is typically the most cost-effective remedial activity. It appears that METG has arbitrarily concluded not to perform source removal, and then developed an analysis to support that decision. METG has been planning for an ET cover for several years, prior to any serious acknowledgement of the potential for source removal. Here, IM implementation will preclude or dramatically increase the cost of the most viable corrective action, source removal, which seems inconsistent with RCRA requirements and METG's RCRA consent decree obligations. The result is the lack of removal of groundwater saturated sources, coupled with implementation of IMs to help ensure that the sources won't be removed in the future.

8. There are continuing unanswered questions about the environmental benefits and therefore the necessity of certain work. For example, there is no clear direct benefit to improvement of groundwater quality related to the removal of Tito Park, and there is the potential to further contaminate groundwater with movement of this waste source. METG has not quantified the effectiveness of the interim cover system at protecting groundwater, plus the interim cover system has not been permitted by DEQ as it is typically done. There were also flaws in the Prickly Pear Creek bypass channel design, pointed out by the State prior to construction. This, coupled with less than appropriate construction oversight management, led to inadequate adequate protection of the Yellowstone Pipeline underlying the Prickly Pear Creek, and the stability of the creek, which led to a costly change order to address the problem.

9. Paragraph 15 of the RCRA consent decree requires that, "Each IM Work Plan shall ensure that the interim measure is designed to mitigate immediate or potential threat(s) to human health and/or the environment, prevent or minimize the spread of hazardous waste or hazardous substances, and is consistent with the objectives of and contribute to the performance of any long-term remedies which may be required at the ASARCO Properties." In the absence of the development of a CMS, the IMWP needs to document the connection to the CMS and the final remedy in each section. Please provide this information in the 2015 IMWP.

10. The State strongly maintains that the public must be informed of the costs of each proposed interim measure and other elements of the budget for the 2015 IMWP, and that such cost estimates should be included in the IM work plan. These estimated costs are essential for full and meaningful public input on the 2015 IMWP, and the IMs planned for 2015 and 2016. In addition, the State has not received cost projections.

11. Similar to previous IMWPs, much of the discussion regarding IM regulatory requirements is general. Please provide substantive details so that the State, as well as the public, can provide meaningful input.

12. Given the level of IM complexity, an overview of the site and contamination history is needed at the beginning of the IMWP so the reader can relate the IMs within the site itself.

13. The IMWP should set forth how the 2015 IMWP actions relate to the CERCLA work, particularly the Process Ponds (OU 1) ROD.

<u>Specific Comments</u>:

14. The 2015 IMWP states, "The soil was removed to eliminate the potential inundation and erosion from potential PPC flooding, meet the function needs of the PPC Realignment, support the development of wetland habitat in the PPC floodplain and reduce the overall footprint of the ET Cover System." Several aspects warrant comment.

    a. "soil was removed to eliminate the potential inundation and erosion from potential PPC flooding" – The HEC-RAS surface water modeling performed for the permitting of the PPC activities does not indicate inundation or erosion of Tito Park during regulated flooding events (< or =100 year event). These wastes have been saturated for more than 80 years without any indication of surface water contaminant impacts. The SPHC lowered these wastes out of groundwater and the removal of the PPC dam eliminates backwater around Tito Park.

    b. "meet the function needs of the PPC Realignment" – Figure 1.2 of the 2015 IMWP clearly contradicts this statement. The active channel and floodway do not intersect with the Tito Park removal area.

    c. "support the development of wetland habitat in in the PPC flood plain" –The documentation submitted to support the permit applications to the ACE and other agencies shows most of the Tito Park removal areas as uplands not wetlands. Lower Lake is shown as wetlands. However, there was only minor removal from that area, and that would be a wetland under any scenario.

    d. "reduce the overall footprint of the ET Cover System" – This statement is correct. The real consideration is one of cost. Did removal of Tito Park and construction of the interim cover system, which is only needed to protect this new on site groundwater source of Tito Park wastes, cost less than the ET cover for this less than 9 acre areas. The analysis described above "Tito Park Grading Options Evaluation" (May 9, 2013) clearly did not demonstrate this.

15. Page 1-2; Section 1.3.2 Performance Evaluation:

A technical evaluation of the effectiveness of improving groundwater quality with the identified IMs has not been provided to the State or the public. Section 3.2 provides groundwater elevation decreases from implementing SPHC. However, this does not address its impact on groundwater quality.

16. Page 1-3; Section 1.4 Proposed Activities:

METG took the Tito Park wastes and transported them onsite, creating a further waste source. The Tito Park wastes were spread around onsite, exposing them to atmospheric and other geochemical leaching processes. METG constructed a cover system (the interim cover system) to limit leaching to groundwater; however METG has not provided the design specifics to the State, nor provided the HELP model. METG has also not provided an interim cover system groundwater monitoring or performance plan, as is typically required for cover systems.

In addition, it appears that METG has not investigated the applicability of Montana Ground Water Pollution Control System permit (MGWPCS) for this interim cover system cover system or the final ET over system. Lewis and Clark County, along with Jamie Schell (Mayor of East Helena), have submitted comments on the 2014 IMWP with similar interim cover system groundwater protection concerns.

17. Page 2-3; Section 2.2.1.2 interim cover system 2 Construction:

The Objectives section states "The primary purpose of the interim cover system 2 is to protectively manage materials excavated during the PPC Realignment until the ET cover east can be constructed." However, the PPC realignment materials have not been identified as contaminated. The purpose is protecting groundwater from the existing contamination sources that will now be exposed to infiltration because the current liner system is being removed. Please provide a quantitative analysis as to the effectiveness of eliminating infiltration for the interim cover system in general and the interim cover system 2.

18. Page 2-5; Section 2.2.2 Monitoring Network Modification:

METG proposes decommissioning monitoring wells based on "30 years of monitoring and evaluation experience." However, METG is implementing IMs in an attempt to dramatically change the hydrogeological system. If so, METG's knowledge of the last 30 years seems to have little bearing on future conditions. Decommissioning monitoring wells without analysis in this circumstance is not appropriate.

The section states "The overall plan and strategy for monitoring the performance of the IMs and their effect on groundwater quality contamination will be developed as part of the final remedy selection." METG should not delay IM performance monitoring until after the final remedy is selected. Performance monitoring of IM components should be begin when IMs are implemented.

19. Page 3-4; Section 3.2 Arsenic and Selenium in Groundwater:

This brief description focuses on water elevation. However, improvement of water quality should be the focus. This section acknowledges that the IMs have substantially altered the flow system and that the plumes are moving more to the west. It states "A western shift observed in both the arsenic and selenium plumes since 2011 is attributable to SPHC IM." If the IMs had been analyzed prior to implementation, this shift may have been predicted and an adequate monitoring plan would be in place to ensure the IM is not contaminating groundwater areas not previously impacted. This section also acknowledges that the hydrogeological system is changing and needs to be monitored, but does not include a monitoring plan to collect data as part of the activities.

20. Page 4-1; Section 4.1 Data Sufficiency:

The groundwater flow model was not used to predict the performance of SPHC IM. This Flow model was used to predict water elevation and flow field changes rather than improvement of groundwater quality. Under the Groundwater F&T Model bullet, METG acknowledges that it has not evaluated the IMs for effectiveness in reducing arsenic and selenium contamination. This evaluation should have occurred prior to implementation of IM cleanup actions.

21. Page 5-6; Section 5.3.1 Key Design Objectives:

The key design objective for the interim cover system and interim cover system 2 is to eliminate infiltration through left in place contaminated soils and groundwater, and to shed off water. However, for the interim cover system 2, this section states that it is only to protect clean soils and sediments from the PPC realignment removals. This seems like a fundamental misunderstanding of cover systems and vadose zone wastes.

22. Page 5-8; Section 5.4.1 Key Design Objectives:

This section states that the ET cover needs only to "...reduc[e] percolation through contaminated media." Montana regulations require ET cover performance to reduce infiltration so that State groundwater is not impacted above regulatory levels. In addition, there should be a monitoring plan to ensure that the ET covers predicted performance is achieved (i.e., performance monitoring) as part of the design.

23. Page 5-9; Section 5.5 Cleanup Standards for Surface Soil:

METG proposes final exposure surface values for the PPC realignment and ET cover systems. The proposed values are 794 mg/kg for arsenic and 650 mg/kg for lead. The arsenic value's source is referenced as the East Helena Superfund Site Operable Unit 2 Record of Decision. METG does not propose values for other hazardous constituents but is relying on these values to ensure other constituents will be below risk levels based on a statement referenced from the ROD. The State did not concur with these standards when EPA issued the ROD. The State maintains its position here.

The final values for hazardous constituents in the surface soil are an important component of long term impacts to human health and the environment. The State believes an explanation of the rationale for the cleanup values should be presented in the IM Work Plan. For example, the IM Work Plan should explain why the arsenic value references recreational land use criteria (presumably human receptors) and the lead value references ecological receptors. For clarity, METG should explain if the proposed arsenic value is protective of ecological receptors. In addition, the manner that the risk assessments conducted under the RCRA program support the arsenic value should be addressed.

24. Page 7-1; Section 7.1.3 Montana Dam Safety Act:

Please reference and attach the DNRC determination letter.

25. Page 7-3; Section 7.2.4 Floodplain Development Permit:

Please reference and attach the City of East Helena approval letter.

Thank you for your consideration of the above.

Sincerely,

Mary Capdeville
Assistant Attorney General

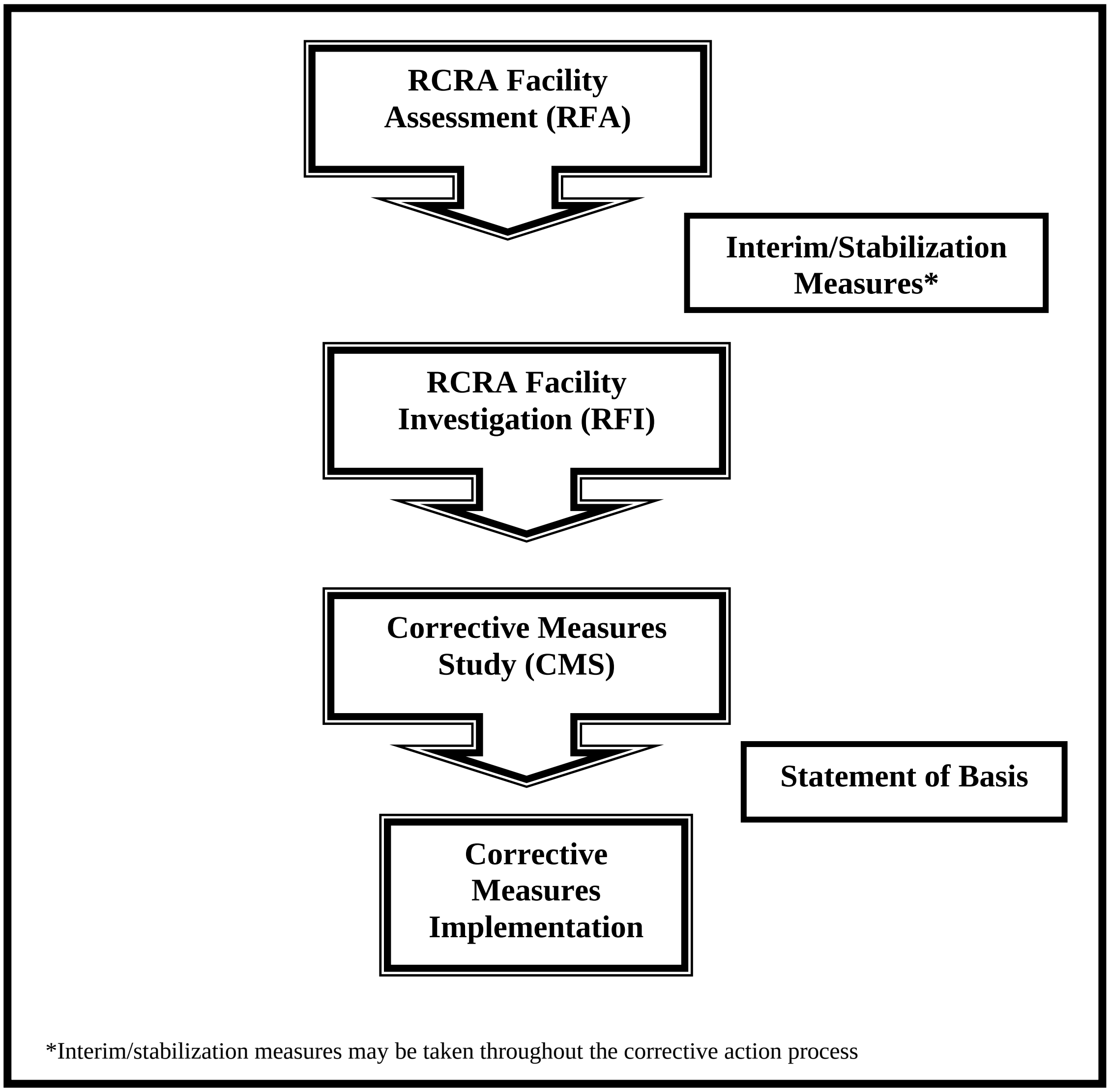
cc: Denise Kirkpatrick, MDEQ
Bill Kirley, MDEQ
Rob Collins, MDOJ
Greg Mullen, MDOJ
Julie DalSoglio, EPA
Joe Vranka, EPA
Chuck Figur, EPA
Alan Tenenbaum, USDOJ
Elliot Rockler, USDOJ
Karen Nelson, USFWS
Cindy Brooks, METG
Lauri Gorton, METG

