City of Cheyenne - Purchasing
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ADDENDUM NUMBER ONE
BID S-6-21

To: All Prospective Bidders and all others concerned

From: City of Cheyenne, Purchasing Manager, TJ Barttelbort

Date: September 22, 2020

Subject: **Addendum Number One to Bid S-6-21 for the Happy Jack Landfill Phase 2, Cells 1 and 2 Construction and Cell 3 Excavation Earthworks project**

The changes, clarifications, omissions, additions, and/or alterations in, on, and to the bid information and specifications shall apply to the Invitation For Bid submitted for and to the project indicated above. Except as modified by this Addendum Number One, all of the terms and provisions of the Invitation for Bid for the above listed project remain in full force and effect. This Addendum Number One supersedes all previous instructions pertaining to the items listed:

Clarifications:

C1: The following documents are provided via this Addendum One:

1. CAD Files (Zip Files provided separately from this Addendum One, via Zip Files entitled "2-12381971_HJLF_Cells1&2_Drawings_IFB_20MAY20". File is uploaded to Bid Posting, here: https://www.cheyennecity.org/Bids-and-Proposals/BID-S-6-21
2. Site Characterization Report, Happy Jack Landfill Expansion (Consisting of 239 Pages).
3. Qualifications Statement Landfill Construction (Consisting of 12 Pages). See A11 Below.
4. Construction Quality Assurance Plan (Consisting of 62 Pages).

C2: A Revised Bid Form for the Earthworks, and Geosynthetic Procurement has been included with this Addendum One. The Bid Form for the Installer remains unchanged. Bidders are instructed to use the Itemized Bid Forms with this Addendum One for their Bid Submission.

C3: An updated Section 01 22 13, Measurement and Payment, for the Earthworks portion of the Bid is included in this Addendum One.

Questions & Responses:

Q1: Can the CAD files be distributed to the bidding contractors?

A1: Yes. CAD files are attached.

Q2: Is there a water source onsite for the contractors use?

A2: No. The contractor will need to provide a water source for dust control and earthworks activities.

Q3: What is the order of filling of stockpiles 1,1A,2 & 3? Can a volume capacity for each be provided?

A3: All stockpile locations are expected to be filled as part of the cell excavation work. Therefore, the Contractor may fill stockpile locations in the order that best suits their construction schedule and sequencing. Note that stockpile slopes shall not exceed 4H:1V. Approximate volume capacity for each stockpile is as follows.

- Stockpile 1 – 139,000 CY
- Stockpile 1A – 152,000 CY
- Stockpile 2 – 430,000 CY
- Stockpile 3 – 1,000,000 CY

Q4: Can the geotechnical report or bores for the excavation area be provided?

A4: Yes. The *"Site Characterization Report, Happy Jack Landfill Expansion"* prepared by Golder Associates, Inc., dated January 2014, is attached.

Q5: Do the stockpiles need to be stripped of topsoil? Is that quantity included in the topsoil stripping pay item? If not how is it paid for?

A5: Topsoil quantities have been modified in the bid form to include stripping stockpile areas. The topsoil stripped from within the stockpile footprints will need to be evenly distributed across Stockpile 3. Topsoil stripping, temporary stockpiling, and placement will be subsidiary to Bid Item 3.

Q6: Will either or both of the Sand Drainage Layer or the Operations layer material need to be purchased from an offside source by the contractor?

A6: It has been assumed that the sand drainage layer material and operations layer material will need to be imported. However, if the contractor can produce a product from onsite material which meets the requirements set forth in the technical specifications, onsite material could be used.

Q7: Does pay item 3&4 on the Geosynthetics procurement sheet include the necessary fabric for the burrito wrap of leachate lines and the sump geotextile? Assuming the earthworks contractor will install the geotextile around leachate line and in sump?

A7: Yes, items 3&4 in the Geosynthetics Procurement bid schedule includes material to wrap the leachate collection pipe gravel. Earthworks contract will install the geotextile around the leachate collection lines and in the sump.

Q8: Are the leachate pumps (and leak detection pumps if any) and the related electric to be installed by a separate contract procured by owner?

A8: Bid Item 13 - Leachate Collection Pump in the Earthworks Bid Form requires the earthworks contractor to procure and install the pump. See Sheet 11 of the Drawings for details. Electrical service will be installed under separate contract by the owner as defined in Section 01 11 00, Part 1.6

Q9: If Rock is encountered that cannot be productively ripped with a D8, will a CO be issued for rock excavation?

A9: In the event that the rock is of such a hardness and texture that it cannot be excavated with a D-9N Caterpillar tractor with a single shank ripper, or equivalent equipment; or, for trench excavation, a 235C Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment the material will be considered rock excavation. A bid item has been included for rock excavation in the revised bid form.

Q10: Will the earthwork contractor unload the items shown on the geosynthetics procurement bid sheet? If so, will the contractor be responsible for the material once it is unloaded and properly stockpiled or will the owner accept ownership? This is of primary concern with GCL and any extended length onsite prior to install.

A10: Yes, the earthworks contractor will be required to unload the geosynthetic identified in the geosynthetic procurement bid sheet. The earthworks contractor will also be responsible for storing and protecting the material prior to installation as defined in Section 01 11 00, Part 1.6. The owner will accept ownership once the material is unloaded and properly stockpiled. HDPE liner will not need to be covered but does need to be stored in a manner which prevents damage from wind and equipment.

Q11: Can you please clarify the pre-qualification process for the geosynthetic installer? Do our qualifications need to be submitted with our bid? Is there a form we need to use? Reference Page 115, 1.3, Pre-Qualification.

A11: **ALL bidders** are required to submit the attached *"Qualifications Statement"* with their bid.

Q12: I would like some clarification on the difference between Soil Stockpile Area 1 and 1a. Is 1a an alternative or will they both be used? Do you have quantities assigned to each stockpile?

A12: Both should be used. Stockpile 1 should be completed first, then Stockpile 1a. See question 3 above for quantities.

Q13: If the Leachate pump installation is by contractor will the owner be providing power directly to each leachate riser location?

A13: Electrical service will be installed under separate contract by the owner as defined in Section 01 11 00, Part 1.6

Q14: Another question that has come up, in the plans it has specs for a gate in the fence, but I don't see it called out anywhere else. Are there gates? And if so, what quantity?

A14: Gate locations are shown on Sheet 3, spaced approximately 500-feet along the litter fence.

Q15: Can the project CQA Plan be provided?

A15: Yes. The *"Construction Quality Assurance Plan"* prepared by Golder Associates, Inc. and Solid Waste Professionals of Wyoming, Revision 1, dated 9/15/17 is attached.

Q15: Are any permits required for crossing beneath the high voltage powerlines north of the cell excavation area?

A15: The contractor will need to coordinate with utility owner's if approval is needed to cross transmission lines. The northern transmission line is owned by the Western Area Power Administration and the southern line is owned by Silver Sage Windpower. Roads shall be a minimum of 20 feet (horizontal) from any transmission line structure and adequate clearance is maintained between the ground and conductors in accordance with the National Electric Safety Code. The contractor is responsible for verifying the equipment crossing the easement will maintain adequate clearance between the equipment and conductors.

Q16: When will the City like to take delivery on the geosynthetic materials? The geosynthetics manufacturers are unlikely to provide pricing for HDPE liner with a June 2021 delivery date. Will the City be willing to take delivery earlier?

A16: The City will take delivery of the 60-mil HDPE liner in January or February of 2021. GCL, geocomposite, and non-woven geotextile needs to be delivered nor earlier than June 1, 2021 but no later June 20, 2021.

ADDENDUM ONE ACKNOWLEDGED:

BY______________________________ TITLE______________________________

(Addendum **must** be signed and returned with bid or receipt of the addendum **must** be acknowledged on the Invitation to Bid).

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SECTION 00 41 00

REVISED ADDENDUM ONE BID FORM

HAPPY JACK LANDFILL
CELLS 1 AND 2 CONSTRUCTION AND CELL 3 EXCAVATION EARTHWORKS PROJECT

BASE BID UNIT PRICE SCHEDULE

Bid Item	Bid Item Description	Unit	Bid Quantity	Unit Price	Total Price
1	Mobilization/Demobilization	LS	1		
2	Erosion and Sediment Control	LS	1		
3	Strip and Stockpile Topsoil	CY	72,200		
4	Excavation	CY	2,200,000		
5	Prepare Cell Subgrade (Finish Grading)	SY	58,500		
6	Anchor Trench	LF	2,200		
7	Sand Drainage Layer	CY	17,500		
8	Cell 2 Termination Berm	LF	490		
9	Perimeter Road and Stormwater Channels (Finish Grading)	LF	3,300		
10	WYDOT Class W Road Base	CY	2,700		
11	Sump Construction	EA	2		
12	LCRS Collection Pipe	LF	870		
13	Leachate Collection Pump	EA	2		
14	Sump Sideslope Riser Pipes	LF	365		
15	Concrete Pipe Protection Slab	CY	12		
16	LCRS Discharge Pipe Systems	EA	2		
17	Pressurized Leachate Force Main	LF	2,415		
18	Seeding	ac	63		
19	Chain Link Fence	LF	2,210		
4X	Rock Excavation	CY	100		

TOTAL BASE BID: $

BID ALTERNATE UNIT PRICE SCHEDULE

Bid Item	Bid Alternate Description	Unit	Bid Alternate Quantity	Unit Price	Total Price
7A	Operations Layer	CY	17,500		

SECTION 00 41 00
BID FORM (ADDENDUM ONE - UNCHANGED)

HAPPY JACK LANDFILL
CELLS 1 AND 2 CONSTRUCTION AND CELL 3 EXCAVATION
GEOSYNTHETICS INSTALLATION

BASE BID UNIT PRICE SCHEDULE

Bid Item	Bid Item Description	Unit	Bid Quantity	Unit Price	Total Price
1	Mobilization/Demobilization	LS	1		
2	Installation of GCL	SF	536,500		
3	Installation of 60 mil HDPE Geomembrane	SF	536,500		
4	Installation of Pipe Penetration	LS	1		

TOTAL BASE BID: $

BID ALTERNATE UNIT PRICE SCHEDULE

Bid Item	Bid Alternate Description	Unit	Bid Alternate Quantity	Unit Price	Total Price
5	Installation of Geocomposite	SY	536,500		

SECTION 00 41 00
REVISED ADDENDUM ONE BID FORM

HAPPY JACK LANDFILL
CELLS 1 AND 2 CONSTRUCTION AND CELL 3 EXCAVATION
GEOSYNTHETICS PROCUREMENT

BASE BID UNIT PRICE SCHEDULE

Bid Item	Bid Item Description	Unit	Bid Quantity	Unit Price	Total Price
1	Furnish 60 mil HDPE Geomembrane (double-sided textured)	SF	591,000		
2	Furnish Geosynthetic Clay Liner (GCL)	SF	591,000		
3	Furnish 12 oz/sy Nonwoven Geotextile Fabric	SF	9,500		
4	Furnish 16 oz/sy Nonwoven Geotextile Fabric	SF	13,500		

TOTAL BASE BID: $

BID ALTERNATE UNIT PRICE SCHEDULE

Bid Item	Bid Alternate Description	Unit	Bid Alternate Quantity	Unit Price	Total Price
5	Furnish 200 mil Geocomposite	SY	591,000		

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. This Section describes the administrative and procedural requirements for how Lump Sum and Unit Price pay items will be measured and paid for when making progress and final payments.

B. Lump Sum and Unit Price pay items listed in this Section refer to and are the same pay items listed in the Bid Form and constitute all pay items for completing the Work in this Contract. Compensation for all services, items, materials, and equipment required to complete the Work shall be paid at the Lump Sums and Unit Prices included in the Contract.

C. All measurements and payments will be based on completed Work performed in strict accordance with the Contract Documents and in accordance with Contract Lump Sums and Unit Prices. Incidental Work and items not listed in the Contract Bid Form will not be paid separately but will be included in the payment for the listed item or items to which such incidental Work applies.

D. Lump Sums and Unit Prices shall include all direct and indirect costs, including CONTRACTOR's overhead and profit for each separately identified item.

E. The OWNER will provide the surveying required for the completion and measurement of the Work as specified in Section 01 71 23 Surveying.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. ENGINEER's estimated quantities for Unit Price pay items, as listed in the Bid Form, are approximate only and are included solely for the purpose of comparison of Bids. OWNER does not expressly or by implication agree that the actual quantities of material encountered or required will correspond therewith and reserves the right to increase or decrease any quantity or to eliminate any quantity, as OWNER may deem necessary.

1.3 PAYMENT PROCEDURES

A. CONTRACTOR shall submit Applications for Payment in accordance with Contract requirements.

1.4 LUMP SUM BID ITEMS

A. Payment items for the Work of this Contract for which Contract Lump Sum payments will be made are listed in the Bid Form. All costs for items of Work which are not specifically mentioned to be included in a particular Lump Sum or Unit Price payment item shall be included in the listed Lump Sum item most closely associated with the Work involved. The Lump Sum price and payment made for each item listed shall constitute full compensation for furnishing all labor, materials, and equipment, and performing any associated CONTRACTOR quality control, environmental protection, safety requirements, tests and reports, and for performing all Work required for which separate payment is not otherwise provided.

B. Contract Lump Sum is full compensation.

1.5 UNIT PRICE BID ITEMS

A. Payment items for the Work of this Contract on which the Contract Unit Price payments will be made are listed in the Bid Form. The Unit Price and payment made for each item listed shall constitute full compensation for furnishing all labor, materials, and equipment, and performing any associated CONTRACTOR quality control, environmental protection, survey control, safety requirements, tests, and reports, and for performing all Work required for each of the Unit Price items.

B. Contract Unit Price multiplied by agreed quantity is full compensation.

1.6 BASE BID ITEM DESCRIPTIONS

Item 1 – Mobilization/Demobilization

1. PAYMENT: Payment will be made for costs to mobilize and demobilize all labor, equipment, supplies, tools, field offices, parts, trailers, portable facilities, fuel tanks, sanitary facilities, and other incidents required to perform the Work, including but not limited to insurance and bonding, locating/verification of existing utilities, construction permits and fees, dust control, site administration expenses, utilities to the job trailer including power, internet/data services, telephone, etc., and site cleanup to the satisfaction of the OWNER.
2. UNIT OF MEASURE: Lump Sum. Payment shall be made at the Lump Sum price, not to exceed 10% of the total Bid Price, at the rate of 50% of the Lump Sum with the first invoice and 50% following Substantial Completion of the Contract.
3. MEASUREMENT: There shall be no measurement for payment.

Item 2 – Erosion and Sediment Control

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs necessary to satisfactorily provide erosion and sedimentation control during the course of the Work. This shall include preparation of a Stormwater Pollution Prevention Plan (SWPPP) and filing a Notice of Intent (NOI) for an NPDES Stormwater Discharge Permit for Construction Activities with the WDEQ. This item shall also include the installation, maintenance, repair, replacement, and removal of temporary erosion control measures as specified in the SWPPP, periodic removal of collected sediment when directed by the CQA MANAGER, and site restoration after construction is complete (i.e., silt fence and hay bale removal, re-grading related to erosional soil loss, etc.).
2. UNIT OF MEASURE: Lump Sum. Payment shall be made at incremental percentages of the Lump Sum price as the Work progresses as agreed to between the CONTRACTOR and the OWNER'S REPRESENTATIVE.
3. MEASUREMENT: There shall be no measurement for payment.

Item 3 – Strip and Stockpile Topsoil

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidentals associated with stripping topsoil from within the Work area as required by the Contract Documents (i.e. the Cell Cell 1, 2 and 3 and soil stockpile areas) or as directed by the CQA MANAGER, temporarily~~and~~ stockpiling in the area shown in the Contract Drawings, and placement on Stockpiles 2 and 3, as necessary and directed by the CQA MANAGER. This item shall also include clearing and grubbing of the Cell 1, 2 and 3 and soil stockpile areas of grasses and forbs, as necessary, and removal of vegetative debris.
2. UNIT OF MEASURE: Cubic yardage of material stripped.
3. MEASUREMENT: The total quantity of stripped topsoil for which payment shall be made shall be computed by field survey or field measurement of stockpiled topsoil.