TABLE I

Activities Related to the CMS Work Plan and CMS Process for East Helena Facility	
Date	**Activity**
6/09/2011	Beneficiaries meeting on CMS WP goals and objectives
6/13/2011	Revised draft CMS WP distributed to beneficiaries
6/14/2011	Updated draft CMS WP distributed to beneficiaries
6/15/2011	Beneficiaries meeting on CMS strategy/technical approach
6/29/2011	EPA response to State comments on draft CMS WP provided to Custodial Trust
7/11/2011	Revised draft CMS WP to EPA
7/15/2011	Revised CMS WP goals distributed to beneficiaries
8/07/2011	Revised draft CMS WP to Beneficiaries
8/10/2011	Beneficiaries meeting to review revised draft CMS WP
10/01/2011	Revised draft CMS WP to EPA
10/17/2011	Meeting with EPA to review revised draft CMS WP
11/08/2011	EPA comments on revised draft CMS WP
12/07/2011	Meeting with EPA to review revised draft CMS WP
12/20/2011	Custodial Trust recommendations to EPA on revised draft CMS WP
12/28/2011	Revised draft CMS WP distributed to beneficiaries
1/19/2012	Meeting with EPA to review revised draft CMS WP
2/07/2012	State comments on revised draft CMS WP
2/27/2012	Meeting with EPA to review revised draft soils CMS WP
4/25/2012	Custodial Trust draft response to comments on revised draft CMS WP
8/20/2012	Custodial Trust first summary of groundwater flow model to support CMS and other EAs★
10/29/2012	Custodial Trust initiated source removal evaluations (including modeling) to support CMS and other EAs★
4/17/2013	Custodial Trust presented evaluations to Beneficiaries
6/27/2013	Meeting with EPA to review revised/updated CMS WP
7/11/2013	Custodial Trust initiated predictive fate and transport modeling to support CMS and other EAs★
9/04/2013	Revised draft CMS WP submitted to EPA
10/09/2013	Revised select sections of CMS WP submitted to EPA
1/13/2014	Revised draft CMS WP distributed to beneficiaries (including soils evaluations)
2/04/2014	Revised draft CMS WP to beneficiaries
2/25/2014	Beneficiaries meeting/review of revised draft CMS WP
3/13/2014	USFWS comments on revised draft CMS WP
3/18/2014	State comments on revised draft CMS WP
9/17/2014	Completed source area investigations field work
11/12/2014	Completed Phase I of Tier II evaluations (Draft Final Phase I TM)
11/25/2014	Initiated Phase II of Tier II evaluations
2/13/2015	Revised draft CMS WP submitted to EPA
2/18/2015	Custodial Trust issued the final report on the source area investigations

★ EAs: Environmental Actions

Figure A. Flowchart of the RCRA Corrective Action Process



***Corrective Action* Process**

The corrective action process generally comprises six activities. These activities are not always undertaken as a linear progression towards final facility cleanup, but can be implemented flexibly to most effectively meet site-specific corrective action needs. Figure A shows a flowchart of the corrective action process.

1. RCRA Facility Assessment (RFA)

Often the first activity in the corrective action process is the RFA. The objective of the RFA is to identify potential and actual releases from SWMUs/AOCs and make preliminary determinations about releases, the need for corrective action, and interim measures.

2. RCRA Facility Investigation (RFI)

The RFI takes place when releases, or potential releases, have been identified and further investigation is necessary. The purpose of the RFI is to gather enough data to fully characterize the nature, extent, and rate of migration of contaminants to determine the appropriate response action.

A site-wide risk assessment is also conducted as part of the RFI. The risk assessment studies the health risks from potential exposure to the contaminants at the site.

3. Corrective Measures Study (CMS)

After the RFI is completed and the regulatory agency determines that cleanup is necessary, the regulatory agency may require the owner/operator to conduct a CMS. The purpose of the CMS is to identify and evaluate cleanup alternatives, called corrective measures, for releases at the facility. The recommended measures are reviewed by the regulatory agency. The regulatory agency then selects what it believes is the best remedy, given the site-specific considerations.

4. Statement of Basis

After review of the CMS, the Department produces a document which describes the basis for remedy selection and provides the public with an opportunity to comment on the proposed remedies. Following public input, the remedy is finalized and included in the permit. When selecting remedies the following are considered: short- and long-term reliability and effectiveness; reduction of toxicity, mobility, or volume of hazardous constituents; implementability; and costs. In addition, proposed remedies must satisfy the following criteria:

- Be protective of human health and the environment;

- Control the sources of releases thereby reducing or eliminating, to the maximum extent practicable, further releases posing a threat to public health and the environment;
- Attain media clean-up standards; and
- Comply with applicable waste management standards.

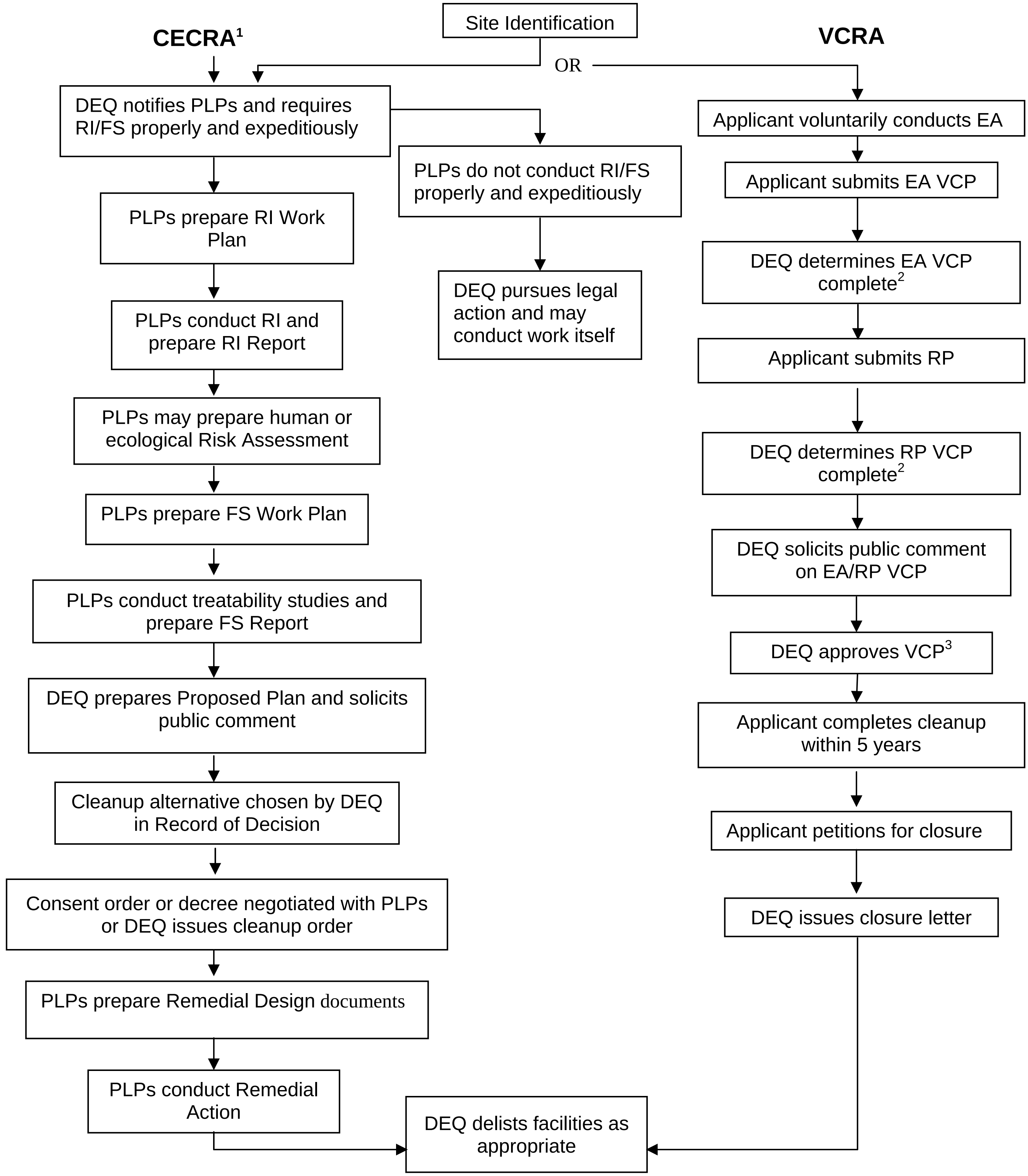
5. Corrective Measures Implementation (CMI)

Once a remedy has been selected, the facility enters the CMI phase of corrective action. During the CMI, the owner/operator of the facility implements the chosen remedy.

6. Interim/Stabilization Measures

Stabilization measures can be implemented at any time in the corrective action process to address ongoing releases and environmental threats in the near-term. Stabilization measures are established in an effort to control or abate immediate threats to human health and the environment and prevent or minimize the further spread of contamination.

Attachment B



[1] Additional public comment may be solicited, interim actions that are consistent with the final remedy may be conducted, and PLPs may petition for allocation under CALA at any time in the CECRA process.

[2] A VCP may require more than one revision to be deemed complete.

[3] A PLP with an approved VCP may petition for allocation under CALA. If VCP not approved, applicant can revise and resubmit VCP.

CECRA - Montana Comprehensive Environmental Cleanup and Responsibility Act

VCRA - Montana Voluntary Cleanup and Redevelopment Act

CALA - Montana Controlled Allocation of Liability Act

DEQ - Montana Department of Environmental Quality

RI - Remedial Investigation

FS - Feasibility Study

PLP - potentially liable person

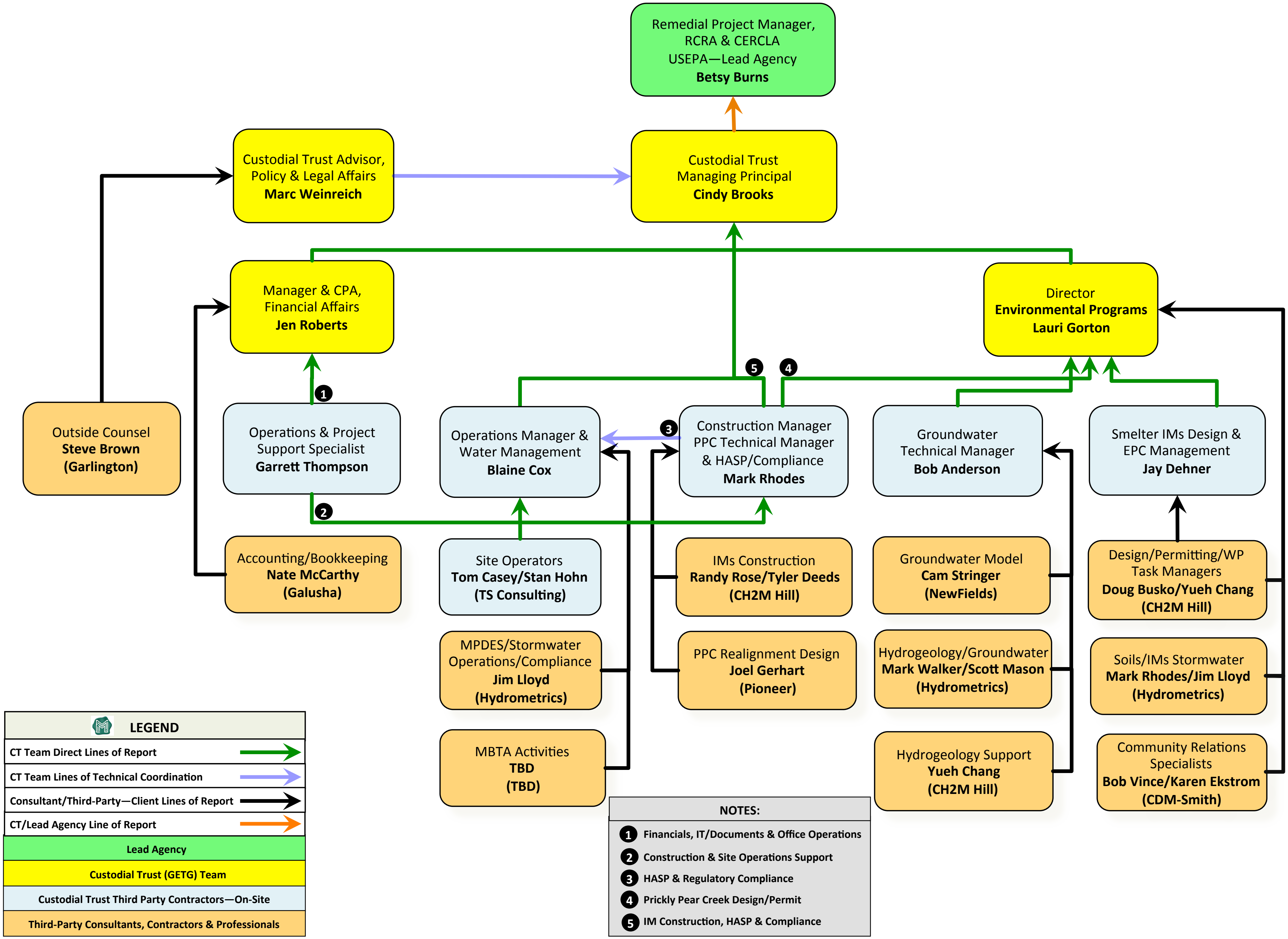
RP - Remediation Proposal

EA - Environmental Assessment

VCP - Voluntary Cleanup Plan

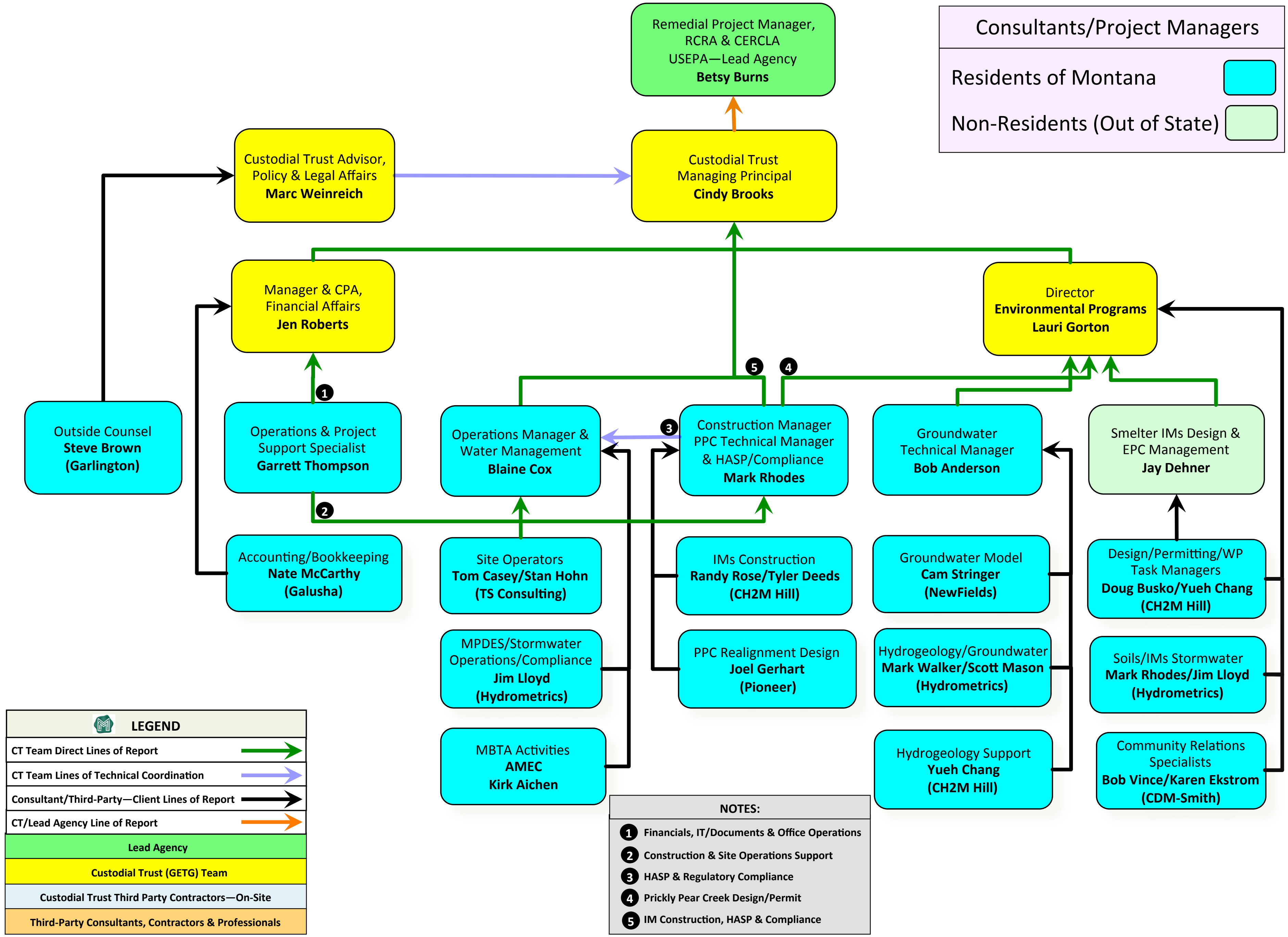
Attachment C-1

Montana Environmental Custodial Trust—East Helena Project/Consultant Team (4/1/2014)



Attachment C-2

Montana Environmental Custodial Trust—East Helena Project/Consultant Team (4/1/2014)



Subject: East Helena - PPC Temporary Bypass Diversion Schedule
Date: Thursday, October 10, 2013 at 6:06:27 PM Eastern Daylight Time
From: Jim Ford
To: Orwan Smith (YPL)
CC: Cindy Brooks (METG), Lauri Gorton (GETG), Stephen Brown (Garlington, Lohn & Robinson, PLLP), Mark Rhodes (Hydrometrics), Ralph Dresel (CH2M Hill), Randy Rose (CH2M Hill), Blaine Cox (METG)

Orwan,

CH2M Hill and their construction contractor, Helena Sand & Gravel, are planning to divert Prickly Pear Creek (PPC) into the PPC Temporary Bypass channel sometime between October 21st and 29th. Has the Yellowstone Pipeline Company made any decisions about stabilizing the stream bank we looked at on September 24th? Please let me know if you would like to discuss this issue further.

Thank you for your time and attention to this matter. Jim

Jim Ford
East Helena Remedial Project Manager
Montana Environmental Trust Group, LLC (METG)
Trustee of the Montana Environmental Custodial Trust
P.O. Box 1230,
East Helena, Montana 59635
www.mtenvironmentaltrust.org

406.227.3734 (office)
406.439.2108 (cell)
jf@mtenvironmentaltrust.org

From: Jim Ford [mailto:jf@mtenvironmentaltrust.org]
Sent: Wednesday, September 25, 2013 3:06 PM
To: Orwan Smith (YPL)
Cc: 'Blaine Cox (METG)'
Subject: PPC Upstream Connection

Orwan,

Thanks for coming out to the site yesterday. Attached is a pdf on the inlet structure to the Prickly Pear Creek (PPC) Bypass. Please let me know if we can provide any other information on our project.

Jim

Jim Ford
East Helena Remedial Project Manager
Montana Environmental Trust Group, LLC (METG)
Trustee of the Montana Environmental Custodial Trust
P.O. Box 1230,
East Helena, Montana 59635
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jf@mtenvironmentaltrust.org

Subject: Fwd: East Helena - PPC Temporary Bypass Diversion Schedule
Date: Tuesday, October 15, 2013 at 9:09:32 PM Eastern Daylight Time
From: Jim
To: Cindy Brooks, Lauri Gorton

FYI

Begin forwarded message:

From: "Smith, Orwan" <Orwan.Smith@p66.com>
Date: October 15, 2013 at 2:14:49 PM MDT
To: Jim Ford <jf@mtenvironmentaltrust.org>
Subject: RE: East Helena - PPC Temporary Bypass Diversion Schedule

Jim,

One of our engineers will be here tomorrow to look at the site. I meet with Helena Sand and Gravel and CH2M Hill on site today to discuss plans to work around YPl and I see no issue with them setting concrete barriers to divert creek flow. Thanks for keeping me informed. If you need to get ahold of me please call my cell. I am not in the office much this month.

Thanks

Orwan Smith
Helena Pipeliner
Yellowstone Pipe Line Company
Office: (406) 441-4750
Cell: (406) 224-1998

From: Jim Ford [mailto:jf@mtenvironmentaltrust.org]
Sent: Thursday, October 10, 2013 4:06 PM
To: Smith, Orwan
Cc: Cindy Brooks (METG); Lauri Gorton (GETG); Stephen Brown (Garlington, Lohn & Robinson, PLLP); Mark Rhodes (Hydrometrics); Ralph Dresel (CH2M Hill); Randy Rose (CH2M Hill); Blaine Cox (METG)
Subject: [EXTERNAL]East Helena - PPC Temporary Bypass Diversion Schedule

Orwan,

CH2M Hill and their construction contractor, Helena Sand & Gravel, are planning to divert Prickly Pear Creek (PPC) into the PPC Temporary Bypass channel sometime between October 21st and 29th. Has the Yellowstone Pipeline Company made any decisions about stabilizing the stream bank we looked at on September 24th? Please let me know if you would like to discuss this issue further.

Thank you for your time and attention to this matter. Jim

Jim Ford
East Helena Remedial Project Manager
Montana Environmental Trust Group, LLC (METG)
Trustee of the Montana Environmental Custodial Trust
P.O. Box 1230,
East Helena, Montana 59635
www.mtenvironmentaltrust.org

406.227.3734 (office)
406.439.2108 (cell)
jf@mtenvironmentaltrust.org

From: Jim Ford [mailto:jf@mtenvironmentaltrust.org]
Sent: Wednesday, September 25, 2013 3:06 PM
To: Orwan Smith (YPL)
Cc: 'Blaine Cox (METG)'
Subject: PPC Upstream Connection

Orwan,

Thanks for coming out to the site yesterday. Attached is a pdf on the inlet structure to the Prickly Pear Creek (PPC) Bypass. Please let me know if we can provide any other information on our project.

Jim

Jim Ford
East Helena Remedial Project Manager
Montana Environmental Trust Group, LLC (METG)
Trustee of the Montana Environmental Custodial Trust
P.O. Box 1230,
East Helena, Montana 59635
www.mtenvironmentaltrust.org

406.227.3734 (office)
406.439.2108 (cell)
jf@mtenvironmentaltrust.org

Subject: FW: CPO-050 NOC 3 for Stream Bank Stabilization
Date: Wednesday, October 16, 2013 at 5:29:36 PM Eastern Daylight Time
From: Mark Rhodes
To: Cynthia Brooks

Cindy,
Attached is CPO-050 Change Management 3 for the PPC Bypass for your signature. This change order is for temporary erosion control on the PPC stream bank to prevent additional erosion next to the Yellowstone Pipeline. CH met with Yellowstone Pipeline yesterday to discuss the bank erosion and potential exposure of the pipeline. Yellowstone Pipeline agreed it was a problem and they are expediting their process to address it, but could not give an exact timeline. In the meantime, they agreed that us placing sandbags along the bank to prevent further erosion was acceptable as a temporary protection effort while we construct the tie ins to the bypass. The additional cost for the sand bagging is $4300 which is relatively cheap insurance to prevent further erosion of the streambank. Also in the change order is the notification of the credit for not filling in the diversion channel into Upper Lake. Helena Sand and Gravel is currently preparing sandbags for the coffer dams, and would like to get the NTP on the additional sand bagging as soon as possible so they can prepare the additional bags all at once. Give me a call you have any further questions on this matter.
Thanks,
Mark

Mark Rhodes, P.E.
Hydrometrics, Inc.
3020 Bozeman Ave.
Helena, MT 59601
PH: 406-443-4150 x123
Cell: 406-431-1637

From: Randal.Rose@CH2M.com [mailto:Randal.Rose@CH2M.com]
Sent: Wednesday, October 16, 2013 12:43 PM
To: Mark Rhodes
Cc: Jay.Dehner@CH2M.com; Ralph.Dresel@CH2M.com; Tyler.Deeds@ch2m.com
Subject: CPO-050 NOC 3 for Stream Bank Stabilization

Hello mark

Please find attached NOC 3 for the PPC Stream Bank Stabilization. Let me know if you have any questions.

Thank You

Randal W. Rose, Ph.D.
Sr. Project Manager

CH2M HILL
randal.rose@ch2m.com
7 West 6th Ave. Suite 519
Helena, MT 59601
Office: 406-559-2021
Cell: 714-697-0037

Subject: FW: Prickly Pear Creek at the Former Asarco Smelter in East Helena
Date: Monday, November 4, 2013 at 12:32:04 PM Eastern Standard Time
From: Jim Ford
To: Cindy Brooks (METG)
CC: Mark Rhodes (Hydrometrics)
Priority: High

From: Jim Ford [mailto:jf@mtenvironmentaltrust.org]
Sent: Monday, September 23, 2013 9:51 AM
To: Orwan Smith (YPL)
Subject: Prickly Pear Creek at the Former Asarco Smelter in East Helena
Importance: High

Orwan,

I left a phone message last week so I thought I would try to reach you via email. We would like to meet with you at our construction site to evaluate Prickly Pear Creek, our site cleanup activities, and the YPL pipeline that crosses the creek near our work activities. Would you have time to meet this week or next?

Thanks, Jim Ford

Jim Ford
East Helena Remedial Project Manager
Montana Environmental Trust Group, LLC (METG)
Trustee of the Montana Environmental Custodial Trust
P.O. Box 1230,
East Helena, Montana 59635
www.mtenvironmentaltrust.org

406.227.3734 (office)
406.439.2108 (cell)
jf@mtenvironmentaltrust.org

Subject: FW: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications
Date: Tuesday, November 19, 2013 at 4:55:09 PM Eastern Standard Time
From: Mark Rhodes
To: Cynthia Brooks

-FYI

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Monday, November 18, 2013 5:42 PM
To: Mark Rhodes
Subject: FW: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

FYI, update on Yellowstone Pipeline discussion…

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Wildin, Carrie A [mailto:Carrie.A.Wildin@p66.com]
Sent: Monday, November 18, 2013 4:02 PM
To: Dresel, Ralph/LAS
Cc: Nugent, Luke A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R; Dan Nebel (dcnebel@terracon.com); Wildin, Carrie A; Piersall, Mike
Subject: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Thanks for the call Ralph!
All, Ralph with CH2M is going to send me the full design package for the rip-rap along the Prickly Pear bank (with cross sections) tomorrow along with some cost estimates for the work and a proposed cost sharing structure. He will also let me know what the permitting agencies have to say. When I receive the design package I will send it over to Dan Nebel with Terracon to take a quick look and get any comments back to Ralph.