Item 4 – Excavation

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs required to excavate Cells 1, 2 and 3 to the subgrade elevations shown in the Contract Drawings, inclusive of the perimeter road and stormwater channels, including load, haul, and placement of excavation spoils in appropriate OWNER-designated stockpile areas as shown in the Contract Drawings and/or as required or directed by the CQA MANAGER, maintaining safe excavation and fill slopes, development and maintenance of temporary haul roads, providing traffic control as necessary, and coordination with Site operations.
2. UNIT OF MEASURE: Cubic yardage of excavation, as computed in the ground prior to excavation.
3. MEASUREMENT: The total quantity of excavated material for which payment shall be made shall be computed by the difference in the pre-construction survey (to be provided by the OWNER) and the as-built survey and/or progress payment surveys performed within the construction limits.

Item 5 – Prepare Cell Subgrade (Finish Grading)

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs required to prepare and finish grade the Cell 1 and 2 subgrade to within ±0.1 feet of the design subgrade elevations shown in the Contract Drawings; including protection and maintenance of the subgrade; drying and/or moisture-conditioning for roller compaction, as required; excavating, hauling, and satisfactorily disposing of and replacing all unsuitable subgrade material; and proof-rolling as directed by the CQA MANAGER.
2. UNIT OF MEASURE: Square yardage of subgrade prepared.
3. MEASUREMENT: The total quantity of subgrade for which payment shall be made shall be computed by the square yardage of subgrade prepared within the Cell 1 and 2 construction limits, as determined by the as-built survey and approved by the CQA MANAGER and GEOSYNTHETICS INSTALLER prior to geosynthetic liner installation.

Item 6 – Anchor Trench

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs required to excavate and backfill the geosynthetic liner

anchor trench; including coordination with the GEOSYNTHETICS INSTALLER on the timing and extent of excavation; excavation of the anchor trench; backfill of the trench with Structural Fill once the geosynthetics have been placed within the trench by the GEOSYNTHETICS INSTALLER; any moisture-conditioning and compaction required for backfill placement; and excavating, hauling, and satisfactorily disposing of and replacing all unsuitable anchor trench materials.

2. UNIT OF MEASURE: Linear footage of anchor trench constructed.
3. MEASUREMENT: The total quantity of anchor trench for which payment shall be made shall be determined by field survey along the centerline of the excavated anchor trench.

Item 7 – Sand Drainage Layer

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement, testing, hauling, and placement of the sand drainage layer in Cells 1 and 2.
2. UNIT OF MEASURE: Cubic yardage of sand drainage layer placed measured in-place.
3. MEASUREMENT: The quantity of sand drainage layer for which payment shall be made shall be determined by field survey of the top of the placement area within Cells 1 and 2 and multiplying this area by the required 1-foot thickness.

Item 8 – Cell 2 Termination Berm

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs required to construct the termination berm along the eastern side of Cell 2, as shown in the Contract Drawings; including hauling and placement of Structural Fill and furnishing and placing the plywood protection layer.
2. UNIT OF MEASURE: Linear footage of termination berm constructed.
3. MEASUREMENT: The total quantity of termination berm for which payment shall be made shall be determined by field survey along the centerline of the constructed termination berm.

Item 9 – Finish Grading of Perimeter Road and Stormwater Channels

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs required to finish grade the perimeter road and stormwater channels to within ±0.1 feet of the design grades shown in the Contract Drawings, including survey control. The earthwork associated with the development of the perimeter road and stormwater channels will be paid under Bid Item 4.
2. UNIT OF MEASURE: Linear footage of channel finish graded.
3. MEASUREMENT: The total quantity of channel for which payment shall be made shall be determined by field survey along the centerline of the channels.

Item 10 – WYDOT Class W Road Base

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidentals associated the procurement, testing, hauling, placement, and compaction of Class W road base material along the perimeter road.
2. UNIT OF MEASURE: Cubic yardage of Class W road base.

3. MEASUREMENT: The total quantity of Class W road base material for which payment shall be made shall be computed by field survey of installation area times 0.5 foot in thickness.

Item 11 – Sump Construction

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the construction of the leachate collection and recovery system (LCRS) sumps, (both primary and secondary) including coordination with the GEOSYNTHETICS INSTALLER on the timing of the earthwork construction and the geosynthetic installations; procurement, testing, hauling, and placing LCRS gravel in the primary sumps and secondary sumps; and installing geotextile fabric (to be provided by GEOSYNTHETICS MANUFACTURER at no cost to CONTRACTOR) as shown in the Contract Drawings. Pipe material and installation costs will be paid under Bid Items 12 and 14.
2. UNIT OF MEASURE: Each.
3. MEASUREMENT: There shall be no measurement for payment.

Item 12 – LCRS Collection Pipe

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement and installation of the 6-inch diameter HDPE SDR 17 perforated LRCS collection pipe and end caps; including procurement, testing, hauling, and placement of LCRS gravel around pipe, and installing geotextile fabric (to be provided by GEOSYNTHETICS MANUFACTURER at no cost to CONTRACTOR) around the LCRS pipe and gravel, as shown in the Contract Drawings.
2. UNIT OF MEASURE: Linear footage of LCRS collection pipe installed.
3. MEASUREMENT: The total quantity of LCRS collection pipe for which payment shall be made shall be determined by field survey along the pipe alignment from sump to pipe end (excluding riser pipe).

Item 13 – LCRS Leachate Collection Pumps

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement and installation of the leachate collection pumps; including all associated fittings and appurtenances, suspension cable, and clamps as specified in the Contract Drawings or as deemed necessary to complete the Work. Pipe hosing material and installation costs will be paid under Bid Item 16.
2. UNIT OF MEASURE: Each.
3. MEASUREMENT: There shall be no measurement for payment.

Item 14 – Sump Sideslope Riser Pipes

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement and installation of the 18-inch diameter SDR 17 HDPE pipe (solid and perforated, in primary LCRS sump), 12-inch diameter SDR 17 HDPE pipe (solid and perforated, in secondary LCRS sump) and 6-inch diameter SDR HDPE pipe (solid, for LCRS collection pipe cleanout riser) along the landfill cell sideslopes, as shown in the Contract Drawings; including excavating riser corridors; procurement, hauling, and installation of Class B Bedding material in the riser corridors; and installing geotextile fabric (to be provided by

GEOSYNTHETICS MANUFACTURER at no cost to CONTRACTOR) around the riser corridors.

2. UNIT OF MEASURE: Linear footage of riser pipe corridor constructed.
3. MEASUREMENT: The total quantity of riser pipe corridor for which payment shall be made shall be determined by field survey along the corridor from pipe end to end (inclusive of the sump length).

Item 15 – Concrete Pipe Protection Slab

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the construction of the concrete headwall at the crest of each riser pipe corridor; including the preparation of approved Structural Fill subgrade; furnishing and placing all formwork, rebar, and concrete as shown in the Contract Drawings, and furnishing and installing protective bollards.
2. UNIT OF MEASURE: Cubic yardage of concrete.
3. MEASUREMENT: The total quantity of concrete for which payment shall be made shall be computed by the cubic yardage of concrete installed, as measured by field measurement.

Item 16 – LCRS Discharge Pipe Systems

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with procurement and installation of the leachate sump distribution and discharge piping systems; including all piping and hoses from the LCRS leachate collection pumps to the pressurized leachate force main and including all associated fittings and appurtenances, flow control structures, valves, meters, couplings, electric heat trace, insulation, cladding, and pipe supports, as specified in the Contract Drawings or as deemed necessary to complete the Work.
2. UNIT OF MEASURE: Each. Payment shall be made at incremental percentages of the Lump Sum price as the Work progresses as approved by the OWNER'S REPRESENTATIVE.
3. MEASUREMENT: There shall be no measurement for payment.

Item 17 – Pressurized Leachate Force Main

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement and installation of the pressurized dual-containment leachate pipe; including trenching, removal of existing fencing around the leachate collection pond as necessary, procurement, hauling, and placement of Class B Bedding material in the trench, placement of drain pipe, electric heat trace, backfilling and compaction of trench, coordination with GEOSYNTHETICS INSTALLER on installation of pipe boot at existing leachate collection pond, fence restoration, and any other work deemed necessary to complete the Work as directed by the OWNER.
2. UNIT OF MEASURE: Linear footage of LCRS collection pipe installed.
3. MEASUREMENT: The total quantity of LCRS collection pipe for which payment shall be made shall be determined by field survey along the pipe alignment from end to end (excluding riser pipe and discharge system to force main).

Item 18 – Seeding

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the seeding and mulching of areas to be re-vegetated as shown in the Contract Drawings, including providing and placing approved seed mix and mulch, furnishing and installing erosion control fabric as specified, and any other work deemed necessary to complete the Work as directed by the OWNER.
2. UNIT OF MEASURE: Acre of seeding, or part thereof.
3. MEASUREMENT: The total quantity of seeding for which payment shall be made shall be the acre, or part thereof, that has been seeded and mulched, as determined from field survey or field measurement.

Item 19 – Chain Link Fence

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the installing chain-link fence as shown in the Contract Drawings.
2. UNIT OF MEASURE: Linear foot of fence installed.
3. MEASUREMENT: The total quantity of chain-link fence for which payment shall be made shall be determined by measurement along the top of the fence from center to center of end posts, excluding the length occupied by any gate openings.

Item 4X – Rock Excavation

1. PAYMENT: In the event that the rock is encountered of such a hardness and texture that it cannot be excavated with a D-9N Caterpillar tractor with a single shank ripper, or equivalent equipment; or, for trench excavation, a 235C Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment, full compensation for all labor, materials, equipment, and other incidental costs required to excavate rock to the subgrade elevations shown in the Contract Drawings, including load, haul, and placement of excavation spoils in appropriate OWNER-designated stockpile areas as shown in the Contract Drawings and/or as required or directed by the CQA MANAGER, maintaining safe excavation and fill slopes, development and maintenance of temporary haul roads, providing traffic control as necessary, and coordination with Site operations.
2. UNIT OF MEASURE: Cubic yardage of excavation, as computed in the ground prior to excavation.
3. MEASUREMENT: The total quantity of excavated material for which payment shall be made shall be computed by field measurement or survey as approved by the CQA MANAGER.

1.7 BID ALTERNATE ITEM DESCRIPTIONS

Item 7A – Operations Layer

1. PAYMENT: Full compensation for all labor, materials, equipment, and other incidental costs associated with the procurement, testing, hauling, and placement of operations layer material in Cells 1 and 2.
2. UNIT OF MEASURE: Cubic yardage of operations layer material placed measured in-place.
3. MEASUREMENT: The quantity of operations layer for which payment shall be made shall be determined by field survey of the top of the placement area

within Cells 1 and 2 and multiplying this area by the required 1-foot thickness.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

REPORT

SITE CHARACTERIZATION REPORT, HAPPY JACK LANDFILL EXPANSION

Happy Jack Landfill
Cheyenne, Wyoming

Submitted to: City of Cheyenne
2101 O'Neil Avenue
Cheyenne, Wyoming 82001

Submitted by: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228

Solid Waste Professionals of Wyoming, LLC
371 Coffeen Avenue
Sheridan, Wyoming 82801

Distribution: Wyoming Department of Environmental Quality (WDEQ)
City of Cheyenne
Golder Associates Inc.
Solid Waste Professionals of Wyoming (SWPW)

PROFESSIONAL GEOLOGIST
JACOB S. WAPLES
PG-3582
WYOMING

January 2014

Project No. 123-81971

Golder Associates

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1.0 INTRODUCTION

1.1 Purpose and Objectives

The City of Cheyenne (City) is planning an expansion to the Happy Jack Landfill (Landfill), located approximately 10 miles west of Cheyenne, Wyoming. Solid Waste Professionals of Wyoming (SWPW) and Golder Associates Inc. (Golder) were retained by the City to advance the siting, design, and permitting of the landfill expansion.

To support the design and permitting of the expansion, SWPW and Golder conducted a site characterization field program at the proposed expansion site (Site). The objectives of the field program were to obtain geotechnical and hydrogeological site data that will be used to develop the permit-level expansion design. This site characterization report summarizes the subsurface soil and groundwater conditions within the proposed expansion footprint.

1.2 Scope of Services

The scope of the site characterization field program was developed by SWPW and Golder based on a review of available geologic and hydrogeologic data from the existing landfill facility and in consultation with the Cheyenne Board of Public Utilities (BOPU) and the Wyoming Department of Environmental Quality (WDEQ). The scope of the site characterization was defined in the document titled *Work Plan for Site Characterization for Permit Application, Happy Jack Landfill Expansion*, prepared by SWPW and Golder dated May 2013, and included the following tasks:

- A literature survey to obtain background information on the general geology of the region;
- A review of existing geologic and hydrogeologic data summarized in the following reports:
  - Trihydro Expansion Operations Evaluation Report, dated April 29, 2011;
  - City of Cheyenne Sanitary Landfill Annual Reports, dated April 9, 2012, and April 16, 2013;
  - Publically available Wyoming State Engineer's Office (SEO) domestic groundwater well permit records;
  - Happy Jack Well Field Wellhead Protection Areas (WHPA) Delineation Report (unknown date); and
  - Cheyenne BOPU production well records.
- A geotechnical exploration program consisting of the advancement of eight geotechnical soil borings, soil sampling, geologic logging, and groundwater measurements in the boreholes advanced within the proposed landfill expansion footprint;
- A geotechnical laboratory testing program conducted on select soil samples collected from the geotechnical boreholes to evaluate engineering properties and classifications, for use in geotechnical design evaluations and analyses;
- A hydrogeologic exploration program consisting of the installation of six groundwater monitoring wells around the perimeter of the proposed landfill expansion footprint, monitoring well development, and initial groundwater level monitoring; and
- The preparation of this *Site Characterization Report*.

1.3 Limitations

This report was prepared exclusively for the use of the City as part of their landfill expansion permit process.

It should be noted that the subsurface conditions summarized in this report are based on the information obtained from the existing documents provided and the limited quantity of soil borings advanced and groundwater monitoring wells installed at the Site. The subsurface conditions described in this report depict only the conditions at those sampling locations at the time of drilling and sampling. Subsurface conditions at other locations may vary from those presented herein. Furthermore, it should be noted that inferred groundwater levels indicated in this report are based on the limited amount of hydrogeologic data for the Site and will fluctuate with seasonal changes as well as other natural and/or man-made actions.

2.0 PROJECT DESCRIPTION

2.1 Background

Since 1966, the City has owned and managed the Happy Jack Landfill to serve the solid waste disposal needs of the residents of Cheyenne and surrounding Laramie County School District #1. In 2008 the City stopped accepting municipal solid waste (MSW) at the Landfill in an effort to conserve the facility's remaining disposal capacity. The City is currently shipping their municipal solid waste to a landfill near Ault, Colorado. The Landfill continues to accept construction and demolition (C&D) wastes.

The City is planning an expansion to the Happy Jack Landfill in order to provide an economical, reliable, long-term waste disposal solution to the community. The City retained Trihydro Corporation (Trihydro) to prepare an *Expansion Options Evaluation Report for the Landfill* (dated April 29, 2011) in which five potential expansion locations within the existing Landfill property boundary were evaluated. Based on this report, the City, in conjunction with SWPW and Golder, selected Fill Area 2 as the most cost-effective and readily achievable expansion option. The site characterization field program and subsurface conditions summarized in this site characterization report are specific to the Fill Area 2 expansion site (Site).

2.2 Site Description

The Site is located north of the currently permitted boundary of the existing Landfill, but within land that is currently owned by the City as part of the Happy Jack Landfill property. A Site Plan showing the footprint of the proposed landfill expansion and the existing landfill permit boundary is presented in Figure 1. The expansion footprint boundaries were limited by the following constraints:

- The existing Happy Jack landfill to the south and the facility's existing stormwater and leachate collection ponds to the southeast;
- The Construction & Demolition Waste Processing and Recycling Center to the west;
- A prescriptive 1,000-foot offset from the nearest Cheyenne BOPU groundwater production well, Koppes No. 6, to the northwest;
- A 2,000-foot offset from the centerline of Happy Jack Road to the north;
- A 200-foot offset from the Silver Sage overhead power line easement to the north; and
- 500-foot offsets from several Duke Energy wind turbines to the east and west.