Chris/Larry,
From a cost sharing perspective, is there a template that we have used in the past for work like this?

Thanks,

Carrie A. Wildin, PE
Maintenance Superintendent
Billings Pipeline Division
406-255-5728
Cell: 806-283-5175
carrie.a.wildin@p66.com

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Monday, November 18, 2013 4:27 PM
To: Piersall, Mike

Cc: Nugent, Luke A; Wildin, Carrie A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R
Subject: [EXTERNAL]RE: PPC Bypass Tie-In Modifications

Thanks Mike,

I'll give Luke or Carrie a call. We're currently in discussions with the joint application folks on this, so I'm not sure how the current application will apply. Initial discussions have turned up no show stoppers regarding permits.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Piersall, Mike [mailto:Michael.Piersall@p66.com]
Sent: Monday, November 18, 2013 3:01 PM
To: Dresel, Ralph/LAS
Cc: Nugent, Luke A; Wildin, Carrie A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R
Subject: RE: PPC Bypass Tie-In Modifications

Ralph,

Your contacts will be Luke Nugent 406-633-1713 and/or Carrie Wildin 806-283-5175. Larry Ostwald has requested a copy of the Joint Application that you have submitted for work in a stream. When the work is being performed Orwan will need to be on site. Let me know if you have any additional questions.

Thanks,
Mike Piersall
Phillips 66 Pipeline, LLC
Operations Engineer
2626 Lillian Avenue
Billings, MT 59101
Office (406) 255-5738
Cell (406) 208-2849

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Monday, November 18, 2013 9:55 AM
To: Piersall, Mike
Cc: Jay.Dehner@CH2M.com; Randal.Rose@CH2M.com; Smith, Orwan
Subject: [EXTERNAL]PPC Bypass Tie-In Modifications

Mike-
As a follow-up to our conversation last week, we are preparing to modify Prickly Pear Creek south of East Helena just north of where the Yellowstone Pipeline crosses. Our engineers have developed a plan to enhance stability of the creek bed in the area between the pipeline and the new bypass channel we just completed. The plan includes modifying the inlet to the bypass as well as strengthening the bank near the pipeline. Since you also have plans for similar work, and since the work will be in proximity of the pipeline, we need to coordinate our efforts before any field work proceeds.

Take a look at the attached preliminary plan of the proposed work and let me know who to coordinate with in your organization. Timing is somewhat critical as the bypass contractor will only be mobilized on site for a short while and we want to get the work done as soon as efficiently possible.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

Subject: Fwd: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications
Date: Thursday, November 21, 2013 at 5:16:21 PM Eastern Standard Time
From: Lauri Gorton
To: Brooks Cindy

Cindy
See below for Yellowstone's standard "easement encroachment" agreement. Would you like me to forward to Steve?

Lauri J. Gorton, P.E.
Director of Environmental Programs and Senior Strategist
Greenfield Environmental Trust Group, Inc.
lg@g-etg.com
414.732.4514

Begin forwarded message:

From: <Ralph.Dresel@CH2M.com>
Date: November 21, 2013 at 2:54:13 PM CST
To: <lg@g-etg.com>, <MRHODES@hydrometrics.com>
Cc: <Jay.Dehner@CH2M.com>, <Randal.Rose@CH2M.com>, <Doug.Busko@CH2M.com>
Subject: FW: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Lauri-
Here's a copy of Yellowstone Pipeline's standard encroachment agreement template, along with a copy of what looks like the original Right of Way agreement. Probably not too early to start reviewing from a legal aspect.

I don't have any response back on the design package yet.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Dresel, Ralph/LAS
Sent: Thursday, November 21, 2013 12:29 PM
To: 'Ostwald, Larry E.'; Carpenter, Chris R
Cc: Wildin, Carrie A; Nugent, Luke A; Smith, Orwan; Kuntz, Michael R; dcnebel@terracon.com; Piersall, Mike; Dehner, Jay/SPK; Rose, Randal/HMT
Subject: RE: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Thanks Larry,

According to the survey data we have, the location shown in the ROW document you attached does cover the area of the pipeline and Prickly Pear Creek.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Ostwald, Larry E. [mailto:Larry.E.Ostwald@p66.com]
Sent: Thursday, November 21, 2013 8:34 AM
To: Dresel, Ralph/LAS; Carpenter, Chris R
Cc: Wildin, Carrie A; Nugent, Luke A; Smith, Orwan; Kuntz, Michael R; dcnebel@terracon.com; Piersall, Mike; Dehner, Jay/SPK; Rose, Randal/HMT
Subject: RE: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Ralph please see the attached Encroachment Agreement for the proposed bank stabilization.

Also Ralph can you verify if the attached agreement covers the area of Prickly Pear Creek?

Larry Ostwald
Property Tax, Real Estate, Right of Way and Claims Advisor
3180 Hwy 12 East
Helena, MT 59601
406-431-3311 cell
406-441-4746 office
406-457-0473 fax

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Tuesday, November 19, 2013 2:37 PM
To: Carpenter, Chris R; Ostwald, Larry E.
Cc: Wildin, Carrie A; Nugent, Luke A; Smith, Orwan; Kuntz, Michael R; dcnebel@terracon.com; Piersall, Mike; Jay.Dehner@CH2M.com; Randal.Rose@CH2M.com
Subject: [EXTERNAL]RE: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Chris/Larry-

Thanks for the call this morning; I think we have a good path forward.

To summarize, there are two areas of concern:

- the south bank of the meander bend which is in close proximity to the pipe and which has been failing for some time due to natural conditions in the creek
- possible head cutting in the creek bed between the bypass inlet and the pipe crossing

There is risk that the pipe along the creek bank would be in danger of exposure with the next high water event. We understand that Phillips has immediate plans to stabilize the area before spring 2014, and is also considering a more permanent solution within the next few years.

The possibility of pipe exposure in the creek bed crossing due to head cutting is less risky since the pipe is 8-9 feet below the creek bed (according to Phillips field personnel).

Our current design for stabilization of the head cut addresses both issues, and was developed with the purpose of reducing risk to all parties without impact to anyone's liability. It includes temporary stabilization of the bank to minimize further natural creek erosion in the vicinity of the pipeline until such time as Phillips implements a more permanent solution to improve long-term performance. The plan also incorporates a grade control extending across the low-flow channel area to protect against head cutting in the channel, and also moves the creek channel further away from the YPL pipeline in the existing high-erosion area.

As we discussed, it seems appropriate that costs for this work be shared. At this time we think the costs associated with the south bank of the meander to be no more than 50% of the total. I will have a better figure later today, and will include that when I send the design package for your review. I'll send the standard agreement forms to the Trust for their comment as soon as I get them from Larry. I'll also pursue the path Chris suggested by possibly using an MSA that may currently exist between CH and Phillips for the cost sharing.

Larry- the property owner is identified as MONTANA ENVIRONMENTAL CUSTODIAL TRUST.

We have a great opportunity here to share resources to efficiently and effectively reduce potential risk to all parties. Thanks for your help.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Carpenter, Chris R [mailto:Chris.R.Carpenter@p66.com]
Sent: Monday, November 18, 2013 4:42 PM
To: Wildin, Carrie A; Dresel, Ralph/LAS
Cc: Nugent, Luke A; Ostwald, Larry E.; Smith, Orwan; Kuntz, Michael R; Dan Nebel (dcnebel@terracon.com); Piersall, Mike
Subject: RE: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

There is a standard agreement that we have and I will review with Larry tomorrow to insure we have the standard indemnification language in the document. The discussion I need to have with Larry is the review by Terracon and what the implications are. If we approve their design, I want to insure we are not accepting liability for potential bank failure and YPL pipeline release. We dealt with a similar issue at MP 319 and tried to stop the work, albeit unsuccessfully, but we need legal opinion on this moving forward. The cost sharing portion needs to address this.

Chris Carpenter
Division Engineer
2626 Lillian Avenue
Billings, MT 59101
Office (406) 255-5724
Cell (406) 647-2470 (new number)

From: Wildin, Carrie A
Sent: Monday, November 18, 2013 5:02 PM
To: 'Ralph.Dresel@CH2M.com'
Cc: Nugent, Luke A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R; Dan Nebel (dcnebel@terracon.com); Wildin, Carrie A; Piersall, Mike
Subject: YP01 Prickly Pear Creek Bank Stabilization / Bypass Tie-In Modifications

Thanks for the call Ralph!
All, Ralph with CH2M is going to send me the full design package for the rip-rap along the Prickly Pear bank (with cross sections) tomorrow along with some cost estimates for the work and a

proposed cost sharing structure. He will also let me know what the permitting agencies have to say. When I receive the design package I will send it over to Dan Nebel with Terracon to take a quick look and get any comments back to Ralph.

Chris/Larry,
From a cost sharing perspective, is there a template that we have used in the past for work like this?

Thanks,

Carrie A. Wildin, PE
Maintenance Superintendent
Billings Pipeline Division
406-255-5728
Cell: 806-283-5175
carrie.a.wildin@p66.com

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Monday, November 18, 2013 4:27 PM
To: Piersall, Mike
Cc: Nugent, Luke A; Wildin, Carrie A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R
Subject: [EXTERNAL]RE: PPC Bypass Tie-In Modifications

Thanks Mike,

I'll give Luke or Carrie a call. We're currently in discussions with the joint application folks on this, so I'm not sure how the current application will apply. Initial discussions have turned up no show stoppers regarding permits.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

From: Piersall, Mike [mailto:Michael.Piersall@p66.com]
Sent: Monday, November 18, 2013 3:01 PM
To: Dresel, Ralph/LAS
Cc: Nugent, Luke A; Wildin, Carrie A; Ostwald, Larry E.; Carpenter, Chris R; Smith, Orwan; Kuntz, Michael R
Subject: RE: PPC Bypass Tie-In Modifications

Ralph,

Your contacts will be Luke Nugent 406-633-1713 and/or Carrie Wildin 806-283-5175. Larry Ostwald has requested a copy of the Joint Application that you have submitted for work in a stream. When the work is being performed Orwan will need to be on site. Let me know if you have any additional questions.

Thanks,
Mike Piersall
Phillips 66 Pipeline, LLC
Operations Engineer
2626 Lillian Avenue
Billings, MT 59101
Office (406) 255-5738
Cell (406) 208-2849

From: Ralph.Dresel@CH2M.com [mailto:Ralph.Dresel@CH2M.com]
Sent: Monday, November 18, 2013 9:55 AM
To: Piersall, Mike
Cc: Jay.Dehner@CH2M.com; Randal.Rose@CH2M.com; Smith, Orwan
Subject: [EXTERNAL]PPC Bypass Tie-In Modifications

Mike-
As a follow-up to our conversation last week, we are preparing to modify Prickly Pear Creek south of East Helena just north of where the Yellowstone Pipeline crosses. Our engineers have developed a plan to enhance stability of the creek bed in the area between the pipeline and the new bypass channel we just completed. The plan includes modifying the inlet to the bypass as well as strengthening the bank near the pipeline. Since you also have plans for similar work, and since the work will be in proximity of the pipeline, we need to coordinate our efforts before any field work proceeds.

Take a look at the attached preliminary plan of the proposed work and let me know who to coordinate with in your organization. Timing is somewhat critical as the bypass contractor will only be mobilized on site for a short while and we want to get the work done as soon as efficiently possible.

-Ralph

Ralph Dresel
Construction Manager

CH2M HILL
Cell (702) 210-3191

Subject: PPC Bypass Intake Issues
Date: Monday, December 2, 2013 at 8:10:44 AM Eastern Standard Time
From: Mark Rhodes
To: Cynthia Brooks, lg@g-etg.com

Cindy/Lauri,
I talked with Ralph on Friday and progress with Yellowstone Pipeline has stalled. It looks like we may have to go with option 1 and stay away from the bank next to the pipeline. I will update you further today after I get a chance to talk to Ralph later this morning.
Mark

Mark W. Rhodes, P.E.
Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59602
Office: 406-443-4150 x123
Cell: 406-431-1637
mrhodes@hydrometrics.com

garlington | lohn | robinson

glr
350 Ryman Street
P.O. Box 7909
Missoula, Montana 59807-7909
(406) 523-2500
Fax (406) 523-2595
www.garlington.com

December 9, 2013

VIA ELECTRONIC AND CERTIFIED MAIL

Dennis.H.Close@p66.com
Dennis H. Close
President
Yellowstone Pipe Line Company
600 North Dairy Ashford, TA 2130
Houston, TX 77079

Van.P.Williams@p66.com
Van P. Williams
General Counsel
Yellowstone Pipe Line Company
600 North Diary Ashford, ML 2076
Houston, TX 77079

Todd.Denton@p66.com
Todd C. Denton
President
Phillips 66 Pipeline LLC
600 North Dairy Ashford, TA 2032
Houston, TX 77079

RE: *Montana Environmental Trust Group*

Dear Mssrs. Close, Williams and Denton:

We are sending this letter on behalf of our client, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (the "Custodial Trust"). The Custodial Trust is an environmental response trust established in 2009 by the United States and the State of Montana as part of the global Asarco bankruptcy settlement. The Custodial Trust's duties and responsibilities are set forth in a Consent Decree and Environmental Settlement Agreement Regarding the Montana Sites (the "Settlement Agreement"). Under the Settlement Agreement, among other things, the Custodial Trust is charged with responsibility for owning, managing, cleaning up and effecting the disposition of the former Asarco Smelter in East Helena, Montana (the "Site") consistent with its fiduciary obligations to the United States and the State of Montana, the sole beneficiaries of the Custodial Trust (the "Beneficiaries"). Cleanup activities at the site are being performed under the direction and with the approval of the US Environmental Protection Agency ("EPA"), the designated Lead Agency for the Site.

The purpose of this letter is to notify the Yellowstone Pipe Line Company ("YPLC") of the Custodial Trust's concerns about YPLC's maintenance and protection of the YPLC petroleum pipeline that crosses Custodial Trust property at the site. Specifically, there has been significant bank erosion along the northern edge of pipeline right-of-way in the area to the west of where the pipeline crosses Prickly Pear Creek ("PPC") upstream from the former East Helena smelter area. While performing its cleanup responsibilities and prior to starting any construction work on reaches of PPC downstream of the pipeline crossing, the Custodial Trust observed the erosion and contacted YPLC representatives who advised the Custodial Trust that the company was aware of the problem.

During the last three months, Custodial Trust representatives have held a number of discussions and meetings with YPLC about the erosion issue. Specifically, YPLC personnel met with Custodial Trust representatives in East Helena on September 24, 2013 and October 15, 2013. More recently, the Custodial Trust and YPLC have been exploring ways that the two organizations might cooperate and share the costs to simultaneously complete the Custodial Trust's construction activities on PPC this year and stabilize the pre-existing deteriorating bank that could result in damage to the pipeline in a high flow event. Unfortunately, YPLC has indicated that the company is unable to reach consensus on a proposed coordination and cost sharing arrangement in time to meet the Custodial Trust's construction schedule. Accordingly, the Custodial Trust is now planning to move forward with the EPA-approved cleanup plans to complete work downstream of the right-of-way and will not be doing any work within the YPLC right-of-way.

As the Custodial Trust has expressed multiple times to YPLC, the Custodial Trust is concerned that the pipeline is at risk of damage in a high flow event on PPC. Based on these concerns, the Custodial Trust asked us to notify YPLC of its concerns about the risk of pipeline damage to the pipeline due to YPLC's failure to maintain the pipeline right-of-way, which could result in significant environmental damage and adversely impact cleanup activities on the Site downstream of the pipeline. On behalf of the Custodial Trust, we also advise YPLC that, under the easement instrument governing YPLC's installation, operation and maintenance of the pipeline, and as a matter of Montana common law, YPLC is obligated to pay any damages that may arise in connection with YPLC's operation of the pipeline.

Thank you in advance for your prompt attention to this issue. You may contact me by telephone at (406) 523-2558 or by email at srbrown@garlington.com.

Very truly yours,

GARLINGTON, LOHN & ROBINSON, PLLP

Stephen R. Brown
Email: srbrown@garlington.com

SRB:amm
c: Betsy Burns—US EPA
Cindy Brooks—Custodial Trust
Lauri Gorton—Custodial Trust
Orwan Smith—YPLC
Chris Carpenter—YPLC
Robert A. Herman—YPLC
Paula Johnson—YPLC
Montana Department of Environmental Quality

Subject: Montana Environmental Custodial Trust - East Helena, Montana
Date: Monday, December 9, 2013 at 6:05:30 PM Eastern Standard Time
From: Stephen R. Brown
To: 'Dennis.H.Close@p66.com', 'Van.P.Williams@p66.com', 'Todd.Denton@p66.com'
CC: 'Betsy Burns (Burns.Betsy@epamail.epa.gov)', 'Cynthia Brooks (cb@g-etg.com)', 'Lauri Gorton (lg@g-etg.com)', 'Chris.R.Carpenter@p66.com', 'Michael.Piersall@p66.com', 'carrie.a.wildin@p66.com', 'Larry.E.Ostwald@p66.com', 'Orwan.Smith@p66.com', 'BLovelace2@mt.gov'

Gentlemen – Attached is a copy of a letter that we are sending to you today on behalf of our client, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust. The letter addresses certain concerns about the Yellowstone Pipeline as it crosses the Trust's property in East Helena, Montana. We appreciate your attention to the concerns expressed in the letter.

Thank you,

Steve Brown

Stephen R. Brown
garlington|lohn|robinson

PO Box 7909 / 350 Ryman Street
Missoula, MT 59807-7909
(406) 523-2558 - Office
(406) 240-5380 - Cell
(406) 523-2595 – Fax
www.garlington.com

Subject: FW: Montana Environmental Custodial Trust - East Helena, Montana
Date: Tuesday, December 10, 2013 at 2:59:38 PM Eastern Standard Time
From: Cynthia Brooks
To: Chuck Figur, Alan Tenenbaum, Elliot Rockler
CC: Stephen Brown, Betsy Burns, Lauri Gorton

As discussed in our meeting this morning, I am forwarding the letter Steve sent to Yellowstone Pipeline Company yesterday. The Custodial Trust is assembling all photo-recordation information, which we can provide to EPA/USDOJ if desired.
Many thanks
Cindy

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc.
Resources for Responsible Site Management, Inc., Trustee for the Industri-plex Custodial Trust
Montana Environmental Trust Group LLC, Trustee of the Montana Environmental Custodial Trust
Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762
cb@g-etg.com

From: Stephen Brown <srbrown@GARLINGTON.COM>
Date: Monday, December 9, 2013 6:05 PM
To: "Dennis H. Close" <Dennis.H.Close@p66.com>, "Van P. Williams" <Van.P.Williams@p66.com>, "Todd C. Denton" <Todd.Denton@p66.com>
Cc: Betsy Burns <Burns.Betsy@epamail.epa.gov>, Cynthia Brooks <cb@g-etg.com>, Lauri Gorton <lg@g-etg.com>, Chris Carpenter <Chris.R.Carpenter@p66.com>, Mike Piersall <Michael.Piersall@p66.com>, "Carrie A. Wildin" <carrie.a.wildin@p66.com>, Larry Ostwald <Larry.E.Ostwald@p66.com>, Orwan Smith <Orwan.Smith@p66.com>, "'BLovelace2@mt.gov'" <BLovelace2@mt.gov>
Subject: Montana Environmental Custodial Trust - East Helena, Montana

Gentlemen – Attached is a copy of a letter that we are sending to you today on behalf of our client, the Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust. The letter addresses certain concerns about the Yellowstone Pipeline as it crosses the Trust's property in East Helena, Montana. We appreciate your attention to the concerns expressed in the letter.

Thank you,

Steve Brown

Stephen R. Brown
garlington|lohn|robinson

PO Box 7909 / 350 Ryman Street
Missoula, MT 59807-7909
(406) 523-2558 - Office
(406) 240-5380 - Cell
(406) 523-2595 – Fax
www.garlington.com

* *

* *

Subject: RE: Montana Environmental Trust
Date: Thursday, December 12, 2013 at 4:31:26 PM Eastern Standard Time
From: Miller, Mike S
To: Cynthia Brooks, Stephen R. Brown
CC: 'Mark Rhodes', Williams, Van P. (LDZX), Ostwald, Larry E., Carpenter, Chris R

Including email addresses for meeting attendees.

Mike

From: Cynthia Brooks [mailto:cb@g-etg.com]
Sent: Thursday, December 12, 2013 10:36 AM
To: Stephen R. Brown; Miller, Mike S
Cc: 'Mark Rhodes'
Subject: [EXTERNAL]Re: Montana Environmental Trust

Good Morning:
To facilitate our conversation, I am forwarding the attached two proposals under consideration for addressing the PPC issues.
Many thanks.
Cindy

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc.
Resources for Responsible Site Management, Inc., Trustee for the Industri-plex Custodial Trust
Montana Environmental Trust Group LLC, Trustee of the Montana Environmental Custodial Trust
Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762
cb@g-etg.com

From: Stephen Brown <srbrown@GARLINGTON.COM>
Date: Thursday, December 12, 2013 12:19 PM
To: "'mike.s.miller@p66.com'" <mike.s.miller@p66.com>
Cc: Cynthia Brooks <cb@g-etg.com>, Mark Rhodes <MRHODES@hydrometrics.com>
Subject: Montana Environmental Trust

Mike – Thanks for making yourself available for a call today. I will send you dial in instructions for a call at 1:00 MST. I will be on the call, along with Cindy Brooks from the Trust, and Mark Rhodes, the engineer from Hydrometrics who is designing the control structures in Prickly Pear Creek.

On the call, we would like to discuss the options within the YPL right of way and outside the right of way. We can discuss the costs of each, and what we believe to be a fair cost share. We also will discuss the timing of the work and what that means for selection of an option, especially if an acceptable encroachment agreement has to be negotiated.

We look forward to a productive call with you.

Thanks,

Steve

Stephen R. Brown
garlington|lohn|robinson

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(406) 240-5380 - Cell
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PHILLIPS 66

Frances E. Nunn
Environmental Coordinator –
Transportation HSE
Pipeline & Terminals- Billings Division
Phillips 66 Company
2626 Lillian Avenue
Billings, MT 59101
Phone 406.255.5714
fran.e.nunn@p66.com

January 31, 2014

FILE COPY

Mr. Todd Tillinger
US Army Corps of Engineers
10 West 15th Street, Suite 2200
Helena, MT 59626
Certified Mail No. 7012 0470 0000 8788 9580

Ms. Chris Evans
Lewis and Clark Conservation District
790 Colleen Street
Helena, MT 59601-9713
Certified Mail No. 7012 0470 0000 8788 9597

Re: **Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and Other Water Bodies. Yellowstone Pipe Line Company – Prickly Pear Creek Encroachment at MM 211.3 – Near East Helena, Lewis and Clark County, Montana**

Dear Mr. Tillinger and Ms. Evans:

Please review the enclosed Joint Application form requesting agency authorization for work on the bank of Prickly Pear Creek south of the town of East Helena. The proposed project involves armoring 200 linear feet of the left (south) creek bank with riprap toe stabilization and willows.

This project was discussed with the resource agencies at the Lewis and Clark Conservation District office on January 7, 2014, attended by Chris Evans (L&CCD), Deb Blank (USACE), Paul Spengler (Lewis and Clark County Floodplain), Jeff Ryan (MDEQ), and Eric Roberts (MFWP).

The agencies present indicated that the work should be done as soon as practicable, and should tie into the upstream end of the new bypass channel due to concerns with the possibility of the creek flanking the bypass channel diversion if the bank continues to move towards the west. With additional high water and bank erosion, the pipe could also become exposed and potentially suspended, therefore, creating the potential for the pipe line to become damaged. Because of the risk to both the pipe line and the bypass channel, we are requesting expedited review of this application, to allow work to commence prior to high water this spring.

Please contact me or Dan Nebel with Terracon (406.371.9851), our consultant for this permit application, if you have any questions.

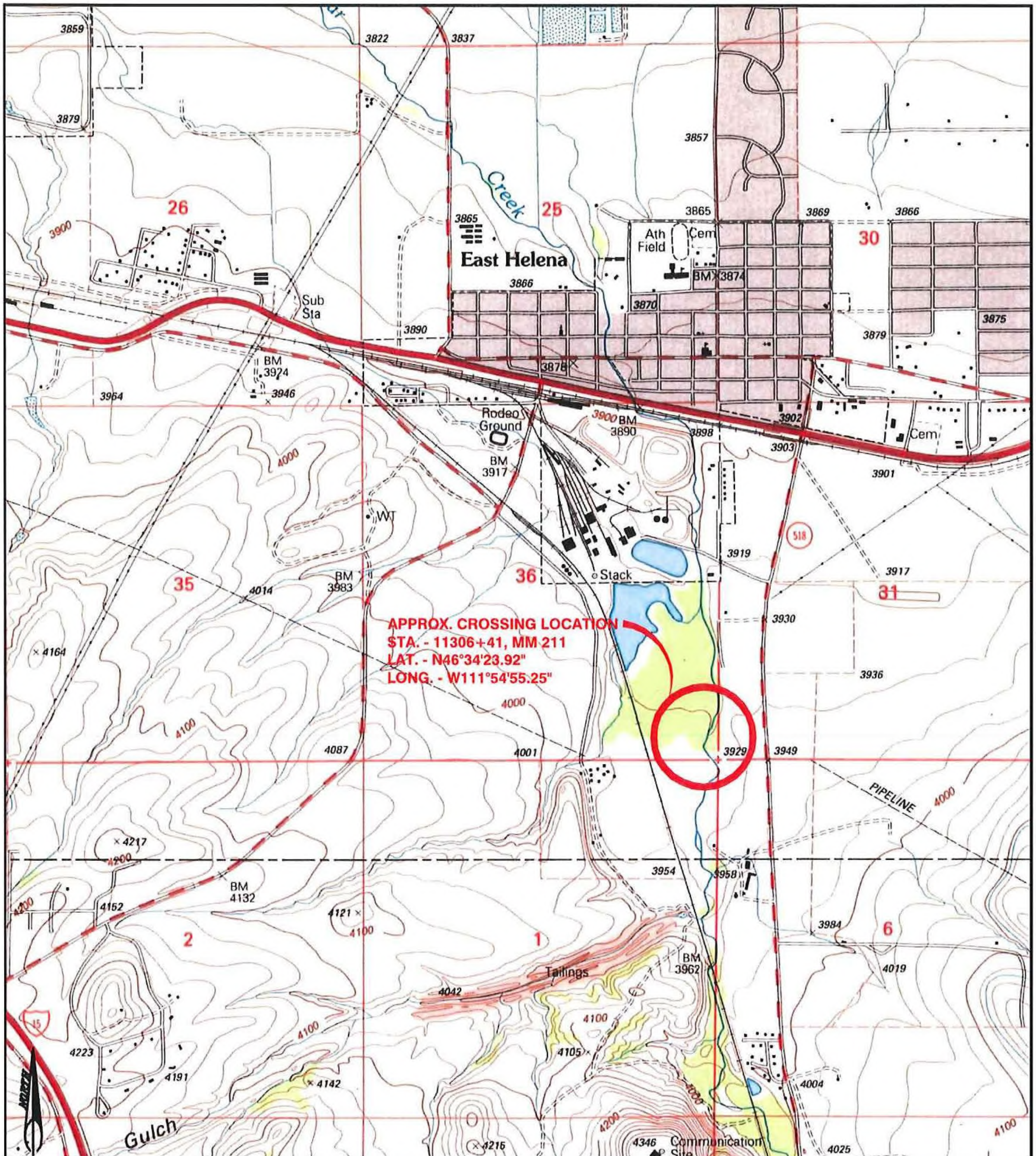
Sincerely,

Frances E Nunn

Fran Nunn, Environmental Coordinator

Attachments

Cc: Dan Nebel, Terracon Consultants, Inc.