The majority of the Happy Jack site is undeveloped and primarily consists of undulating hills with gradual slopes. The land surrounding the Site is either vacant or leased to Duke Energy as part of a wind turbine farm. The southern portion of the Site falls within the limits of the existing C&D Waste Processing and Recycling Facility permit boundary (Terracon 2011). As such, a portion of the proposed expansion area is currently being utilized for material staging and stockpiling associated with the processing and recycling operations. The Site is located within the existing Cheyenne BOPU Happy Jack well field, with seven BOPU water supply wells located within a one mile radius.

3.0 FIELD EXPOLORATION AND LABORATORY TESTING PROGRAMS

3.1 General

This section provides a general description of the geotechnical and hydrogeologic field explorations and laboratory testing program. Full-time oversight, sample collection, and geologic logging were provided by a Golder field geologist. Visual classification of the collected samples and drill cuttings was performed in accordance with Golder's standard technical soil classification procedures.

3.2 Geotechnical Field Program

The geotechnical field program was conducted between June 17 and 26, 2013. The drilling work was performed by Drilling Engineers, Inc. out of Fort Collins, Colorado. The geotechnical field exploration program consisted of the advancement of eight geotechnical boreholes (identified as GBH-2013-01 through GBH-2013-08) within the proposed expansion footprint. The boreholes were spaced across the Site in an effort to provide maximum spatial distribution within the proposed footprint. The borehole locations are shown on Figure 2. Table 3-1 presents the borehole coordinates, elevations, and termination depths.

Table 3-1: Borehole Summary

Boring ID	Northing[1]	Easting[1]	Surface Elevation[2]	Maximum Depth (ft bgs[3])
GBH-2013-01	232,247.1	700,582.6	6,613.79	94.5
GBH-2013-02	232,145.1	701,622.8	6,585.03	99.4
GBH-2013-03	232,933.6	700,793.8	6,594.80	99.4
GBH-2013-04	232,606.1	701,381.5	6,597.85	100.9
GBH-2013-05	232,672.0	702,081.9	6,587.45	99.9
GBH-2013-06	233,413.0	700,677.9	6,567.28	101.0
GBH-2013-07	233,217.3	701,326.7	6,589.31	99.3
GBH-2013-08	233,484.2	701,486.7	6,583.59	99.4

Notes:
1) NAD83; all distances are in feet
2) NAVD88; all elevations are in feet above mean sea level (ft AMSL)
3) Feet below ground surface

The geotechnical boreholes were advanced using a CME 75 truck-mounted drill rig and 4.5-inch inside diameter (ID) hollow stem augers. Drilling and field sampling procedures were performed in general accordance with ASTM test designation D1586. Standard penetration tests (SPT) were performed at five-foot intervals and soil samples were collected using three types of samplers:

- Traditional SPT split-spoon samplers – Disturbed samples were collected using a 2-inch outside diameter (OD) (1.37-inch inner diameter [ID]) split-spoon sampler with a 24-inch length. A 140-lb hammer free falling 30 inches was used to drive the split-spoon sampler and to obtain SPT blow counts. N-values shown on the boring logs represent the number of blows required for 1-foot penetration of the sampler into the soil, after an initial 6-inch "seating" drive depth. The N-values are shown on the boring logs included as Appendix A.
- Larger diameter, thick-walled, split-tube California samplers – Relatively undisturbed soil samples of fine-grained soils were collected using 3-inch outside diameter (OD) (2.5-inch inner diameter [ID]) samplers fitted with brass liners.
- Bulk Samples – Disturbed composite depth bulk soil samples were retrieved from soil boring auger cuttings.

Soil samples collected during the subsurface investigation were visually classified in the field. Soil classification was performed in general accordance with the Unified Soil Classification System (ASTM D-2487). The borehole logs are presented in Appendix A.

3.3 Geotechnical Laboratory Testing Program

The geotechnical laboratory testing program was initiated immediately following the geotechnical field exploration program. Selected soil samples were tested at Golder's geotechnical soils laboratory in Lakewood, Colorado. Samples were analyzed to assist in the classification of subsurface strata and for use in establishing geotechnical engineering properties of the materials encountered.

The following laboratory tests were performed in accordance with the referenced ASTM testing standards:

- Seventeen sieve analyses (ASTM D-422);
- Three hydrometer analyses (ASTM D-422);
- Fourteen Atterberg limits tests (ASTM D-4318);
- Seventeen moisture content tests (ASTM D-2216);
- Nine specific gravity tests (ASTM D-854);
- Four Standard Proctor moisture-density relationship tests (ASTM D-698);
- One isotropically consolidated undrained (CU) triaxial shear strength test (ASTM D-4767);
- Two permeability tests on recompacted samples (ASTM D-5084); and
- One consolidation test (D-2435).

Laboratory test data are presented in Appendix D with index property data summarized in Table 3-2. After receiving the results of the laboratory analyses, the borehole logs were modified as necessary to reflect the laboratory soil classification.

Table 3-2: Index Property Laboratory Test Results Summary

Sample Type	Sample Number	Sample Name	Sample Depth (ft bgs)	USCS[1]	Delivered Moisture (%)	Atterberg Limits			Grain Size Distribution			Specific Gravity	Moisture/Density Relationship Standard Proctor		Permeability[7]
						LL[2]	PL[3]	PI[4]	% Finer ¾"	% Finer #4	% Finer #200		Dry Density (pcf[5])	Moisture (%)	cm/sec
Pail	G-2	GBH-2013-01	34-38	CL	19.3	42	21	21	100	100	62	2.68	109.5	16.7	6.4×10^{-9}
Bag	SS-10	GBH-2013-01	49-51	SC	11.8	30	19	11	100	93	39	2.71	--	--	-
Bag	SS-6	GBH-2013-02	29-31	SC	17.3	33	21	12	100	99	39	2.68	--	--	-
Bag	SS-13	GBH-2013-02	74-75	SC	7.5	--	--	--	100	95	19	--	--	--	-
Bag	SS-5	GBH-2013-03	19-21	SC-SM	12.6	27	20	7	100	99	44	2.68	--	--	-
Bag	SS-9	GBH-2013-03	59-61	SC	10.6	29	20	9	100	99	33	--	--	--	-
Pail	G-1	GBH-2013-03	5-20	CL	16.1	34	17	17	100	97	53	2.68	102.8	14.0	2.3×10^{-6}
Bag	G-2	GBH-2013-03	26-28	CL	--	33	18	15	100	94	53	--	--	--	-
Bag	SS-8	GBH-2013-04	35-37	SC	16.1	36	20	16	100	96	47	--	--	--	-
Bag	SS-13	GBH-2013-04	60-62	SC	5.5	--	--	--	100	91	19	--	--	--	-
Bag	SS-15	GBH-2013-04	70-71.8	SC	15.2	30	20	10	100	98	33	--	--	--	-
Bag	MC-1	GBH-2013-06	24-25	SM	10.7	25	19	6	--	--	--	2.67	--	--	-
Bag	SS-7	GBH-2013-06	34-36	SC	11.0	30	18	12	100	98	34	--	--	--	-
Bag	SS-13	GBH-2013-06	69-70.5	SC	9.7	45	25	20	100	81	31	--	--	--	-
Bag	SS-18	GBH-2013-06	94-95	SC	1.7	--	--	--	100	85	10	--	--	--	-
Pail	G-1	GBH-2013-06	3-18	SC	6.1	--	--	--	100	94	38	2.69	124.1/125.7*	9.6/9.1*	-
MC[6]	MC-1	GBH-2013-06	24-25	SM	10.7	25	19	6	--	--	--	2.67	--	--	-
Pail	G-2	GBH-2013-06	22-38	SM	--	--	--	--	100	95	39	2.66	122.8/124.3*	11.3/10.8*	-
Bag	MC-1	GBH-2013-07	19-21	CL	20.7	--	--	--	--	--	--	2.69	--	--	-
Bag	SS-8	GBH-2013-07	39-41	SC	--	33	19	14	--	--	--	--	--	--	-
Bag	SS-14	GBH-2013-07	79-81	SC	14.3	26	18	8	100	98	31	--	--	--	-

Notes:
1) USCS – Unified Soil Classification System
2) Liquid Limit
3) Plastic Limi
4) Plasticity Index
5) Pounds per cubic foot
6) Modified California sampler
7) Remolded to approximately 97% of the Standard Proctor maximum dry density at 2.5% above optimum moisture content
* Over size corrected value per ASTM D4718

3.4 Hydrogeologic Exploration Program

The hydrogeologic field program was conducted between August 14 and September 6, 2013. Drilling and installation of the monitoring wells were performed by Cascade Drilling L.P. (Cascade) out of West Jordan, Utah. The hydrogeologic field program included installation of five groundwater monitoring wells (identified as the "GMW-2013" series) around the perimeter of the proposed expansion footprint. The monitoring well locations were initially selected to allow for groundwater monitoring of the unconfined aquifer upgradient and downgradient of the Site.

It should be noted that the hydrogeologic conditions encountered at the expansion Site and summarized in Section 5.0 differed significantly from those anticipated, based on conditions previously observed and reported by Trihydro in the *City of Cheyenne Sanitary Landfill Annual Reports* (from 2011 and 2012). Final groundwater levels during well drilling were observed at depths exceeding the expected water level depths. Therefore, the scope of the hydrogeologic field program was modified from the scope originally proposed in the Work Plan for Site Characterization for Permit Application, Happy Jack Landfill Expansion (dated May 2013) to suit the hydrologic conditions encountered at the expansion Site. Modifications included drilling and installing deeper wells to intercept the principal confined aquifer (the uppermost aquifer encountered in the expansion area) and reducing the quantity of monitoring wells installed. The monitoring well locations are shown on Figure 2. Table 3-3 presents the monitoring well coordinates, elevations, screened interval depths, and termination depths. Well construction logs are presented in Appendix C.

Table 3-3: Groundwater Monitoring Well Summary

Well	Northing[1]	Easting[1]	TOC Elevation[2,3]	Maximum Drilled Depth[4] (ft bgs[5])	Screened Interval (ft bgs[5])
GMW-2013-01	232717.2	700342.2	6599.54	236	176.0 – 216.0
GMW-2013-03	233652.2	701399.4	6581.44	216	176.0 – 216.0
GMW-2013-04	233307.5	702002.9	6584.26	226	186.0 – 216.0
GMW-2013-06	232172.4	702171.9	6563.09	190	156.5 – 186.5
GMW-2013-07	233697.5	700456.9	6567.99	310	186.0 – 236.0

Notes:
1) NAD83; all distances are in feet
2) NAVD88; all elevations are in feet above mean sea level (ft AMSL)
3) TOC – Top of 2-inch PVC casing
4) During well installation some boreholes were advanced beyond the water table due to slow groundwater infiltration. Screened intervals were selected based on stable groundwater levels observed in the open boreholes. If borehole termination depths extended beyond the selected screen interval, the boreholes were backfilled with bentonite to the bottom of the screened interval.
5) Feet below ground surface

The monitoring well boreholes were advanced with a truck-mounted Boart Longyear sonic drill rig operated by Cascade using sonic rotary drilling techniques. The boreholes were advanced using 7-inch outside diameter (OD) casing, and soil cores were collecting using a 4-inch inside diameter (ID) soil core barrel. Soil core run lengths varied between approximately 5 to 30 feet per run, depending on the material encountered. When the soil barrel was full or became plugged it was returned to the surface and the soil core was vibrated out of the soil barrel and into clear plastic sheaths. The soil core was laid out onto the ground and a Golder field geologist logged the material for geologic properties. Special attention was given to the grain size, staining, color, and moisture content of the material. These properties typically provide evidence of the presence of groundwater. The well construction logs presented in Appendix C include the geologic logging of the monitoring well boreholes; a photo log of the core samples is presented in Appendix C.

Cascade advanced the soil core barrel without the use of water wherever practical in order to maintain the integrity of the natural moisture content of the material recovered. However, the materials encountered were often hard or very dense so Cascade had to use water to advance the soil barrel for some intervals. When water was required, Cascade did not use water in the bottom portions of the run so natural moisture content could be observed in the bottom portions of the run intervals. The drill casing was advanced using water to clear the drill cuttings from the borehole. The drill casing was advanced to the top of the previously advanced soil core interval. The use of water during drilling often made natural moisture conditions difficult to observe. Because of this, a systematic approach to observing the presence of groundwater in the boreholes between runs was developed for borehole advancement below 80 feet below ground surface. This technique included the following:

- Soil core run lengths were limited to 20 feet;
- The amount of water used to advance the casing and soil core barrel were recorded for each run. Water return was observed during casing and soil core barrel advancement;
- Soil core properties were observed for indications of the presence of groundwater including:
  - The presence of coarse grained materials (sand and gravel);
  - Moisture conditions;
  - Staining; and
  - Reduced recovery of materials in the run (sand and gravel washed out);
- The water level of the borehole was recorded;
- Where practical a minimum of 50% of the water used to advance the casing and soil core barrel was purged from the borehole using either air lift methods or a bailer. Volumes purged were based on the assumption that there was more than 50% water return;
- Water levels of the borehole were recorded until stabilization was observed; and
- Rising water levels observed in the boreholes indicated the presence of groundwater. Groundwater was purged and recovery was observed multiple times where necessary to ensure that groundwater was present.

4.0 GEOTECHNICAL CONDITIONS

4.1 Surficial Conditions

The general terrain of the region is undulating hills with gradual slopes. The topsoil is comprised of thin organic silts, and grasses and sagebrush are the predominant vegetation. There is limited ephemeral surface water throughout the area.

4.2 Regional Geology

The Ogallala Formation of the Miocene and Pliocene age underlies the Site. The Ogallala Formation has been observed to be 330 feet thick along western portions of Laramie County and thinning eastward toward the state line. The Ogallala Formation consists of lenticular beds of sand and gravel deposited by braided streams, unconsolidated silt and clay deposits, and thin limestone beds. The Ogallala Formation's materials are heterogeneous and change from predominately coarse materials west near the mountains to finer materials in the eastern part of the county. As reported in the *Happy Jack Well Field Wellhead Protection Areas (WHPA) Delineation Report* (date unknown), the Ogallala Formation is exposed throughout the Happy Jack well field.

Lowry and Crist (1967) define the water-bearing beds in the Ogallala Formation as lenses, stringers, and irregular masses of sand and gravel which are interbedded with silt and clay. The heterogeneity of the formation is what is believed to contribute to a large range in transmissibility of the water-bearing zones of the formation.

4.3 Subsurface Soil Conditions

The subsurface soil conditions encountered in the geotechnical and hydrogeologic boreholes were primarily characterized as complex alluvial sequences of the Ogallala Formation that vary laterally across the Site. The subsurface soils consist mostly of clayey-silty sand and sandy-silty clay with localized lenses of sandy gravel. Three hydrogeologic cross sections were positioned across the Site to graphically present the geologic and hydrogeologic structure underlying the proposed expansion footprint. These cross sections are presented in Figures 3 and 4. For the purposes of these cross sections, subsurface soils were categorized as either high permeability materials (i.e., sands/gravels) or low permeability materials (i.e., clays/silts). Descriptions and geotechnical properties of these soil groups are presented below.

4.3.1 Clayey and Silty Sands

A summary of the index property testing results from select clayey sand and silty sand soil samples is summarized in Table 4-1 below. The samples are classified as clayey sand (SC), silty sand (SM), and silty, clayey sand (SC-SM). The relative density of the material was primarily very dense (i.e., SPT N-value greater than 50), often times causing refusal of the split spoon sampler.