SE1/4, SE1/4, SE1/4, SECTION 36, T.10N., R.3W.
USGS QUADRANGLE – EAST HELENA
NOT TO SCALE

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists
2110 Overland Avenue, Suite 124 Billings, MT 59102
PH. (406) 656-3072 FAX. (406) 656-3578

Prickly Pear Creek
Station 11306+41 / MM 211
ConocoPhillips Pipe Line Co.
Yellowstone Pipe Line
Montana

1

DESIGNED BY:	
DRAWN BY:	tlesnik
APPVD. BY:	
SCALE:	As Shown
DATE:	February, 2012
JOB NO.	11080
FILE NAME:	LTLPRKYPR.DWG
SHEET NO.:	1 OF 1

Revised: 2/16/12 (310 form 270) Form may be downloaded from: www.dnrc.mt.gov/permits/default.asp	**AGENCY USE ONLY:** Application # ________ Date Received ________ Date Accepted ____________ / Initials _____ Date Forwarded to DFWP ________

This space is for all Department of Transportation and SPA 124 permits (government projects).
Project Name ________________________________
Control Number ______________________ Contract letting date ______________________________
MEPA/NEPA Compliance ☐ Yes ☐ No If yes, #14 of this application does not apply.

JOINT APPLICATION FOR PROPOSED WORK IN MONTANA'S STREAMS, WETLANDS, FLOODPLAINS, AND OTHER WATER BODIES

Use this form to apply for one or all local, state, or federal permits listed below. The applicant is the responsible party for the project and the point of contact unless otherwise designated. **"Information for Applicant"** includes agency contacts and instructions for completing this application. To **avoid delays**, submit all required information, including **a project site map and drawings.** Incomplete applications will result in the delay of the application process. **Other laws may apply**.

The applicant is responsible for obtaining all necessary permits and landowner permission before beginning work.

✓	PERMIT	AGENCY	FEE
✓	310 Permit	Local Conservation District	No fee
	SPA 124 Permit	Department of Fish, Wildlife and Parks	No fee
✓	Floodplain Permit	Local Floodplain Administrator	Varies by city/county ($25 - $500+)
✓	Section 404 Permit, Section 10 Permit	U. S. Army Corps of Engineers	Varies ($0 - $100)
✓	318 Authorization 401 Certification	Department of Environmental Quality	$250 (318); $400 - $20,000 (401)
	Navigable Rivers Land Use License or Easement	Department of Natural Resources and Conservation, Trust Lands Management Division	License $25; Easement $50, plus annual fee

A. APPLICANT INFORMATION

NAME OF **APPLICANT** (person responsible for project): Yellowstone Pipe Line Company

Has the landowner consented to this project? ◻ Yes x No – Discussions with the landowner are underway. Permission is expected to be granted.

Yellowstone Pipe Line Company
2626 Lillian Avenue
Billings, MT 59101
c/o Fran Nunn, Environmental Coordinator

406.255.5714 office
406.671.4815 cell
fran.e.nunn@p66.com

NAME OF **LANDOWNER** (if different from applicant):
Montana Environmental Trust Group LLC (Trustee)
PO Box 1390
Helena, MT 59624-1390

NAME OF **CONTRACTOR/AGENT** (if one is used):
Terracon Consultants, Inc.
2110 Overland Ave, Ste 124
Billings, MT 59102

406.656.3072 office
406.670.1682 cell
dcnebel@terracon.com

B. PROJECT SITE INFORMATION

NAME OF **STREAM** or **WATER BODY** at project location: Prickly Pear Creek

Nearest Town: East Helena

SE1/4 SE1/4 Section 36, Township 10 North, Range 3 West, Lewis and Clark County, Montana

Longitude: -111° 54' 52.67" W Latitude: 46° 34' 23.56" N

Property Address: 325 Manlove Avenue, East Helena, MT 59635

The state owns the beds of certain state navigable waterways. Is this a state navigable waterway? Yes or [No.]
If yes, send copy of this application to appropriate DNRC land office – see Information for Applicant.

ATTACH A PROJECT SITE MAP OR A SKETCH that includes: 1) the water body where the project will take place, roads, tributaries, landmarks; 2) a circled "X" representing the exact project location. IF NOT CLEARLY STATED ON THE MAP OR SKETCH, **PROVIDE WRITTEN DIRECTIONS TO THE SITE.**

C. PROJECT INFORMATION

1. **TYPE OF PROJECT** (check all that apply)

☐ Bridge/Culvert/Ford Construction	☐ Fish Habitat	☐ Mining
☐ Bridge/Culvert/Ford Removal	☐ Recreation (docks, marinas, etc.)	☐ Dredging
☐ Road Construction/Maintenance	☐ New Residential Structure	☐ Core Drill
✓ Bank Stabilization/Alteration	☐ Manufactured Home	☐ Placement of Fill
☐ Flood Protection	☐ Improvement to Existing Structure	☐ Diversion Dam
☐ Channel Alteration	☐ Commercial Structure	✓ Utilities
☐ Irrigation Structure	☐ Wetland Alteration	☐ Pond
☐ Water Well/Cistern	☐ Temporary Construction Access	☐ Debris Removal
☐ Excavation/Pit	☐ Other ______________________	

2. **PLAN OR DRAWING** of the proposed project **MUST** be attached. **This plan or drawing must include**:

- a plan view (looking at the project from above)
- dimensions of the project (height, width, depth in feet)
- location of storage or stockpile materials
- drainage facilities
- an arrow indicating north
- a cross section or profile view
- an elevation view
- dimensions and location of fill or excavation sites
- location of existing or proposed structures, such as buildings, utilities, roads, or bridges

3. **IS THIS APPLICATION FOR** an annual maintenance permit? ☐ Yes ✓ No
(If yes, an annual plan of operation must be attached to this application – see "Information for Applicant")

4. **PROPOSED CONSTRUCTION DATE.** Include a project timeline.
Start date : 2/15/2014
Finish date: 3/31/2014 (prior to potential spring high water flows)
Is any portion of the work already completed? ☐ Yes ✓ No
(If yes, describe the completed work.)

5. **WHAT IS THE PURPOSE** of the proposed project?
The Yellowstone Pipe Line 10" refined petroleum products pipe line is near exposure at this location. The bank has eroded towards the south and is within 3 feet of the pipe line. With additional high water and bank erosion,

the pipe could become exposed and potentially suspended. The proposed project would involve constructing rock riprap toe stabilization in order to halt the movement of the bank southward thus protecting the pipe line from future exposure. It is uncertain what effects the temporary bypass channel and associated grade control structure recently constructed immediately downstream from this project will have during high flow events. In order to eliminate the risk of damage to the pipeline, and prevent flanking of the bypass diversion, bank hardening is necessary.

6. **PROVIDE A BRIEF DESCRIPTION** of the proposed project.
Yellowstone Pipe Line Company is proposing to armor the left (south) stream bank at this location by placing rock riprap along approximately 200 linear feet.

First, the sandbags must be removed and properly disposed of. The bank will be sloped at 2H:1V. Approximately 100 cubic yards of MDT Type II rock (D_{50} = 18"; D_{MAX} = 36") will be placed along the sloped bank and keyed in 3' below the channel bed elevation, and extending to approximately the ordinary high water mark. The riprap voids will be filled with a 50/50 mix of topsoil and native streambed material. Above the riprap soil lifts will be constructed using KoirMat 700. The finished elevation of the soil lifts will be the same as the adjacent ground surface. Willow bundles will be placed above the riprap and below the soil lifts, angled towards the stream at about 30 to 45 degrees. The upper bank above the willows will be reseeded with a native seed mix and treated for weeds as necessary until vegetation is re-established.

7. **WHAT IS THE CURRENT CONDITION** of the proposed project site? Describe the existing bank condition, bank slope, height, nearby structures, and wetlands.

The left bank (looking downstream) is about 4' to 5' high, and vertical. The upper bank consists of grasses of undetermined species. NWI classifies the area as PSSAh (Palustrine, Scrub/shrub, temporarily flooded, diked/impounded). A temporary bypass channel was recently constructed immediately downstream from the pipe line right-of-way associated with a federally funded superfund cleanup. There is an overhead power line about 85' directly to the south of the pipe line. The Asarco smelter slag piles are about 3,300' to the north. A railroad runs north/south about 1000' to the west. A county road (Rte 518) is 870'to the east. There are sand bags on the bank that were placed by unknown persons, presumably when the bypass channel was constructed.

8. **PROJECT DIMENSIONS**. How many linear feet of bank will be impacted? How far will the proposed project encroach into and extend away from the water body?

Approximately 200 linear feet of the south bank would be impacted by the placement of riprap and soil lifts. The project will encroach into the waterway less than 5 feet. The willows will eventually create overhanging cover and shade along about 200 feet of bank.

9. **VEGETATION.** Describe the vegetation present on site. How much vegetation will be disturbed or covered with fill material during project installation? (Agencies require that only vegetation necessary to do the work be removed.) Describe the revegetation plan for all disturbed areas of the project site in detail.

Vegetation will be preserved to the extent practicable. Disturbed areas on the upper bank will be reseeded with native species. Bundled willow cuttings (5 – 10 cuttings per bundle) will be planted on 1 foot centers, leaning towards the channel at about 30 – 45 degrees. Cuttings will be 6' to 8' in length and 0.75" to 1.25" in diameter. At least half of the length of the cuttings will be in the bank with the bottoms within the low water elevation.

The adjacent bank is identified as wetlands on NWI maps. Although rock will be placed along the bank, no wetlands will be filled. The adjacent wetland disturbance will be temporary and grasses and shrubs will be re-established when the work is completed.

10. **MATERIALS**. Describe the materials to be used and how much.

Cubic yards/Linear feet	Size and Type	Source
100 cubic yards	Rock – D_{50}=18"; D_{MAX}=36"	Local Supplier
As needed	Approved overland or streamside seed mix	Local Supplier
Willow cuttings	Same Species as existing on site	On Site or Local supplier if supplemental plantings are needed.

11. **EQUIPMENT**. What equipment is proposed to be used for the work? Where and how will the equipment be used on the stream bank and/or the waterbody?

A trackhoe will be used for excavation, placement of rock and re-grading. A dump truck will be used to transport the necessary materials to the site. Support/incidental equipment will be used as needed.

12. **DESCRIBE PLANNED EFFORTS TO MINIMIZE PROJECT IMPACTS**. Consider the impacts of the proposed project, even if temporary. What efforts will be taken to:

- Minimize erosion, sedimentation, or turbidity?

Work will be done during low flows, when the channel is dry or mostly dry; therefore, turbidity is not anticipated. The disturbed overland areas will be re-graded and reseed as soon as practical.

- Minimize stream channel alterations?

The creek channel has been extensively modified along approximately one mile downstream from the project location resulting from the construction of a temporary bypass channel associated with a restoration project being conducted and funded by others. The 200 linear feet of bank armor proposed by YPL will have minimal impacts on the stream channel.

- Minimize effects to stream flow or water quality caused by materials used or removal of ground cover?

Existing ground cover will only be removed to the extent needed to allow for rock/soil lift placement.

- Minimize effects on fish and aquatic habitat?

The pipeline must be protected in order to reduce risk to fish and aquatic habitat. The addition of willows along the outer bend will enhance fish habitat. Work will be done during the winter/early spring when the flows are low to minimize impacts.

- Minimize risks of flooding or erosion problems upstream and downstream?

The riprap toe is not expected to have an effect on the capacity of the channel to carry flood flows. The downstream bypass channel is heavily armored and it is unlikely there would be any affects from the 200 feet of bank stabilization. A floodplain permit will be required from the Lewis and Clark County Floodplain Administrator prior to construction.

- Minimize vegetation disturbance, protect existing vegetation, and control weeds?

Disturbed areas will be re-graded and re-seeded with an approved mix as soon as practical following construction. Revegetation success will be monitored and disturbed areas reseeded/replanted if necessary. The reclaimed area will also be monitored/controlled for noxious weeds as necessary.

13. **WHAT ARE THE NATURAL RESOURCE BENEFITS** of the proposed project?

Stabilizing the eroding bank will protect the pipe line from potential exposure and damage. Planting willows on the bank will enhance riparian habitat.

14. **LIST ALTERNATIVES** to the proposed project. Why was the proposed alternative selected?

No-action is not an option as it does not address the current risk to the pipe line. Line lowering would disturb a much greater area and is not warranted in this case. Horizontal Directional Drilling is not warranted because where the pipe line crosses the creek there is sufficient vertical cover (about 8 feet). The vulnerable section of pipe line is running parallel to the creek slightly downstream from where the pipe line crosses under the creek. A shorter section of armoring was considered but ruled out because of the potential for the downstream bypass diversion to be flanked if the bank continues to move towards the west.

D. ADDITIONAL INFORMATION FOR SECTION 404, SECTION 10, AND FLOODPLAIN PERMITS ONLY. If applying for a Section 404 or Section 10 permit, fill out questions 1-3. If applying for a floodplain permit, fill out questions 3-6. (Additional information is required for floodplain permits – See "Information for Applicant.")

1. Will the project involve placement of fill material below the ordinary high water mark, a wetland, or other waters of the US? If yes, what is the surface area to be filled? How many cubic yards of fill material will be used? Note: A delineation of the wetland may be required.

The adjacent bank is identified as wetlands on NWI maps. Although rock will be placed along the bank, no wetlands will be filled. The adjacent wetland disturbance will be temporary and grasses and shrubs will be re-established when the work is completed.

2. Description of avoidance, mitigation, and compensation (see Information for Applicant). Attach additional sheets if necessary.

Avoidance is not practical since that would leave the pipeline in a vulnerable state. Stream bank impacts will not exceed 200 feet, therefore, no compensatory stream mitigation is proposed. No wetlands will be permanently impacted, therefore, no compensatory wetland mitigation is proposed.

3. List the names and address of landowners adjacent to the project site. This includes properties adjacent to and across from the project site. (Some floodplain communities require certified adjoining landowner lists).

Landowners at project site:
Montana Environmental Trust Group LLC (Trustee)
PO Box 1390
Helena, MT 59624-1390
Geocodes:
05-1786-01-1-02-15-AG00 (north of pipe line right-of-way)
05-1888-36-2-01-01-0000 (south of pipe line right-of-way)

4. List all applicable local, state, and federal permits and indicate whether they were issued, waived, denied, or pending. Note: All required local, state, and federal permits, or proof of waiver must be issued prior to the issuance of a floodplain permit.

Pending – 310 Permit, 404 Permit, 318 Authorization or Waiver, and Lewis and Clark County Floodplain

5. Floodplain Map Number: 30049C2333E Panel 2333 of 2450 Lewis and Clark County, Montana

6. Does this project comply with local planning or zoning regulations? ✓Yes ☐ No

E. SIGNATURES/AUTHORIZATIONS -- Each agency must have original signatures signed in blue ink.

After completing the form, make the required number of copies and **then sign each copy.** Send the copies with original signatures and additional information required directly to each applicable agency.

The statements contained in this application are true and correct. The applicant possess' the authority to undertake the work described herein or is acting as the duly authorized agent of the landowner. The applicant understands that the granting of a permit does not include landowner permission to access land or construct a project. Inspections of the project site after notice by inspection authorities are hereby authorized.

APPLICANT (Person responsible for project):
Print Name: Fran Nunn, Environmental Coordinator

Frances E Nunn 1/31/2014
Signature of Applicant Date

LANDOWNER:
Print Name: ______________________

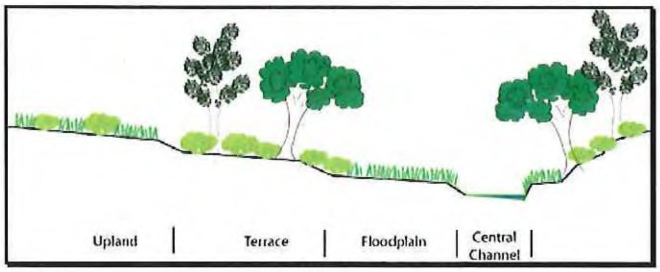
____
Signature of Landowner Date

*CONTRACTOR/AGENT:
Print Name: Dan Nebel, Terracon Consultants, Inc.

Dan I. Nebel Jan 31, 2014
Signature of Contractor/Agent Date
*Contact agency to determine if contractor signature is required.

Guide to Planting Willow and Cottonwood Stem Cuttings For Streamside Restoration

Stem cuttings can provide an inexpensive, native source of materials, that are resistant to washout during high flows, resistant to drought, can be planted with minimal disturbance to the streambank, and can establish in existing competitive vegetation.



Willow and cottonwood species are recommended over other types of cuttings because of their ability to readily form roots throughout the length of their stems

Plantings can occur at the water line, up the bank, and on top of bank in relatively dry soil, as long as cuttings are long enough to reach into the mid-summer water table.

In general, small to medium size shrub-type willows and rhizomatous or creeping-type willows are used for planting within the channel banks. Tree-type willows and cottonwoods are normally selected for the upper bank and floodplain areas. The shrubby species provide protection for the tree species when planted in this manner.

More shade will be produced with tall and/or wide canopy species. This is important for water temperatures and fish habitat. Stem flexibility is important for species at the waterline to mid-bank on streams with high velocities, debris loads, and ice flows.

The species planted at the waterline should be a single species so that all the cuttings have similar characteristics for the full length of any one stream reach so that varying sizes and shapes do not cause the force of water to move behind that planted line. The entire problem section should be planted, not just parts of a reach or curve. This will reduce the chance of water eroding behind the planting.

When to Harvest Cuttings
Establishment success is significantly increased if cuttings are taken from live, dormant willows or cottonwoods either after leaf fall in late fall, winter, or very early spring before the buds start to break.

Cutting Size
Pole cuttings (large diameter unrooted stems) of shrub-type willows are recommended for most plantings from water line to mid-bank. Pole cuttings of tree-type willows and cottonwoods are recommended on upper-banks and floodplains where the water table is relatively deep. Pole cuttings provide an effective means to reach saturated soils and establish a high concentration of roots for that portion of the stem within the moist zone.

Generally, whips (less than 3/4 inch diameter) are not recommended because energy reserves in the stem are limited. Rhizomatous or spreading willow stems will rarely get much bigger than 3/4 inches in diameter.

Tree-type willows can be several inches in diameter. Larger diameter cuttings have more energy and stored reserves than smaller diameter cuttings. Highest survival rates are obtained using cuttings 2 to 3 inches in diameter.

Cuttings as large as 8 inches in diameter have been tested with excellent success. However, the larger the cutting diameter, the longer the cutting should be, and the deeper the hole should be to support it.

The deciding factor for selecting the cutting diameter is the planting method you will use. Larger diameter and longer cuttings will be needed for more severely eroding sites and where the water table is deeper.

Cutting Length
Cutting length is largely determined by the depth to the mid-summer water table and erosive force of stream at the planting site. Make sure:

*6-8 inches of cutting are in the mid-summer watertable

*3-4 buds are above the ground

*No less than 1/2 the total length is in the ground

*If long periods of inundation exceeding 30 days are likely, cuttings should be long enough to extend 6-12 inches above the expected high water level

*If weeds are a problem, the cutting should extend above herbaceous growth in summer to receive adequate light and below the weed root mass to minimize competition.

*When planting for bank stabilization, the cutting should extend 2-3 feet above ground so as it leafs out, it can provide immediate bank erosion protection.

Harvesting Cuttings
Native willow and cottonwood stands located near the rehabilitation site are the most common source of stem cuttings. Make sure to obtain landowner permission prior to harvesting any cuttings.

Lopping shears, pruning shears, a small wood saw, brush cutters, or a chain saw can be used to harvest cuttings. Size of the cuttings will determine what you use to harvest them.

* Ensure all equipment is sharp and make clean cuts.

* Use live wood at least 2 year old or older. The best wood is 2-7 years old with smooth bark which is not split or deeply furrowed.

* Avoid whips and suckers (current year's growth) because they lack the stored energy reserves necessary to consistently sprout when planted especially in dry conditions.

* No more than 1/3 of any individual plant should be removed. In the case of rhizomatous species, no more than 40-50% of the stand should be removed.

* When harvesting from native stands, ensure the stand will not be denuded or destroyed by your cutting activity. Try to spread your harvesting activity throughout the stand.

* Remove the apical bud plus several inches off of the cutting. The apical bud (bud at the tip of the branch) draws too much energy from stored reserves, reducing the chance of survival. Its removal will reroute energy to the side buds including the root buds. The upper part stem also has the flowering parts. By cutting it off, energy is also redirected to the older parts of stem.

* Trim off all side branches so cutting is a single stem.

* A processing consideration is to cut the top of cutting with a horizontal cut and bottom of cutting with a 45 degree cut. This allows quick recognition of cutting top. One of the most important steps in this process is the identification of the **TOP** of the cutting.

Painting Harvested Cuttings
When the top of cutting has been identified, it can be painted. Dipping the **TOP** 1-2 inches of cutting into a 50:50 percent mix of light colored latex paint and water, does a number of things. Perhaps the best reason for painting the top of cuttings is it helps planting crews plant cuttings properly, with the top up! It also helps locate the cuttings more easily for future planting evaluations. It may also prevent excessive transpiration of water from cutting.

Storage of Cuttings
To minimize storage time, harvest cuttings in late winter to early spring and plant immediately when possible. If this is not possible, cuttings can be harvested in late fall or winter and stored in a large cooler at 33-40°F until just before planting. Whether cuttings are kept in a cooler, root cellar, garage, or shop floor, make sure the storage area is dark, moist, and cool at all times.

Pre-plant Soaking of Cuttings
Soaking the cuttings prior to planting will increased survival in addition to root and shoot production. Pre-soaking improves stem water content and early root and shoot initiation. Soaking is important because it initiates root growth processes within the inner layer of bark in willows and cottonwoods. Prior to planting, all cuttings should be soaked for a minimum of 24 hours. The entire cutting should be covered with water. Any part of cutting that is exposed will start sprouting as the soaking date comes closer to bud break.

Planting Densities
Plant cuttings about 1-3 feet apart for creeping-types, 3-8 feet apart for shrub-types and about 8-16 feet apart for tree-types. In areas where you expect erosion, plant creeping-types 1-2 feet apart to ensure better protection of the banks. If the holes are large enough, multiple stems can be planted together.

Crowding cuttings a little will not stress them because they will not lack for water when planted into the mid-season water table and more dense plantings will provide better protection to the bank.

When and Where to Plant
Willow and cottonwood cuttings have been successfully planted from early spring to late fall (dormant plantings).

* Preferably, cuttings should be planted in early spring after spring runoff occurs in streams and rivers. Avoid planting cuttings during the heat of summer because of the stress it places on them.

* Consideration should be given to planting outside curves of a stream first and allowing time for establishment. Delay planting the inside curve until two or three years later. The inside curve is often not eroding and will begin to heal without planting. In addition, if the inside curve becomes established prior to the outside meander; there is a good chance that the stream current will be pushed into the eroding outside meander. This will increase the stress on the outside meander and make establishing woody riparian species more difficult.

* It is essential to have good contact between cutting and soil for roots to sprout. Air pockets around the cutting will kill the roots. Additional soil may be needed to ensure good soil to stem contact. Preference should be given to native soil nearby to encourage mycorrhizal formation and/or nodule formation by nitrogenfixing organisms.

* Mud the cuttings in after they are placed in the hole. Use a bucket and mix soil and water together to get the consistency of cheap syrup. Pour the mix into the hole around the cutting until it reaches the surface. As the water leaches into the surrounding soil, the soil will settle out around the cutting and will ensure good soil to stem contact.