Table 4-1: Properties of Clayey and Silty Sands

USCS Group Symbols	N-Values	Relative Density	Moisture Content (%)	Liquid Limit (LL)	Plasticity Index (PI)	Fines (% Passing No. 200)	Specific Gravity
SC, SM, SC-SM	7–98 Avg. 60	Med. Dense to Very Dense	1.7–17.3 Avg. 10.7	25–45 Avg. 31	6–20 Avg. 11	10–47 Avg. 33	2.68

4.3.2 Sandy Clays and Silt

A summary of the index property testing results from select sandy clay and silt soil samples is summarized in Table 4-2 below. The samples are generally classified as low plasticity clay (CL) and low plasticity silt (ML), with small discontinuous seams of medium to high plasticity silt (MH) noted in the field. The consistency of the cohesive materials was stiff to hard (i.e., SPT N-value greater than 32), often times causing refusal of the split spoon sampler.

Table 4-2: Properties of Sandy Clays and Silt

USCS Group Symbols	N-Values	Consistency	Moisture Content (%)	Liquid Limit (LL)	Plasticity Index (PI)	Fines (% Passing No. 200)	Specific Gravity
CL, ML, MH	12–96 Avg. 47	Stiff to hard	16.1–20.7 Avg. 18.7	17–21 Avg. 19	11–21 Avg. 18	53–62 Avg. 56	2.68

Drained effective stress shear strength parameters were derived from an isotropically consolidated undrained (CU) triaxial shear strength test on a CL sample obtained from borehole GBH-2013-07 and collected from the depth interval 24–25 ft bgs. However, it should be noted that due to significant sample disturbance, only one undisturbed modified California sampler tube was recovered from the sampling interval for shearing. The remaining two shear points were tested using remolded samples from the undisturbed sampler tube. As a result, the drained effective stress shear strength was defined using only the frictional component of shear strength. The CU triaxial test resulted in a peak effective friction angle of 32 degrees and a residual effective friction angle of 28 degrees at large strain failure.

A consolidation test on one undisturbed CL sample of the low plasticity clay material from borehole GBH-2013-06 and collected from the depth interval 24–25 ft bgs indicated that the soil is normally consolidated with an estimated compression index (C_c) of 0.2 and an estimated coefficient of consolidation (C_v) of $3.7x10^{-4}$ centimeters squared per second (cm^2/sec). It should be noted that the sample specimen was not inundated prior to loading in order to better evaluate the anticipated consolidation resulting from the landfill loading. As a consequence, however, the resulting consolidation curve did exhibit typical secondary consolidation behavior at the longer loading durations. This is likely due to the low in situ moisture contents within the clay and silt materials.

Laboratory permeability tests were conducted on two recompacted bulk samples collected from the sandy clay materials. The bulk samples were remolded to approximately 97% of the Standard Proctor maximum dry density at approximately 2.5% above the optimum moisture content and subjected to a confining pressure of 10 pounds per square inch (psi) to conservatively simulate initial waste placement operations. A summary of the index properties and permeability testing results is presented in Table 4-3 below.

Table 4-3: Index Property and Permeability Data Summary

Borehole	**Sample**	**Depth (ft bgs)**	**USCS Group Symbol**	**Fines (% Passing No. 200)**	**Plasticity Index**	**Permeability (cm/sec)**
GBH-2013-01	G-2	34-38	CL	62	21	6.4×10^{-9}
GBH-2013-03	G-1	5-20	CL	53	17	2.3×10^{-6}

The difference in the measured permeability is likely the result of the varying fines contents and plasticity of the samples, with the lower permeability sample (G-2 from GBH-2013-01) having approximately 10% more fines by weight and higher plasticity than the G-1 sample from borehole GBH-2013-03.

5.0 HYDROGEOLOGIC CONDITIONS

5.1 Regional Hydrogeology

The primary regional drinking water aquifers in the region are within the Ogallala Formation. The City of Cheyenne supplements the municipal water supply using wells screened within the confined aquifer of the Ogallala Formation with seven BOPU water supply wells located within a one-mile radius of the expansion footprint. The regional potentiometric surface of the upper aquifer in the Ogallala Formation trends eastward with local north-south variations, and has a gradient of less than 1% (Crist 1980).

5.2 Existing Landfill Facility

The hydrogeologic conditions underlying the existing landfill facility have been well documented. As reported by Trihydro in the facility's *Annual Reports* (2011 and 2012), three saturated zones are currently monitored beneath the existing landfill. These zones are referred to by Trihydo as the Perched 1 Water-Bearing Zone, the Principal Unconfined Aquifer, and the Confined Aquifer. The current environmental monitoring network for the existing landfill facility includes 33 groundwater monitoring wells or piezometers screened within these water bearing zones.

Perched intermittent saturated conditions have been reported along the southern portions of the existing landfill, due to the seasonal recharge from the Spring Creek drainage. Based on reported well gauging data, depth to water in this Perched 1 Water-Bearing Zone in the southern portion of the existing landfill ranges from 6 to 45 ft bgs.

Trihydro also reported that the entire existing landfill is underlain by an unconfined aquifer at approximately 150 to 160 ft bgs. The thickness of the Principal Unconfined Aquifer reportedly varies from 5 to 50 feet, and it is believed to comprise two or more interconnected water-bearing zones.

The Confined Aquifer lies below the Principal Unconfined Aquifer at a depth of approximately 170 ft bgs. The Unconfined and Confined Aquifers are reportedly separated by a leaky aquitard composed of clay and sandy clay between 5 and 20 feet thick.

5.3 Expansion Site

The hydrogeology of the expansion Site differs significantly from that previously defined at the existing landfill. No shallow perched water-bearing zones were encountered during the geotechnical field program. In addition, no indication of the presence of an unconfined or perched aquifer was encountered during the drilling of the monitoring well boreholes.

The primary water-bearing zone encountered at the expansion Site was the Confined Aquifer, at depths ranging from 162 to 218 ft bgs. Hydrogeologic observations during drilling indicated that this first aquifer encountered at the expansion Site was confined below the clay aquitard previously defined at the existing landfill, and thus is not representative of an unconfined aquifer. Unique drilling protocols were implemented during the drilling of the monitoring well boreholes to ensure that the confined aquifer was in fact the first water-bearing zone encountered (see Section 3.4).

These hydrogeologic data suggest that what has been previously defined as the unconfined aquifer at the existing landfill is instead likely a series of limited, perched water-bearing zones at greater depths. This is supported by the following field observations:

- The existing monitoring wells intercepting these shallow water-bearing zones (SRM-4, SRM-5, SRM-7, and SRM-8) are either dry or have not demonstrated a consistent or realistic groundwater gradient with time;
- Monitoring well MW-06 was initially installed and screened between 126 and 146 feet below ground surface (ft bgs), above the aquitard material. After the purging of the drilling fluids, the well was dry;
- Monitoring well borehole MW-01 was drilled to 230 ft bgs, was left open, and was bailed for five days in order to observe water levels. The water levels remained stable within the confined aquifer depths with no indications of infiltration from overlying water-bearing zones noted; and
- Monitoring well borehole MW-07 was drilled to 310 ft bgs, was left open, and was bailed for two days in order to observe water levels. The water levels remained stable within the confined aquifer depths with no indications of infiltration from overlying water-bearing zones noted.

A summary of groundwater level measurements collected on October 14, 2013, during the hydrogeologic field exploration program is presented in Table 5-1 below. Three hydrogeologic cross sections were positioned across the Site to graphically present the geologic and hydrogeologic conditions underlying the proposed expansion footprint. These sections are presented in Figures 3 and 4.

Table 5-1: Depth to Groundwater Measurements (October 14, 2013)

Well	TOC Elevation[1,2]	Depth to Groundwater (ft bgs[3])	Groundwater Elevation[1]	Bottom of Well Screen Elevation[1]
GMW-2013-01	6599.54	218.40	6381.14	6380.90
GMW-2013-03	6581.44	201.61	6379.83	6363.43
GMW-2013-04	6584.26	204.07	6380.19	6366.05
GMW-2013-06	6563.09	161.76	6401.33	6374.17
GMW-2013-07	6567.99	200.89	6367.10	6329.47
C-1	6621.27	212.21	6409.06	*Unknown*
C-2	6550.48	146.51	6403.97	*Unknown*
C-3	6601.42	197.25	6404.17	*Unknown*

Notes:
1) NAVD88; all elevations are in feet above mean sea level (ft AMSL)
2) TOC – Top of (inner well) casing
3) Feet below ground surface

Groundwater level measurements were taken in the five newly installed monitoring wells around the perimeter of the proposed expansion footprint (identified as the GMW-2013-XX series) as well as the three existing groundwater monitoring wells screened in the confined aquifer at the existing landfill facility (i.e., “C” series wells). As previously noted, groundwater level measurements were also attempted in the existing monitoring wells intercepting what was previously defined as the principal unconfined aquifer in the vicinity of the expansion Site (SRM-4, SRM-5, SRM-7, and SRM-8) but the wells were dry.

Inferred groundwater contours are presented in Figure 3. Historically, the hydraulic gradient of the confined aquifer has been reported to the east, based on groundwater data collected from the “C” well series. However, groundwater contours generated from the data presented in Table 5-1 (i.e., based on the additional data points from the monitoring wells installed during this hydrogeologic field program) indicate that the local directions of groundwater flow are to the north-northwest and north-northeast. It is hypothesized that the north-northwest gradient may be a consequence of groundwater pumping from the nearest BOPU municipal well, Koppes No. 6 (located 1,000 feet to the northwest), with the expansion Site situated near the edge of the pumping well’s radius of influence. Regular groundwater level monitoring coupled with a review of available seasonal municipal pumping records is recommended to validate these inferred groundwater contours.

6.0 HYPOTHETICAL CONTAMINANT TRANSPORT

A hypothetical leakage scenario was simulated to estimate subsurface travel time of leachate from the base of the proposed landfill expansion area to a hypothetical receptor located along Happy Jack Road. The simulated scenario is conservative and assumes the following:

- Vertical leakage through the landfill liner system (i.e., 12-inch operations layer, geomembrane, and geosynthetic clay liner) has already occurred;
- One foot of leachate accumulates on the 2.5-foot thick compacted clay liner and subgrade (design and regulatory maximum permissible hydraulic head);
- Vertical transport of leachate leaking through the clay liner, subgrade, and through the unsaturated zone; and
- Horizontal transport of leachate in groundwater downgradient to a hypothetical receptor, (i.e., a potential well located adjacent to Happy Jack Road, north of the landfill expansion area).

To evaluate this hypothetical leakage scenario, a site conceptual model was developed based on the geotechnical and hydrogeologic information presented herein. The travel time of the leachate was evaluated in three stages:

1. Flow through the compacted clay liner and subgrade to the unsaturated soil zone;
2. Flow through the unsaturated zone to the water table; and
3. Flow through the saturated zone, from the northwest corner of the propose landfill expansion area to the nearest hypothetical downgradient receptor.

The site conceptual model and hypothetical advective travel time calculation is illustrated graphically in Figure 5. A detailed summary of the model and calculations is presented in Appendix E.

The calculations indicate that the total travel time from a hypothetical leak in the landfill liner to the hypothetical receptor (i.e., potential groundwater well located immediately north of Happy Jack Road) is on the order of 240 years.

7.0 REFERENCES

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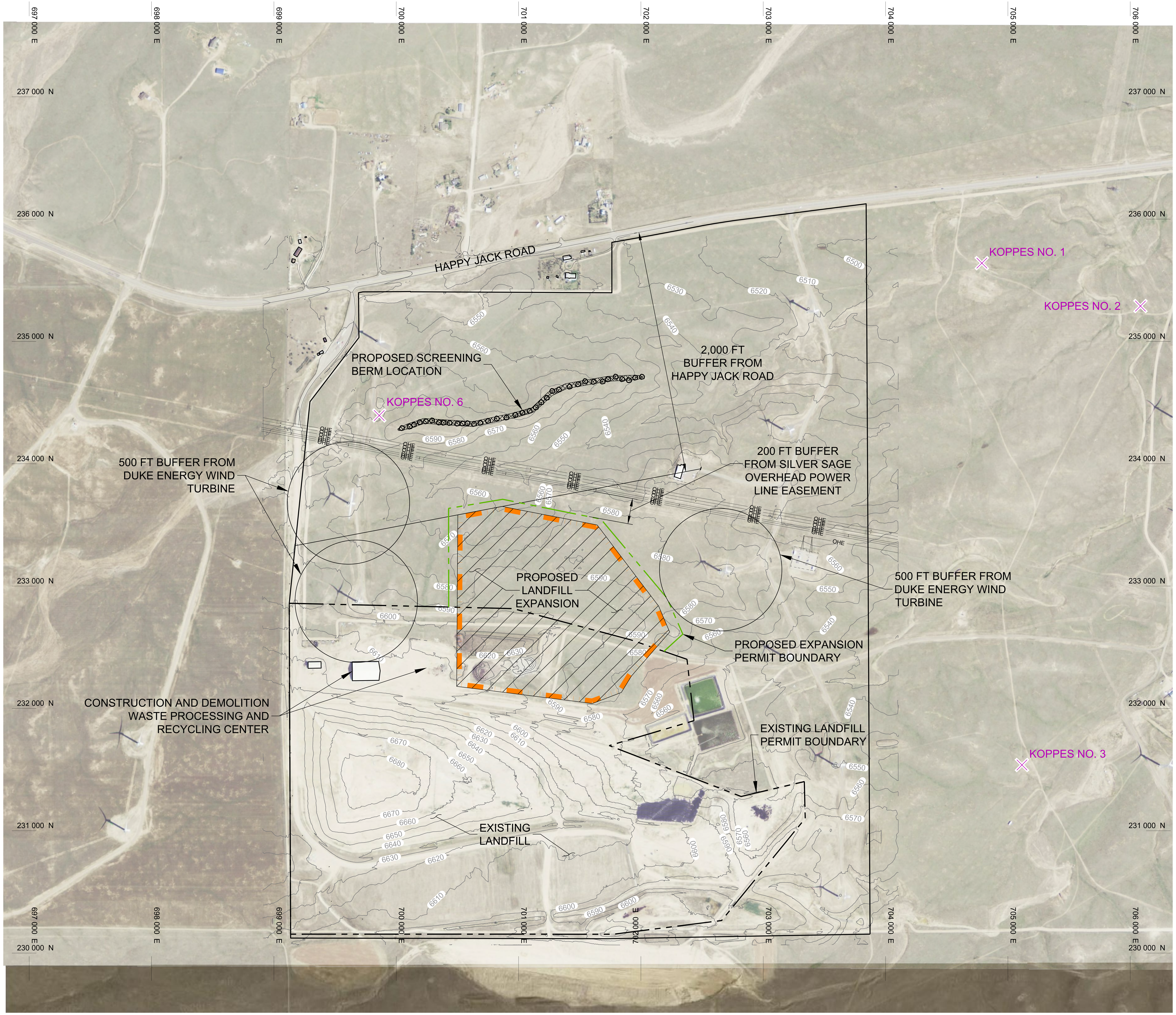
van Genuchten, M. T. 1980. A closed form equation for predicting the hydraulic conductivity of unsaturated soils. ***Soil Science Society of America Journal*** 44: 892-898.