The above article is taken from the NRCS Technical Note Plant Materials No. 23 by J. Chris Hoag, USDA-NRCS Plant Materials Center, Idaho, http://www.plant-materials.nrcs.usda.gov/pubs/idpmctn7064.pdf

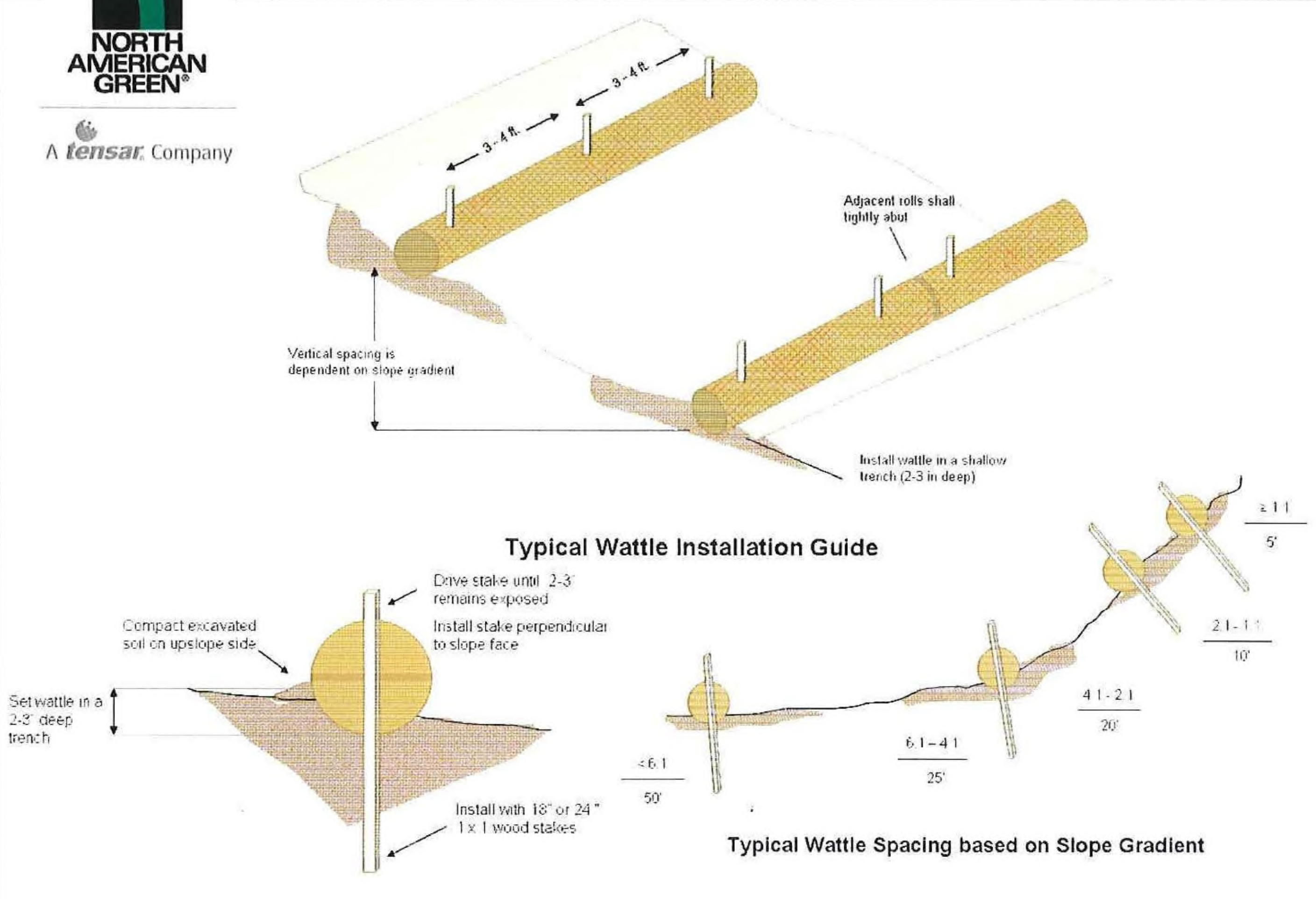
Stream Permits
Hand planting of these stem cuttings and/or containerized plants is encouraged by Missoula Conservation District and no 310 Permit is needed to do the planting as long as the work is done by hand on the existing bank or a stream or river.

If machinery is to be used, or the bank is to be sloped back or recontoured, a 310 Permit as well as other stream permits will be needed.

Submitted by: Tara Comfort, Resource Conservationist, Missoula Conservation District.

NORTH AMERICAN GREEN®
A tensar Company

Straw Wattle Installation Guide



Typical Wattle Installation Guide

Entrenchment Detail

Typical Wattle Spacing based on Slope Gradient

1. BEGIN AT THE LOCATION WHERE THE WATTLE IS TO BE INSTALLED BY EXCAVATING A 2-3" (5-7.5 CM) DEEP X 9" (22.9 CM) WIDE TRENCH ALONG THE CONTOUR OF THE SLOPE. EXCAVATED SOIL SHOULD BE PLACED UP-SLOPE FROM THE ANCHOR TRENCH.

2. PLACE THE WATTLE IN THE TRENCH SO THAT IT CONTOURS TO THE SOIL SURFACE. COMPACT SOIL FROM THE EXCAVATED TRENCH AGAINST THE WATTLE ON THE UPHILL SIDE. ADJACENT WATTLES SHOULD TIGHTLY ABUT.

3. SECURE THE WATTLE WITH 18-24" (45.7-61 CM) STAKES EVERY 3-4' (0.9 - 1.2 M) AND WITH A STAKE ON EACH END. STAKES SHOULD BE DRIVEN THROUGH THE MIDDLE OF THE WATTLE LEAVING AT LEAST 2-3" (5-7.5 CM) OF STAKE EXTENDING ABOVE THE WATTLE. STAKES SHOULD BE DRIVEN PERPENDICULAR TO SLOPE FACE.

North American Green Straw Wattles are a Best Management Practice (BMP) that offers an effective and economical alternative to silt fence and straw bales for sediment control and storm water runoff.

Guidelines are provided to assist in design, installation, and structure spacing. The guidelines may require modification due to variation in soil type, rainfall intensity or duration, and amount of runoff affecting the application site.

To maximize sediment containment with the Straw Wattle, place the initial structure at the top/crest of the slope if significant runoff is expected from above. If no runoff from above is expected, the initial Straw Wattle can be installed at the appropriate distance downhill from the top/crest of the slope. The final structure should be installed at or just beyond the bottom/toe of the slope. Wattles should be installed perpendicular to the primary direction of overland flow.

Straw Wattles are a temporary sediment control device and are not intended to replace rolled erosion control products (RECPs) or hydraulic erosion control products (HECPs). If vegetation is desired for permanent erosion control, North American Green recommends that RECPs or HECPs be used to provide effective immediate erosion control until vegetation is established. Straw Wattles may be used in conjunction with blankets, mats, and mulches as supplemental sediment and runoff control for these applications. Like all sediment control devices, the effectiveness of the Straw Wattle is dependent on storage capacity.

For additional installation assistance, please contact North American Green's Technical Services Department at 1 -800-772-2040

14649 Highway 41 North, Evansville, Indiana 47725
1-800-772-2040 www.nagreen.com Rev. 1/2008

DETAIL A-1

Subject: Bank armoring Prickly Pear Creek

Date: Monday, February 3, 2014 at 2:35:00 PM Eastern Standard Time

From: Ostwald, Larry E.

To: sbrown@garlington.com, Ralph.Dresel@CH2M.com, cb@g-etg.com

CC: Ostwald, Larry E., lb@g-etg.com

Attached is our plan to protect Yellowstone Pipe Line Company's pipeline from bank erosion on Prickly Pear Creek.

Larry Ostwald
Property Tax, Real Estate, Right of Way and Claims Advisor
3180 Hwy 12 East
Helena, MT 59601
406-431-3311 cell
406-441-4746 office
406-457-0473 fax

Subject: Yellowstone Pipeline Bank Stabilization
Date: Friday, March 7, 2014 at 11:33:24 AM Eastern Standard Time
From: Cynthia Brooks
To: Larry Ostwald, Chris Carpenter, Mike Piersall, Carrie A. Wildin, Orwan Smith
CC: Mark Rhodes, Betsy Burns, Stephen Brown

Good Morning:

I am writing to inquire about the status of the bank stabilization work planned by Yellowstone Pipeline Company (YPC), which is required to address erosion in the point where the YPC crosses Prickly Pear Creek in East Helena. As you probably know, flows in Prickly Pear Creek are very high due to significant snowmelt because of recent rain and warm weather. The Custodial Trust remains concerned about the need for YPC to address its maintenance obligations because of potential adverse impacts to downstream areas if there is a problem with the pipeline. Can you please advise of the status of YPC's plans to stabilize the bank and protect the pipeline?

Thank you for your prompt response.

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc.
Resources for Responsible Site Management, Inc., Trustee for the Industri-plex Custodial Trust
Montana Environmental Trust Group LLC, Trustee of the Montana Environmental Custodial Trust
Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762
cb@g-etg.com

Subject: RE: Yellowstone Pipeline Bank Stabilization
Date: Friday, March 7, 2014 at 4:03:24 PM Eastern Standard Time
From: Wildin, Carrie A
To: 'Cynthia Brooks', Ostwald, Larry E., Carpenter, Chris R, Piersall, Mike, Smith, Orwan
CC: Mark Rhodes, Betsy Burns, Stephen Brown, Miller, Mike S, Kuntz, Michael R, Nunn, Fran E, Wildin, Carrie A, Ramer, Jean (Terracon)

Cynthia,
I appreciate your concern for our Prickly Pear Creek parallel pipeline encroachment. We are monitoring our pipeline on site and via aerial patrol per our policies and will continue to do so through this high water period and after. As of now, no cover has been lost near the pipeline.
Our project to stabilize the creek bank near our pipeline has been designed and is currently awaiting approval for submitted permits from the Corp of Engineers, Floodplain Administration and the Montana Department of Natural Resources/Environmental Quality. We met onsite with the Montana Department of Environmental Quality and the Lewis and Clark Conservation district to review the 310 permit application yesterday. We hope to receive all permit approvals by mid-April and plan to go to work as soon thereafter as the water flow conditions allow.
Again, thank you for your concern.

Carrie A. Wildin, PE
Maintenance Superintendent
Billings Pipeline Division
406-255-5728
Cell: 806-283-5175
carrie.a.wildin@p66.com

From: Cynthia Brooks [mailto:cb@g-etg.com]
Sent: Friday, March 07, 2014 9:33 AM
To: Ostwald, Larry E.; Carpenter, Chris R; Piersall, Mike; Wildin, Carrie A; Smith, Orwan
Cc: Mark Rhodes; Betsy Burns; Stephen Brown
Subject: [EXTERNAL]Yellowstone Pipeline Bank Stabilization

Good Morning:

I am writing to inquire about the status of the bank stabilization work planned by Yellowstone Pipeline Company (YPC), which is required to address erosion in the point where the YPC crosses Prickly Pear Creek in East Helena. As you probably know, flows in Prickly Pear Creek are very high due to significant snowmelt because of recent rain and warm weather. The Custodial Trust remains concerned about the need for YPC to address its maintenance obligations because of potential adverse impacts to downstream areas if there is a problem with the pipeline. Can you please advise of the status of YPC's plans to stabilize the bank and protect the pipeline?

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Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762

cb@g-etg.com

Subject: Re: Yellowstone Pipeline Bank Stabilization
Date: Friday, March 7, 2014 at 4:33:50 PM Eastern Standard Time
From: Cynthia Brooks
To: Wildin, Carrie A, Ostwald, Larry E., Carpenter, Chris R, Piersall, Mike, Smith, Orwan
CC: Mark Rhodes, Betsy Burns, Stephen Brown, Miller, Mike S, Kuntz, Michael R, Nunn, Fran E, Ramer, Jean (Terracon)

Hi Carrie
Thank you for the update on the status of YPC's permitting process. I'm glad to know that you're closely monitoring the situation. It will be great to get the stabilization work is done.
All the best
Cindy

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc.
Resources for Responsible Site Management, Inc., Trustee for the Industri-plex Custodial Trust
Montana Environmental Trust Group LLC, Trustee of the Montana Environmental Custodial Trust
Greenfield Environmental Multistate Trust LLC, Trustee of the Multistate Environmental Response Trust
Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762
cb@g-etg.com

From: "Carrie A. Wildin" <carrie.a.wildin@p66.com>
Date: Friday, March 7, 2014 at 4:03 PM
To: Cynthia Brooks <cb@g-etg.com>, Larry Ostwald <Larry.E.Ostwald@p66.com>, Chris Carpenter <Chris.R.Carpenter@p66.com>, Mike Piersall <Michael.Piersall@p66.com>, Orwan Smith <Orwan.Smith@p66.com>
Cc: Mark Rhodes <MRHODES@hydrometrics.com>, Betsy Burns <burns.betsy@epa.gov>, Stephen Brown <srbrown@GARLINGTON.COM>, "Miller, Mike S" <Mike.S.Miller@p66.com>, "Kuntz, Michael R" <Michael.R.Kuntz@p66.com>, "Nunn, Fran E" <Fran.E.Nunn@p66.com>, "Carrie A. Wildin" <carrie.a.wildin@p66.com>, "Ramer, Jean (Terracon)" <Jean.Ramer@contractor.p66.com>
Subject: RE: Yellowstone Pipeline Bank Stabilization

Cynthia,
I appreciate your concern for our Prickly Pear Creek parallel pipeline encroachment. We are monitoring our pipeline on site and via aerial patrol per our policies and will continue to do so through this high water period and after. As of now, no cover has been lost near the pipeline.
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Carrie A. Wildin, PE
Maintenance Superintendent

Billings Pipeline Division
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Cell: 806-283-5175
carrie.a.wildin@p66.com

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Sent: Friday, March 07, 2014 9:33 AM
To: Ostwald, Larry E.; Carpenter, Chris R; Piersall, Mike; Wildin, Carrie A; Smith, Orwan
Cc: Mark Rhodes; Betsy Burns; Stephen Brown
Subject: [EXTERNAL]Yellowstone Pipeline Bank Stabilization

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Greenfield Environmental Savannah Trust LLC, Trustee of the Savannah Environmental Response Trust
617-448-9762
cb@g-etg.com

Subject: YPL Bank Stabilization

Date: Tuesday, August 12, 2014 at 12:41:43 PM Eastern Daylight Time

From: Mark Rhodes

To: Cynthia Brooks, lg@g-etg.com

FYI- I received a call from Orwan Smith at Yellowstone Pipeline yesterday and they will be starting their bank stabilization project on Monday.
-Mark

Mark Rhodes, P.E.
Hydrometrics, Inc.
3020 Bozeman Ave.
Helena, MT 59601
PH: 406-443-4150 x123
Cell: 406-431-1637