FIGURES



LEGEND

1880	EXISTING GROUND TOPOGRAPHY
▬ ▬ ▬	PROPOSED LIMIT OF WASTE
——	PROPERTY LINE
— - - —	EXISTING LANDFILL PERMIT BOUNDARY
— - - —	PROPOSED EXPANSION PERMIT BOUNDARY
KOPPES NO. 2 ✕	EXISTING CHEYENNE BOARD OF PUBLIC UTILITIES GROUNDWATER PRODUCTION WELL
▨	PROPOSED SCREENING BERM LOCATION

REFERENCES

1. COORDINATE SYSTEM BASED ON HAPPY JACK LANDFILL SITE COORDINATE SYSTEM.
2. CONTOUR INTERVAL IS TEN FEET.

0 400 800 1200
SCALE FEET

PROJECT
CITY OF CHEYENNE
HAPPY JACK LANDFILL EXPANSION
LARAMIE COUNTY, WYOMING

TITLE
SITE PLAN

Golder Associates

PROJECT No.		123-81971	FILE No.	12381971C001
DESIGN	PDS	01/03/14	SCALE	AS SHOWN
CADD	PDS	01/03/14		
CHECK	JAR	01/03/14		1
REVIEW	RM	01/03/14		

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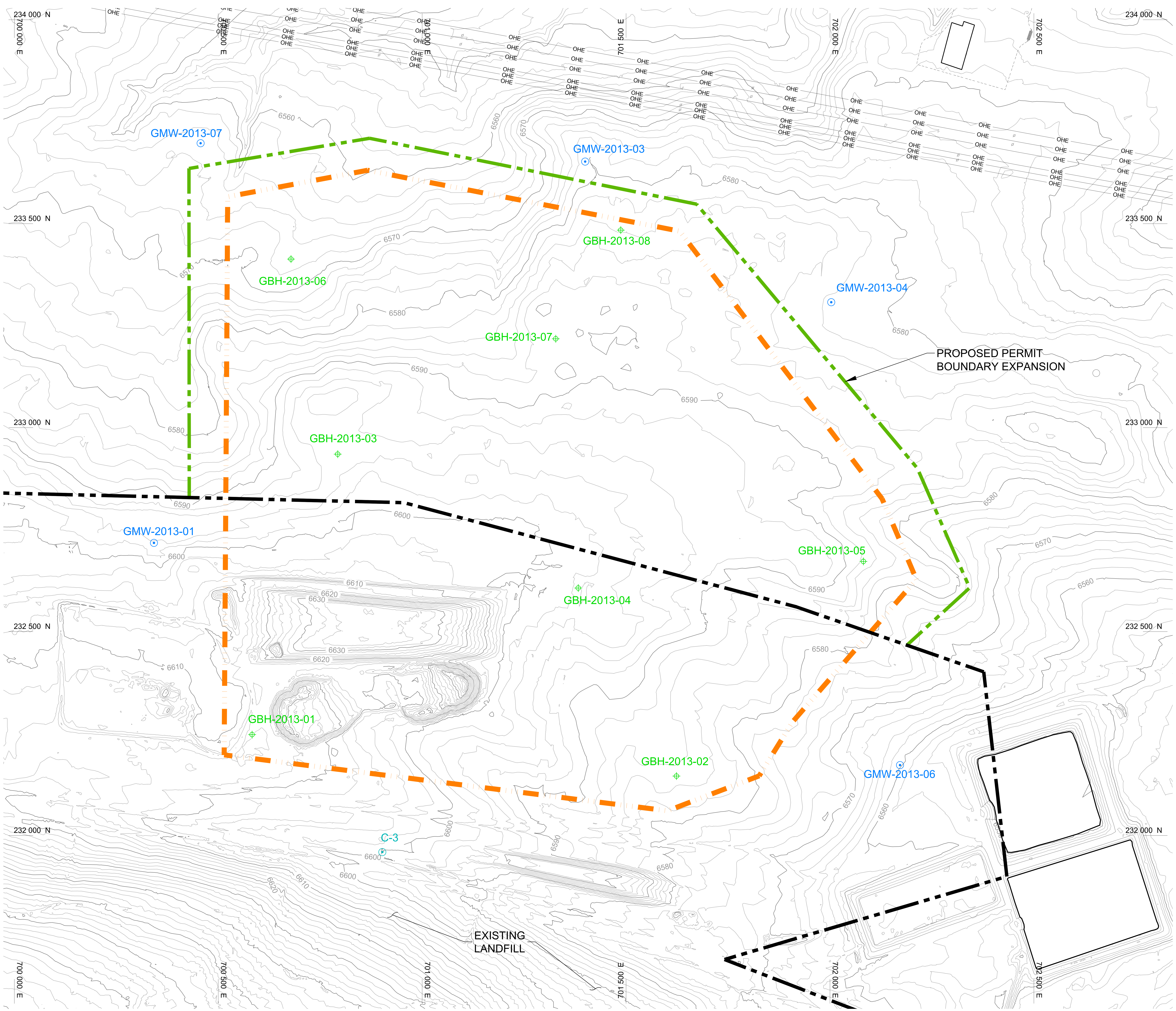


LEGEND

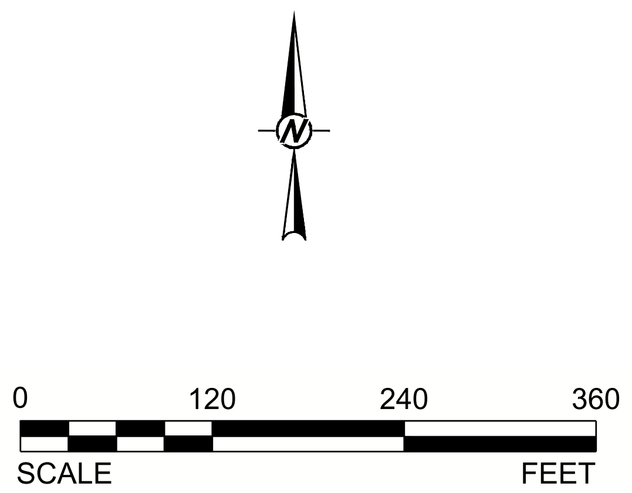
1880	EXISTING GROUND TOPOGRAPHY
▬ ▬ ▬	PROPOSED LIMIT OF WASTE
▬ · ▬ · ▬	EXISTING LANDFILL PERMIT BOUNDARY
▬ · ▬ · ▬	PROPOSED EXPANSION PERMIT BOUNDARY
GMW-2013-04 ⊙	EXISTING GROUNDWATER MONITORING WELL
GBH-2013-04 ⌖	LOCATION OF GEOTECHNICAL BOREHOLE
C-3 ⊙	PREVIOUSLY EXISTING GROUNDWATER MONITORING WELL

REFERENCES

1. COORDINATE SYSTEM BASED ON HAPPY JACK LANDFILL SITE COORDINATE SYSTEM.
2. CONTOUR INTERVAL IS TWO FEET.

NOTES

1. CELL BOUNDARIES ARE APPROXIMATE.
2. CELLS MAY BE DIVIDED WITH TEMPORARY DIVIDER BERMS DURING CONSTRUCTION AND PLACEMENT OF WASTE.



PROJECT

CITY OF CHEYENNE
HAPPY JACK LANDFILL EXPANSION
LARAMIE COUNTY, WYOMING

TITLE

FIELD EXPLORATION PLAN

Golder Associates

PROJECT No.		123-81971	FILE No.	12381971C002
DESIGN	PDS	01/03/14	SCALE	AS SHOWN
CADD	PDS	01/03/14		
CHECK	JAR	01/03/14		2
REVIEW	RM	01/03/14		

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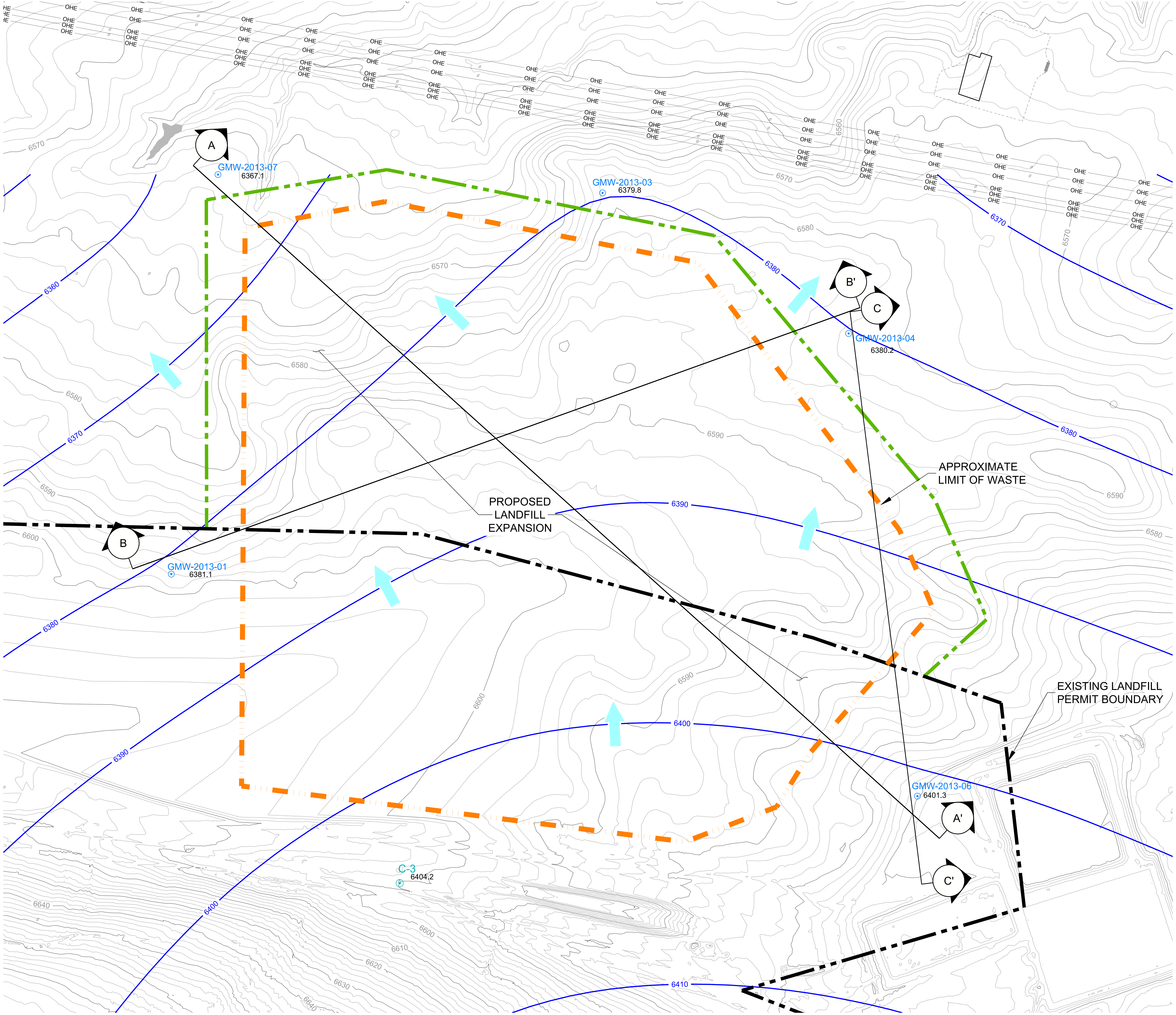

LEGEND

1880	EXISTING GROUND TOPOGRAPHY
6390 6380	INFERRED GROUNDWATER ELEVATION CONTOURS
➡	INFERRED GROUNDWATER FLOW DIRECTIONS
▬ ▪ ▬	PROPOSED LIMIT OF WASTE
───	PROPERTY LINE
── ▪ ─ ▪ ──	EXISTING LANDFILL PERMIT BOUNDARY
── ▪ ─ ▪ ──	PROPOSED EXPANSION PERMIT BOUNDARY
GMW-2013-04 ⊙ 6380.2	EXISTING GROUNDWATER MONITORING WELL WITH GROUNDWATER ELEVATION
C-3 ⊙ 6404.2	PREVIOUSLY EXISTING GROUNDWATER MONITORING WELL WITH GROUNDWATER ELEVATION
A	HYDROGEOLOGIC CROSS SECTION LOCATION (SEE DRAWING 4)

REFERENCES

1. COORDINATE SYSTEM BASED ON HAPPY JACK LANDFILL SITE COORDINATE SYSTEM.
2. CONTOUR INTERVAL IS TEN FEET.
3. GROUNDWATER CONTOURS WERE INFERRED FROM WELL GAUGING DATA COLLECTED ON OCTOBER 14, 2013.

N

0 120 240 360
SCALE FEET

PROJECT

CITY OF CHEYENNE
HAPPY JACK LANDFILL EXPANSION
LARAMIE COUNTY, WYOMING

TITLE

GROUNDWATER CONTOUR PLAN

Golder Associates

PROJECT No.		123-81971	FILE No.	12381971C003
DESIGN	CETB	01/03/14	SCALE	AS SHOWN
CADD	CETB	01/03/14		
CHECK	JAR	01/03/14		3
REVIEW	RM	01/03/14		

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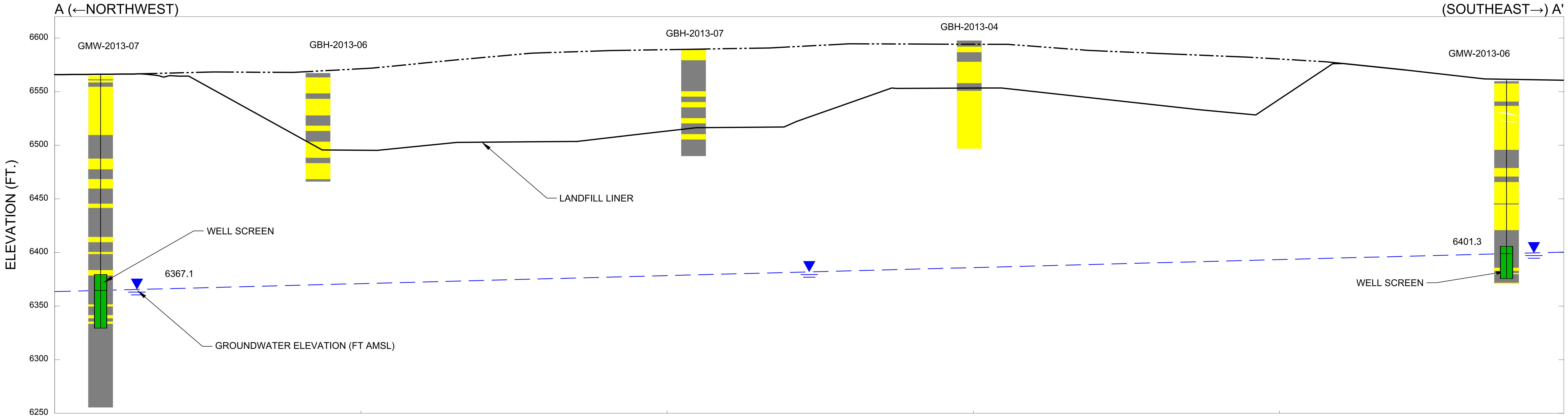
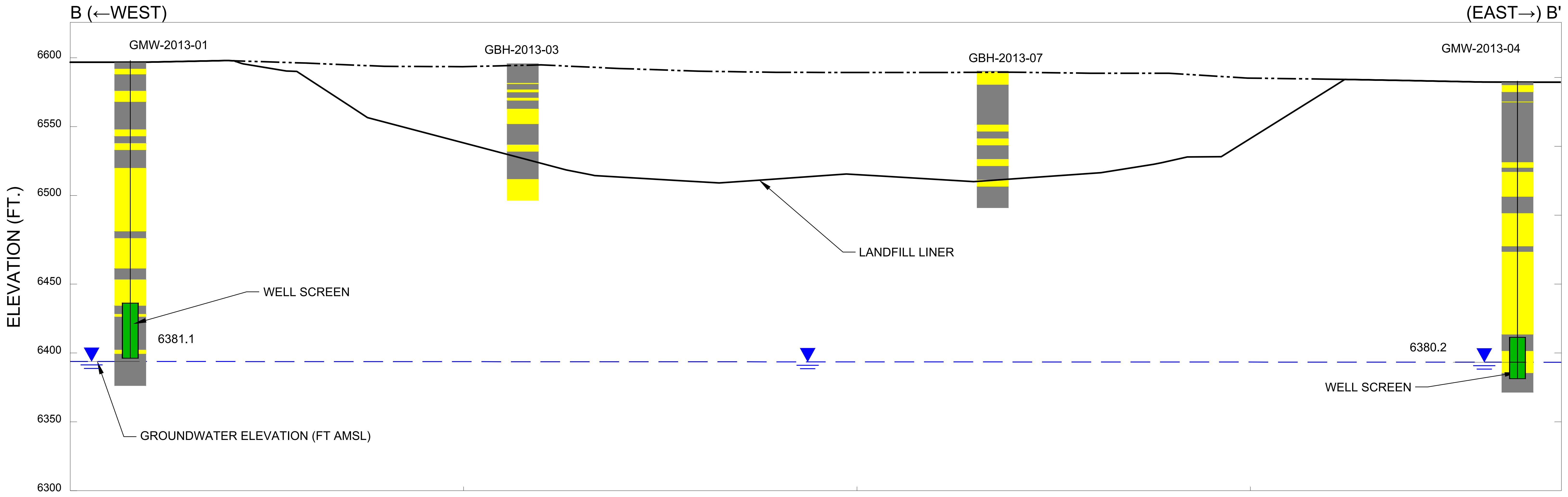
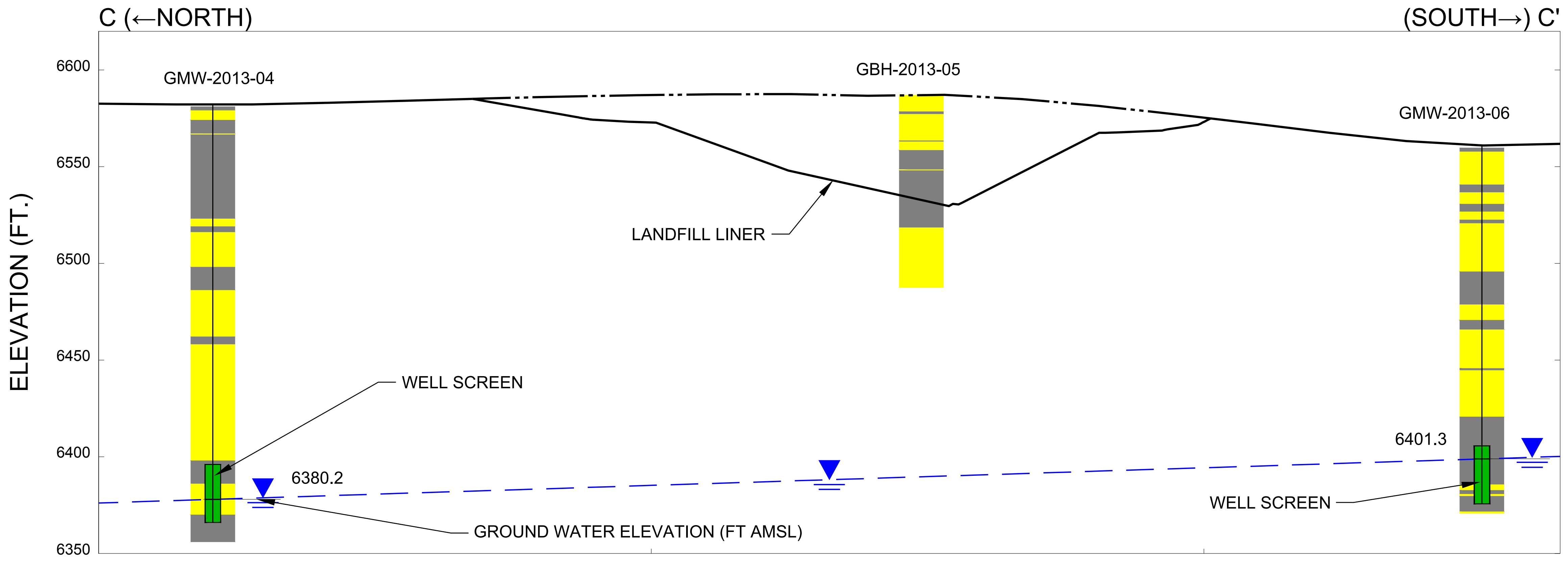


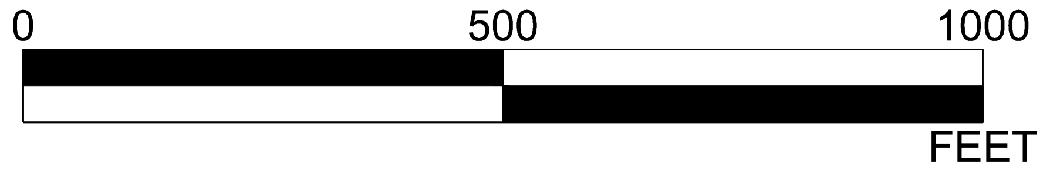


LEGEND

🟨	HIGH PERMEABILITY MATERIAL (SAND / GRAVEL)
⬛	LOW PERMEABILITY MATERIAL (CLAY / SILT)



HORIZONTAL SCALE



PROJECT

CITY OF CHEYENNE
HAPPY JACK LANDFILL EXPANSION
LARAMIE COUNTY, WYOMING

TITLE

HYDROGEOLOGIC CROSS SECTIONS

Golder Associates

PROJECT No.		123-81971	FILE No.	12381971C004
DESIGN	CETB	01/03/14	SCALE	AS SHOWN
CADD	CETB	01/03/14		4
CHECK	JAR	01/03/14		
REVIEW	RM	01/03/14		

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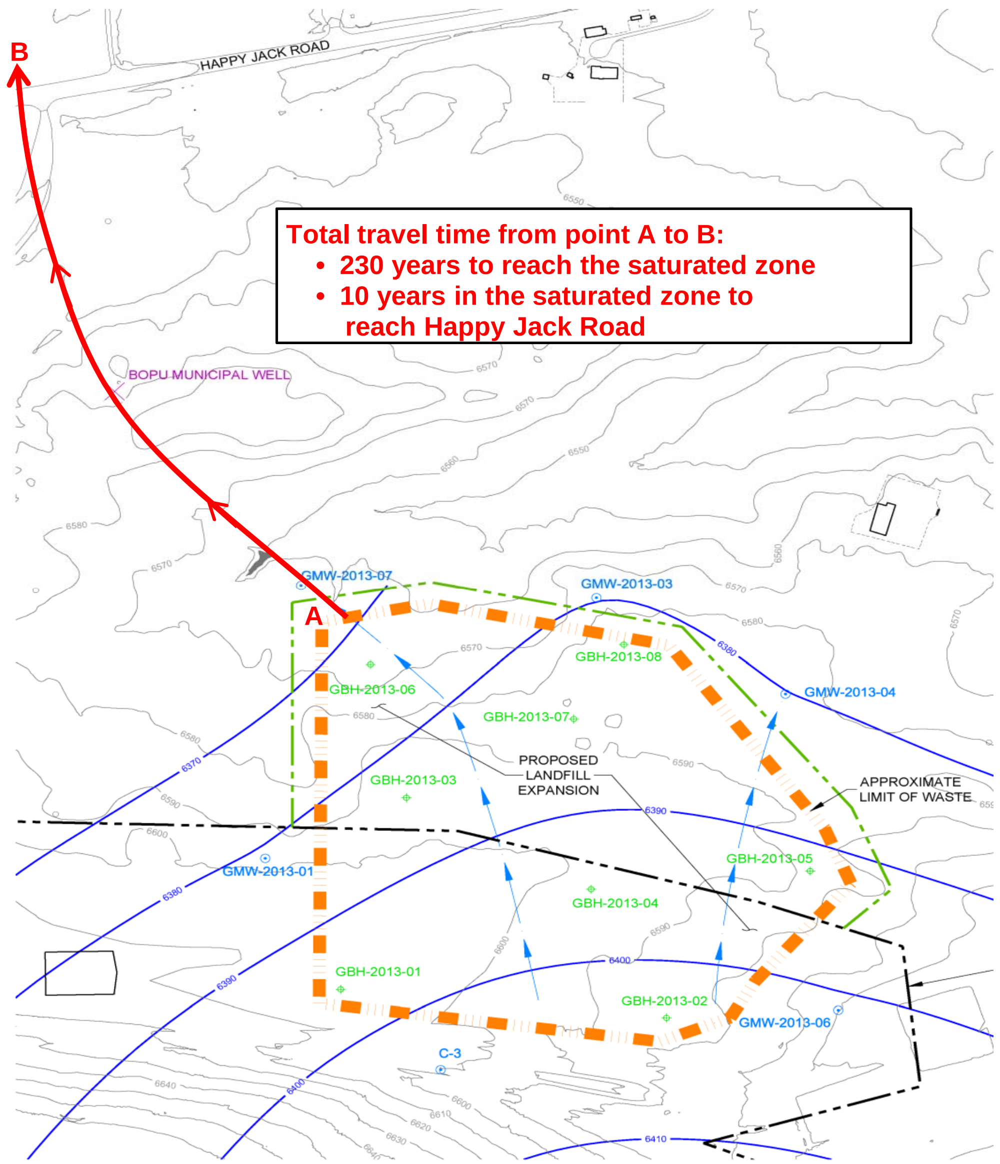


Total travel time from point A to B:

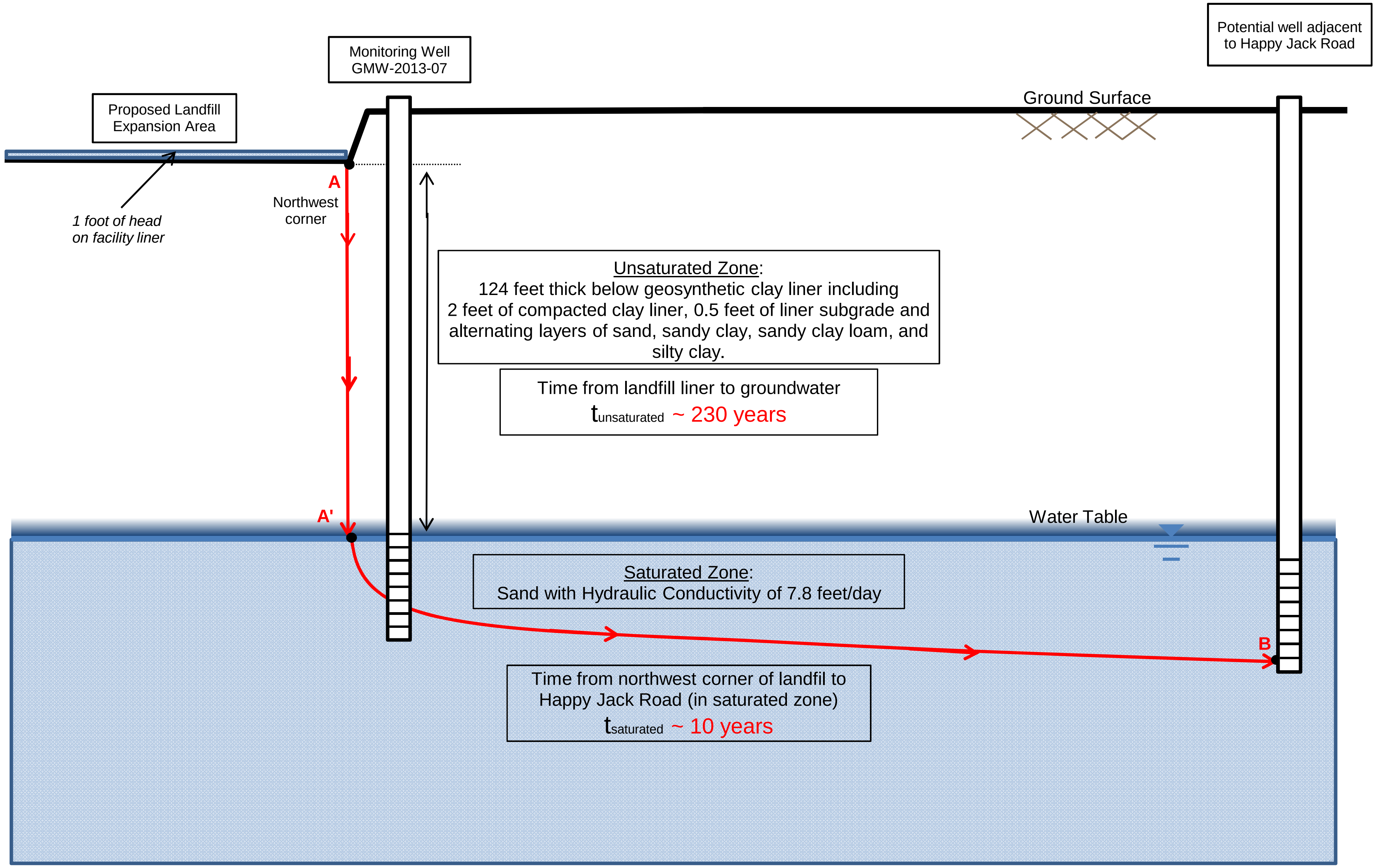
- **230 years to reach the saturated zone**
- **10 years in the saturated zone to reach Happy Jack Road**

🟧 ▪ 🟧 Approximate Limit of Waste

6400 Approximate Water Table Elevation (ft msl)
10-foot contour interval shown

Approximate Flow Line showing assumed pathway in groundwater

A Point of interest on vertical cross-section



<u>Unsaturated Zone</u>:
124 feet thick below geosynthetic clay liner including 2 feet of compacted clay liner, 0.5 feet of liner subgrade and alternating layers of sand, sandy clay, sandy clay loam, and silty clay.

Time from landfill liner to groundwater
$t_{unsaturated}$ ~ 230 years

<u>Saturated Zone</u>:
Sand with Hydraulic Conductivity of 7.8 feet/day

Time from northwest corner of landfil to Happy Jack Road (in saturated zone)
$t_{saturated}$ ~ 10 years

Schematic cross-section (not to scale)

Figure 5

Conceptual Site Model for Hypothetical Contaminant Transport

City of Cheyenne, Laramie County, Wyoming
Happy Jack Landfill Expansion
Golder Associates

Denver, Colorado, USA
1/3/2014 123-81971

J:\12JOBS\123-81971 Happy Jack LF Expansion\3 - Field Program\SITE CHARACTERIZATION REPORT\Travel time calcs\[Happy Jack LF_travel time figure Rev4.xlsx]1

APPENDIX A
BORING LOGS

RECORD OF BOREHOLE GBH-2013-01

SHEET 1 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: 81.0 ft
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/19/2013 11:33:52 AM	N: 232,247.14 E: 700,582.55	ELEVATION W.L.: 6532.8 ft
	DRILLED DEPTH: 94.5 ft	GS ELEVATION: 6613.8 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
0		0.0-0.5ft ASPHALT		■							
1		0.5-4.0ft (SM) SILTY SAND		░	0.0-2.0	SS-1	SS	11-12-16-20	28	1.80 2.00	0.5-1.8ft (SM) SILTY SAND, fine to coarse grained, well graded, dark brown, homogeneous, moist, compact
2	6612		SM	░							
3				░							
4	6610	4.0-10.1ft (ML) SILT		▥							
5				▥	4.0-6.0	SS-2	SS	4-7-8-9	15	2.00 2.00	4.0-6.0ft (ML) clayey SILT, low plasticity, some fine to coarse sand, dark brown, homogeneous, moist, stiff
6	6608			▥							
7			ML	▥							
8	6606			▥							
9				▥							
10	6604	10.1-20.0ft (SM) SILTY SAND		░	9.0-11.0	SS-3	SS	12-14-24-30	38	2.00 2.00	9.0-10.1ft (ML) SILT, low plasticity, some fine to coarse sand, some clay, dark brown, homogeneous, moist, hard 10.1-11.0ft (SM) SILTY SAND, fine to coarse grained, well graded, some fine gravel, dark tan, homogeneous, moist, dense
11				░							
12	6602			░							
13				░							
14	6600			░							
15		15.0-20.0ft (SM) SILTY SAND	SM	░	14.0-16.0	SS-4	SS	7-34-38-18	72	2.00 2.00	14.0-16.0ft (SM) SILTY SAND, fine to coarse grained, well graded, some fine gravel, dark tan, homogeneous, moist, very dense
16	6598			░							
17			SM	░							
18	6596			░	16.0-19.0	G-1	GRAB			3.00	16.0-19.0ft Composite grab sample collected from auger cuttings.
19				░	19.0-19.9	MC-1	MC	38-50/5"	Refusal	0.90 0.90	19.0-19.9ft (SM) SILTY SAND, fine to coarse grained, well graded, some fine gravel, some clay, dark tan, homogeneous, moist, very dense
20	6594										

■ Asphalt

░ USCS Silty Sand (SM)

▥ USCS Silt (ML)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME 75	DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-01

SHEET 2 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/19/2013 11:33:52 AM
DRILLED DEPTH: 94.5 ft

COORDINATES:
N: 232,247.14 E: 700,582.55
GS ELEVATION: 6613.8 ft

DEPTH W.L.: 81.0 ft
ELEVATION W.L.: 6532.8 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
20		20.0-29.0ft (SM) SILTY SAND	SM	▥							
21											
22	6592										
23											
24	6590				24.0-26.0	SS-5	SS	10-19-25-30	44	2.00 2.00	24.0-26.0ft (SM) SILTY SAND, fine grained, poorly graded, light brown, homogeneous, moist, dense
25											
26	6588										
27											
28	6586										
29		29.0-44.0ft (CL) SILTY CLAY	CL	▨	29.0-31.0	SS-6	SS	7-19-30-25	49	2.00 2.00	29.0-31.0ft (CL) SILTY CLAY, low plasticity, light brown, homogeneous, moist, dense
30	6584										
31											
32	6582										
33											
34	6580				34.0-36.0	SS-7	SS	6-13-13-22	26	2.00 2.00	34.0-36.0ft (CL) SILTY CLAY, low plasticity, trace fine to medium sand, dark brown, homogeneous, moist, very stiff
35											
36	6578				36.0-39.0	G-2	GRAB			3.00	36.0-39.0ft Composite grab sample collected from auger cuttings.
37											
38	6576										
39					39.0-39.4	SS-8	SS	50/4"	Refusal	0.40 0.40	39.0-39.4ft (CL) SILTY CLAY, medium plasticity, trace fine sand, tan, homogeneous, dry, hard
40	6574										

■ Asphalt
▥ USCS Silty Sand (SM)
▥ USCS Silt (ML)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-01

SHEET 3 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/19/2013 11:33:52 AM
DRILLED DEPTH: 94.5 ft

COORDINATES:
N: 232,247.14 E: 700,582.55
GS ELEVATION: 6613.8 ft

DEPTH W.L.: 81.0 ft
ELEVATION W.L.: 6532.8 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
40				▨							
41				▨							
42	6572		CL	▨							
43				▨							
44	6570	44.0-51.0ft (SC) CLAYEY SAND		▨	44.0-45.5	SS-9	SS	32-35-50	85	1.50 1.50	44.0-45.5ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some silt, light brown, moist, very dense
45				▨							
46	6568			▨							
47				▨							
48	6566		SC	▨							
49				▨	49.0-51.0	SS-10	SS	11-21-33-46	54	2.00 2.00	49.0-51.0ft (SC) CLAYEY SAND, low plasticity, trace fine gravel, dark brown, homogeneous, moist, hard
50	6564			▨							
51		51.0-64.0ft (CL) SILTY CLAY		▨							
52	6562			▨							
53				▨							
54	6560			▨	54.0-54.9	MC-2	MC	24-50/4"	Refusal	0.90 0.90	54.0-54.9ft (CL) sandy SILTY CLAY, medium plasticity, light brown, homogeneous, moist, hard
55				▨							
56	6558		CL	▨							
57				▨							
58	6556			▨							
59				▨	59.0-60.9	SS-11	SS	9-25-35-50/4"	60	1.90 1.90	59.0-60.9ft (CL) sandy SILTY CLAY, medium plasticity, trace fine gravel, light brown, homogeneous, moist, hard
60	6554										

■ Asphalt

▥ USCS Silty Sand (SM)

▥ USCS Silt (ML)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-01

SHEET 4 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/19/2013 11:33:52 AM
DRILLED DEPTH: 94.5 ft

COORDINATES:
N: 232,247.14 E: 700,582.55
GS ELEVATION: 6613.8 ft

DEPTH W.L.: 81.0 ft
ELEVATION W.L.: 6532.8 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
60 61 62 63	6552		CL	▨	59.0-60.9	SS-11	SS	9-25-35-50/4"	60	1.90 1.90	59.0-60.9ft (CL) sandy SILTY CLAY, medium plasticity, trace fine gravel, light brown, homogeneous, moist, hard
64 65 66 67 68	6550 6548 6546	64.0-79.0ft (SC) CLAYEY SAND	SC	▨	64.0-64.4	SS-12	SS	50/5"	Refusal	0.40 0.40	64.0-64.4ft (SC) CLAYEY SAND, fine to coarse grained, well graded, medium plasticity, light tan, homogeneous, strong HCL reaction, dry, very dense
69 70 71 72 73	6544 6542			▨	69.0-69.2	None	SS	50/2"	Refusal	0.20 0.20	69.0-69.2ft (SC) CLAYEY SAND, fine to coarse grained, well graded, light tan, homogeneous, strong HCL reaction, dry, very dense
74 75 76 77 78	6540 6538 6536			▨	74.0-74.1	None	SS	50/1"	Refusal	0.10 0.10	74.0-74.1ft (SC) CLAYEY SAND, fine to coarse grained, well graded, light tan, homogeneous, strong HCL reaction, dry, very dense
79 80	6534	79.0-94.5ft (CL) SILTY CLAY	CL	▨	79.0-80.0	SS-13	SS	46-50	Refusal	1.00 1.00	79.0-80.0ft (CL) SILTY CLAY, medium plasticity, some fine to medium sand, tan, homogeneous, strong HCL reaction, moist, hard

■ Asphalt
▥ USCS Silty Sand (SM)
▥ USCS Silt (ML)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-01

SHEET 5 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/19/2013 11:33:52 AM
DRILLED DEPTH: 94.5 ft

COORDINATES:
N: 232,247.14 E: 700,582.55
GS ELEVATION: 6613.8 ft

DEPTH W.L.: 81.0 ft
ELEVATION W.L.: 6532.8 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
80				▨							
81				▨							
82	6532			▨							
83				▨							
84	6530			▨	84.0-85.3	SS-14	SS	15-32-50/3"	Refusal	1.30 / 1.30	84.0-85.3ft (CL) SILTY CLAY, medium plasticity, trace fine gravel, some fine to coarse sand, tan, homogeneous, strong HCL reaction, moist, hard
85				▨							
86	6528			▨							
87			CL	▨							
88	6526			▨							
89				▨	89.0-89.9	SS-15	SS	31-50/5"	Refusal	0.90 / 0.90	89.0-89.9ft (CL) SILTY CLAY, medium plasticity, trace fine gravel, some fine to coarse sand, tan, homogeneous, strong HCL reaction, moist, hard
90	6524			▨							
91				▨							
92	6522			▨							
93				▨							
94	6520			▨	94.0-94.5	SS-16	SS	50/6"	Refusal	0.00 / 0.50	94.0-94.5ft Refusal, no recovery

Borehole terminated at 94.5-ft depth.

■ Asphalt	▥ USCS Silty Sand (SM)	▥ USCS Silt (ML)	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-02

SHEET 1 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/18/2013 2:01:11 PM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 232,145.11 E: 701,622.82
GS ELEVATION: 6585.0 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
0		0.0-0.3ft (OL) TOPSOIL 0.3-4.0ft (SM) SILTY SAND	OL								
1	6584				0.0-2.0	SS-1	SS	4-5-4-5	9	1.10 2.00	0.0-0.3ft (OL) ORGANIC SILT, low plasticity, dark brown, homogeneous, dry, stiff 0.3-1.1ft (SM) SILTY SAND, fine grained, poorly graded, trace clay, trace fine gravel, dark tan brown, homogeneous, moist, loose
2			SM								
3	6582										
4		4.0-9.4ft (SC) CLAYEY SAND									
5	6580				4.0-6.0	SS-2	SS	15-19-16-17	35	1.80 2.00	4.0-5.8ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace silt, trace fine gravel, light tan, homogeneous, dry, dense
6											
7	6578		SC								
8											
9	6576										
10		9.4-18.0ft (ML) SILT			9.0-11.0	SS-3	SS	9-11-13-19	24	2.00 2.00	9.0-9.4ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace silt, trace fine gravel, light tan, homogeneous, moist, compact 9.4-11.0ft (ML) clayey SILT, low plasticity, trace fine sand, dark tan, homogeneous, moist, very stiff
11	6574										
12											
13	6572		ML								
14											
15	6570				14.0-15.5	MC-1	MC	12-22-30	52	1.50 1.50	14.0-15.5ft (ML) clayey SILT, low plasticity, trace fine sand, dark tan, homogeneous, moist, hard
16											
17	6568				15.5-18.0	G-1	GRAB			2.50	15.5-18.0ft Composite grab sample collected from auger cuttings.
18		18.0-22.0ft (SM) SILTY SAND									
19	6566		SM		19.0-21.0	SS-4	SS	15-26-28-26	54	1.70 2.00	19.0-20.7ft (SM) SILTY SAND, fine to coarse grained, well graded, trace clay, trace fine gravel, light tan, homogeneous, moist, very dense
20											

⁘ Topsoil	⁞ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)	▥ USCS Silt (ML)	▨ USCS Low Plasticity Clay (CL)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-02

SHEET 2 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/18/2013 2:01:11 PM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 232,145.11 E: 701,622.82
GS ELEVATION: 6585.0 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
20				▥	19.0-21.0	SS-4	SS	15-26-28-26	54	1.70 / 2.00	
21	6564		SM	▥							
22		22.0-36.0ft (SC) CLAYEY SAND		▨							
23	6562			▨							
24				▨							
25	6560			▨	24.0-25.9	SS-5	SS	10-20-32-50/4"	52	1.90 / 1.90	24.0-25.9ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine to coarse gravel, light tan, homogeneous, moist, very dense
26				▨							
27	6558			▨							
28				▨							
29	6556		SC	▨							
30				▨	29.0-31.0	SS-6	SS	10-17-23-33	40	2.00 / 2.00	29.0-31.0ft (SC) CLAYEY SAND, low plasticity, some fine to coarse sand, light brown, homogeneous, moist, dense
31	6554			▨							
32				▨							
33	6552			▨							
34				▨							
35	6550			▨	34.0-36.0	SS-7	SS	11-23-29-31	52	2.00 / 2.00	34.0-36.0ft (SC) CLAYEY SAND, low plasticity, some fine to coarse sand, light brown, homogeneous, moist, very dense
36		36.0-44.0ft (SM) SILTY SAND		▥							
37	6548			▥	35.0-39.0	G-2	GRAB			4.00	35.0-39.0ft Composite grab sample collected from auger cuttings.
38			SM	▥							
39	6546			▥	39.0-40.5	MC-2	MC	19-27-50	77	1.50 / 1.50	39.0-40.5ft (SM) SILTY SAND, fine to coarse grained, well graded, trace fine gravel, dark tan, homogeneous, moist, very dense
40											

▤	Topsoil
▥	USCS Silty Sand (SM)
▨	USCS Clayey Sand (SC)
▥	USCS Silt (ML)
▨	USCS Low Plasticity Clay (CL)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-02

SHEET 3 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/18/2013 2:01:11 PM	N: 232,145.11 E: 701,622.82	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6585.0 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
40					39.0-40.5	MC-2	MC	19-27-50	77	1.50 1.50	
41	6544										
42			SM								
43	6542										
44		44.0-52.0ft (SC) CLAYEY SAND			44.0-44.8	SS-8	SS	24-50/3"	Refusal	0.80 0.80	44.0-44.8ft (SC) CLAYEY SAND, fine to coarse grained, well graded, light tan, homogeneous, moist, very dense
45	6540										
46											
47	6538										
48			SC								
49	6536				49.0-49.8	SS-9	SS	33-50/4"	Refusal	0.80 0.80	49.0-49.8ft (SC) CLAYEY SAND, fine grained, poorly graded, some silt, trace fine gravel, light tan, homogeneous, moist, very dense
50											
51	6534										
52		52.0-64.0ft (SM) SILTY SAND									
53	6532										
54					54.0-54.7	SS-10	SS	34-50/2"	Refusal	0.70 0.70	54.0-54.7ft (SM) SILTY SAND, fine to medium grained, poorly graded, trace coarse sand, light tan, homogeneous, moist, very dense
55	6530										
56			SM								
57	6528										
58											
59	6526				59.0-60.4	SS-11	SS	13-26-50/4"	Refusal	1.40 1.40	59.0-60.4ft (SM) SILTY SAND, fine to medium grained, poorly graded, trace coarse sand, light tan, homogeneous, moist, very dense
60											

⁘ Topsoil	▥ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)	▥ USCS Silt (ML)	▨ USCS Low Plasticity Clay (CL)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-02

SHEET 4 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/18/2013 2:01:11 PM	N: 232,145.11 E: 701,622.82	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6585.0 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
60				▥	59.0-60.4	SS-11	SS	13-26-50/4"	Refusal		
61	6524			▥							
62			SM	▥							
63	6522			▥							
64		64.0-87.0ft (SC) CLAYEY SAND		▨	64.0-65.3	SS-12	SS	14-41-50/3"	Refusal	1.30 1.30	64.0-65.3ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, moist, very dense
65	6520			▨							
66				▨							
67	6518			▨							
68				▨							
69	6516			▨	69.0-69.0	None	SS	50/0"	Refusal	0.00 0.00	69.0ft Refusal, no recovery
70				▨							
71	6514			▨							
72			SC	▨							
73	6512			▨							
74				▨	74.0-75.0	SS-13	SS	34-50	Refusal	1.00 1.00	74.0-75.0ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some silt, trace fine gravel, light tan, homogeneous, moist, very dense
75	6510			▨							
76				▨							
77	6508			▨							
78				▨							
79	6506			▨	79.0-79.2	SS-14	SS	50/2"	Refusal	0.20 0.20	79.0-79.2ft (SC) CLAYEY SAND, fine to coarse grained, well graded, low plasticity, trace fine gravel, light tan, homogeneous, moist, very dense
80											

⁘ Topsoil	▥ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)	▥ USCS Silt (ML)	▨ USCS Low Plasticity Clay (CL)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME-75	DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-02

SHEET 5 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/18/2013 2:01:11 PM	N: 232,145.11 E: 701,622.82	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6585.0 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
80			SC	▨							
81	6504										
82											
83	6502										
84					84.0-84.3	SS-15	SS	50/3"	Refusal	0.30 0.30	84.0-84.3ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, light tan, homogeneous, moist, very dense
85	6500										
86											
87	6498	87.0-92.0ft (CL) SILTY CLAY	CL	▨							
88											
89	6496				89.0-90.4	SS-16	SS	18-33-50/5"	Refusal	1.40 1.40	89.0-90.4ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, trace fine gravel, dark tan, homogeneous, moist, hard
90											
91	6494										
92		92.0-99.4ft (SC) CLAYEY SAND	SC	▨							
93	6492										
94					94.0-94.9	SS-17	SS	34-50/4"	Refusal	0.40 0.90	94.0-94.4ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, light tan, homogeneous, strong HCL reaction, moist, very dense
95	6490										
96											
97	6488										
98											
99	6486				99.0-99.4	SS-18	SS	50/5"	Refusal	0.00 0.40	99.0-99.4ft Refusal, no recovery

Borehole terminated at 99.4-ft depth.

▨ Topsoil	▨ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)	▨ USCS Silt (ML)	▨ USCS Low Plasticity Clay (CL)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME-75	DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-03

SHEET 1 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/20/2013 11:18:55 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 232,933.64 E: 700,793.79
GS ELEVATION: 6594.8 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
0 1	6594	0.0-14.0ft (CL) SILTY CLAY	CL	▨	0.0-2.0	SS-1	SS	4-5-7-4	12	1.20 / 2.00	0.0-1.2ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, brown, homogeneous, dry, stiff
2 3	6592										
4 5	6590				4.0-6.0	SS-2	SS	7-10-11-12	21	1.30 / 2.00	4.0-5.3ft (CL) sandy SILTY CLAY, medium plasticity, dark yellowish brown, homogeneous, moist, very stiff
6 7 8	6588				6.0-20.0	G-1	GRAB			14.00	6.0-20.0ft Composite grab sample collected from auger cuttings.
9 10	6586				9.0-11.0	SS-3	SS	8-14-19-20	33	1.80 / 2.00	9.0-10.8ft (CL) sandy SILTY CLAY, poorly graded, medium plasticity, some clay, light brown, homogeneous, dry, hard
11 12 13	6584 6582										
14		14.0-15.0ft (SW) SAND	SW	⁘	14.0-16.0	SS-4	SS	18-20-22-24	42	1.90 / 2.00	14.0-15.0ft (SW) gravelly SAND, fine to coarse grained, well graded, trace silt, tan, homogeneous, dry, dense 15.0-15.9ft (CL) sandy SILTY CLAY, poorly graded, medium plasticity, light brown, homogeneous, dry, hard
15	6580	15.0-19.0ft (CL) SILTY CLAY	CL	▨							
16 17 18	6578										
19 20	6576	19.0-21.0ft (SC-SM) silty CLAYEY SAND	SC-SM	▥	19.0-21.0	SS-5	SS	12-23-33-43	56	1.90 / 2.00	19.0-20.9ft (SC-SM) silty CLAYEY SAND, poorly graded, low plasticity, light yellowish brown, homogeneous, dry, hard

▨ USCS Low Plasticity Clay (CL)
⁘ USCS Well-graded Sand (SW)
▥ USCS Clayey Sand (SC-SM)
○ USCS Poorly-graded Gravel (GP)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-03

SHEET 2 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/20/2013 11:18:55 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 232,933.64 E: 700,793.79
GS ELEVATION: 6594.8 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
20	6574		SC-SM	▥	19.0-21.0	SS-5	SS	12-23-33-43	56	1.90 2.00	19.0-20.9ft (SC-SM) silty CLAYEY SAND, poorly graded, low plasticity, light yellowish brown, homogeneous, dry, hard
21		21.0-25.0ft (CL) SILTY CLAY	CL	▨	21.0-40.0	G-2	GRAB			19.00	21.0-40.0ft Composite grab sample collected from auger cuttings.
24	6572				24.0-24.0	None	SS	50/0"	Refusal	0.00 0.00	24.0ft Refusal, no recovery
25	6570	25.0-27.0ft (GP) GRAVEL	GP								
27	6568	27.0-33.0ft (CL) SILTY CLAY	CL	▨							
29	6566				29.0-29.3	MC-1	SS	50/3"	Refusal	0.30 0.30	29.0-29.3ft Refusal, no sample collected
33	6564 6562	33.0-39.0ft (SC) CLAYEY SAND	SC	▨							
34	6560				34.0-35.4	SS-6	SS	31-40-50/4"	Refusal	1.30 1.40	34.0-35.3ft (SC) CLAYEY SAND, fine to coarse grained, well graded, light brown, homogeneous, moist, very dense
39	6558 6556	39.0-44.0ft (SP) SAND	SP		39.0-39.8	MC-2	MC	48-50/3"	Refusal	0.50 0.80	39.0-39.5ft (SP) SAND, coarse grained, poorly graded, trace silt, tan, homogeneous, dry, very dense
40											

▨ USCS Low Plasticity Clay (CL)
▒ USCS Well-graded Sand (SW)
▥ USCS Clayey Sand (SC-SM)
○ USCS Poorly-graded Gravel (GP)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-03

SHEET 3 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/20/2013 11:18:55 AM	N: 232,933.64 E: 700,793.79	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6594.8 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC/ATT (ft)	SAMPLE DESCRIPTION
40 41 42 43	6554 6552		SP	░							
44 45 46 47 48	6550 6548 6546	44.0-49.0ft (ML) clayey SILT	ML	▥	44.0-44.9	SS-7	SS	30-50/5"	Refusal	0.90/0.90	44.0-44.9ft (ML) clayey SILT, low plasticity, some fine sand, light brown, homogeneous, dry, hard
49 50 51 52 53	6544 6542	49.0-59.0ft (CL) SILTY CLAY	CL	▨	49.0-50.4	SS-8	SS	14-39-50/5"	Refusal	1.40/1.40	49.0-50.4ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, light brown, homogeneous, dry, hard
54 55 56 57 58	6540 6538 6536		CL	▨	54.0-54.8	MC-3	MC	34-50/3"	Refusal	0.80/0.80	54.0-54.8ft (CL) SILTY CLAY, medium plasticity, trace fine to coarse sand, light brown, homogeneous, moist, hard
59 60		59.0-64.0ft (SC) CLAYEY SAND	SC	▨	59.0-60.4	SS-9	SS	23-37-50/5"	Refusal	1.40/1.40	59.0-60.4ft (SC) CLAYEY SAND, medium plasticity, light brown, homogeneous, moist, hard

▨ USCS Low Plasticity Clay (CL)

░ USCS Well-graded Sand (SW)

▥ USCS Clayey Sand (SC-SM)

○ USCS Poorly-graded Gravel (GP)

▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-03

SHEET 4 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/20/2013 11:18:55 AM	N: 232,933.64 E: 700,793.79	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6594.8 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
60				▨	59.0-60.4	SS-9	SS	23-37-50/5"	Refusal		
61	6534			▨							
62			SC	▨							
63	6532			▨							
64		64.0-74.0ft (MH) sandy CLAYEY SILT		▥	64.0-64.1	SS-10	SS	50/1"	Refusal	0.10 0.10	64.0-64.1ft (MH) sandy CLAYEY SILT, medium plasticity, light tan, homogeneous, strong HCL reaction, dry, hard
65	6530			▥							
66				▥							
67	6528			▥							
68				▥							
69	6526		MH	▥	69.0-69.3	SS-11	SS	50/4"	Refusal	0.30 0.30	69.0-69.3ft (MH) sandy CLAYEY SILT, medium plasticity, light tan, homogeneous, strong HCL reaction, dry, hard
70				▥							
71	6524			▥							
72				▥							
73	6522			▥							
74		74.0-84.0ft (CL) SILTY CLAY		▨	74.0-74.4	SS-12	SS	50/5"	Refusal	0.40 0.40	74.0-74.4ft (CL) sandy SILTY CLAY, medium plasticity, trace fine gravel, light tan, homogeneous, strong HCL reaction, moist, hard
75	6520			▨							
76				▨							
77	6518		CL	▨							
78				▨							
79	6516			▨	79.0-81.0	SS-13	SS	19-28-43-23	71	2.00 2.00	79.0-81.0ft (CL) SILTY CLAY, medium plasticity, trace fine gravel, some fine to coarse sand, light brown, homogeneous, strong HCL reaction, moist, hard
80											

▨ USCS Low Plasticity Clay (CL)

⁙ USCS Well-graded Sand (SW)

▥ USCS Clayey Sand (SC-SM)

○ USCS Poorly-graded Gravel (GP)

▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-03

SHEET 5 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/20/2013 11:18:55 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 232,933.64 E: 700,793.79
GS ELEVATION: 6594.8 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
80			CL	▨	79.0-81.0	SS-13	SS	19-28-43-23	71	2.00 2.00	79.0-81.0ft (CL) SILTY CLAY, medium plasticity, trace fine gravel, some fine to coarse sand, light brown, homogeneous, strong HCL reaction, moist, hard
81	6514										
82											
83	6512										
84		84.0-99.4ft (SC) CLAYEY SAND	SC	▨	84.0-84.5	SS-14	SS	50	Refusal	0.50 0.50	84.0-84.5ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, dark tan, homogeneous, strong HCL reaction, moist, very dense
85	6510										
86											
87	6508										
88											
89	6506				89.0-89.9	SS-15	SS	28-50/4"	Refusal	0.80 0.90	89.0-89.8ft (SC) CLAYEY SAND, medium to coarse grained, poorly graded, trace fine gravel, dark tan, homogeneous, weak HCL reaction, moist, very dense
90											
91	6504										
92											
93	6502										
94					94.0-94.5	SS-16	SS	50-6"	Refusal	0.50 0.50	94.0-94.5ft (SC) CLAYEY SAND, medium to coarse grained, poorly graded, trace fine gravel, light tan, homogeneous, moderate HCL reaction, moist, very dense
95	6500										
96											
97	6498										
98											
99	6496				99.0-99.4	SS-17	SS	50/5"	Refusal	0.40 0.40	99.0-99.4ft (SC) CLAYEY SAND, medium to coarse grained, poorly graded, trace fine gravel, light tan, homogeneous, moist, very dense

Borehole terminated at 99.4-ft depth.

▨ USCS Low Plasticity Clay (CL)
⁘ USCS Well-graded Sand (SW)
▥ USCS Clayey Sand (SC-SM)
○ USCS Poorly-graded Gravel (GP)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-04

SHEET 1 of 6

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/17/2013 2:01:11 PM
DRILLED DEPTH: 100.9 ft

COORDINATES:
N: 232,606.08 E: 701,381.52
GS ELEVATION: 6597.9 ft

DEPTH W.L.: 70.0 ft
ELEVATION W.L.: 6527.9 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
0		0.0-0.2ft (OL) TOPSOIL 0.2-5.8ft (CL) SILTY CLAY	OL								
1					0.0-2.0	SS-1	SS	6-5-8-9	13	1.70 2.00	0.2-1.7ft (CL) sandy SILTY CLAY, medium plasticity, trace fine to coarse gravel, dark tan brown, homogeneous, moist, stiff
2	6596										
3			CL								
4	6594										
5											5.0-5.8ft (CL) sandy SILTY CLAY, medium plasticity, trace fine to coarse gravel, dark tan brown, homogeneous, moist, hard
6	6592	5.8-11.1ft (SC) CLAYEY SAND			5.0-7.0	SS-2	SS	9-20-21-22	41	2.00 2.00	5.8-7.0ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace silt, pale brown, homogeneous, moist, dense
7											
8	6590		SC								
9											
10	6588										10.0-11.1ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace silt, pale brown, homogeneous, moist, very dense
11		11.1-20.0ft (CL) SILTY CLAY			10.0-11.5	SS-3	SS	16-17-50	67	1.50 1.50	11.1-11.5ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, light brown, homogeneous, moist, hard
12	6586										
13											
14	6584										
15			CL								
16	6582				15.0-17.0	SS-4	SS	3-17-25-17	42	2.00 2.00	15.0-17.0ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, light brown, homogeneous, moist, hard
17											
18	6580										
19					17.0-20.0	G-1	GRAB			3.00	17.0-20.0ft Composite grab sample collected from auger cuttings.
20	6578										

Topsoil

USCS Low Plasticity Clay (CL)

USCS Clayey Sand (SC)

USCS Well-graded Sand (SW)

USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-04

SHEET 2 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: 70.0 ft
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/17/2013 2:01:11 PM	N: 232,606.08 E: 701,381.52	ELEVATION W.L.: 6527.9 ft
	DRILLED DEPTH: 100.9 ft	GS ELEVATION: 6597.9 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
20		20.0-24.0ft (SW) SAND	SW	⁘	20.0-21.5	SS-5	SS	31-47-50	97	1.50 / 1.50	20.0-21.5ft (SW) gravelly SAND, fine to coarse grained, well graded, trace silt, pale brown, homogeneous, moist, very dense
21											
22	6576										
23											
24	6574	24.0-40.0ft (SC) CLAYEY SAND	SC	▨							
25					25.0-27.0	SS-6	SS	19-25-30-34	55	2.00 / 2.00	25.0-27.0ft (SC) CLAYEY SAND, fine grained, poorly graded, dark tan brown, homogeneous, moist, very dense
26	6572										
27											
28	6570										
29											
30	6568				30.0-32.0	SS-7	SS	9-22-31-45	53	2.00 / 2.00	30.0-32.0ft (SC) CLAYEY SAND, fine grained, poorly graded, dark tan brown, homogeneous, moist, very dense
31											
32	6566				32.0-35.0	G-2	GRAB			3.00	32.0-35.0ft Composite grab sample collected from auger cuttings.
33											
34	6564										
35					35.0-37.0	SS-8	SS	10-25-30-33	55	2.00 / 2.00	35.0-37.0ft (SC) CLAYEY SAND, fine grained, poorly graded, medium plasticity, trace fine gravel, dark yellowish brown, homogeneous, moist, very dense
36	6562										
37											
38	6560										
39											
40	6558										

⁘ Topsoil

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

⁘ USCS Well-graded Sand (SW)

▥ USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-04

SHEET 3 of 6

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/17/2013 2:01:11 PM
DRILLED DEPTH: 100.9 ft

COORDINATES:
N: 232,606.08 E: 701,381.52
GS ELEVATION: 6597.9 ft

DEPTH W.L.: 70.0 ft
ELEVATION W.L.: 6527.9 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
40		40.0-47.0ft (CL) SILTY CLAY	CL	▨							
41					40.0-42.0	SS-9	SS	20-20-24-40	44	2.00 / 2.00	40.0-42.0ft (CL) sandy SILTY CLAY, medium plasticity, trace coarse sand, dark tan brown, homogeneous, moist, hard
42	6556										
43											
44	6554										
45											
46	6552				45.0-47.0	SS-10	SS	9-21-24-30	45	1.30 / 2.00	45.0-46.3ft (CL) sandy SILTY CLAY, medium plasticity, some clay, trace coarse sand, dark tan brown, homogeneous, moist, hard
47		47.0-75.0ft (SC) CLAYEY SAND	SC	▨							
48	6550										
49											
50	6548				50.0-50.5	SS-11	SS	50	Refusal	0.50 / 0.50	50.0-50.5ft (SC) CLAYEY SAND, fine and coarse grained, gap graded, some fine gravel, light tan, homogeneous, dry, very dense
51											
52	6546										
53											
54	6544										
55					55.0-55.4	SS-12	SS	50/5"	Refusal	0.40 / 0.40	55.0-55.4ft (SC) CLAYEY SAND, fine and coarse grained, gap graded, some fine gravel, light tan, homogeneous, dry, very dense
56	6542										
57											
58	6540										
59											
60	6538										

⛆ Topsoil	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)	⁘ USCS Well-graded Sand (SW)	▥ USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-04

SHEET 4 of 6

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/17/2013 2:01:11 PM
DRILLED DEPTH: 100.9 ft

COORDINATES:
N: 232,606.08 E: 701,381.52
GS ELEVATION: 6597.9 ft

DEPTH W.L.: 70.0 ft
ELEVATION W.L.: 6527.9 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
60			SC	▨	60.0-61.4	SS-13	SS	35-40-50/5"	Refusal	1.40 1.40	60.0-61.4ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine gravel, trace silt, light tan, homogeneous, dry, very dense
62	6536										
64	6534										
65					65.0-66.4	SS-14	SS	20-40-50/4"	Refusal	1.40 1.40	65.0-66.4ft (SC) CLAYEY SAND, fine grained, poorly graded, dark tan brown, homogeneous, moist, very dense
66	6532										
68	6530										
70	6528				70.0-71.4	SS-15	SS	22-33-55/4"	Refusal	1.40 1.40	70.0-71.4ft (SC) CLAYEY SAND, fine grained, poorly graded, dark tan brown, homogeneous, moist, very dense
72	6526										
74	6524										
75		75.0-90.0ft (SM) SILTY SAND	SM	▥	75.0-75.3	SS-16	SS	50/3"	Refusal	0.30 0.30	75.0-75.3ft (SM) SILTY SAND, fine and coarse grained, gap graded, some fine gravel, light tan, homogeneous, dry, very dense
76	6522										
78	6520										
80	6518										

⛆	Topsoil
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
⁘	USCS Well-graded Sand (SW)
▥	USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

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DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-04

SHEET 5 of 6

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/17/2013 2:01:11 PM
DRILLED DEPTH: 100.9 ft

COORDINATES:
N: 232,606.08 E: 701,381.52
GS ELEVATION: 6597.9 ft

DEPTH W.L.: 70.0 ft
ELEVATION W.L.: 6527.9 ft
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
80					80.0-80.5	SS-17	SS	50	Refusal	0.50 0.50	80.0-80.5ft (SM) SILTY SAND, fine and coarse grained, gap graded, some fine gravel, light tan, homogeneous, moist, very dense
81											
82	6516										
83											
84	6514										
85			SM		85.0-86.1	SS-18	SS	14-36-50/1"	Refusal	1.10 1.10	85.0-86.1ft (SM) SILTY SAND, fine and coarse grained, gap graded, trace fine gravel, light tan, homogeneous, moist, very dense
86	6512										
87											
88	6510										
89											
90	6508	90.0-100.9ft (SC) CLAYEY SAND			90.0-91.4	SS-19	SS	11-17-50/5"	Refusal	1.40 1.40	90.0-91.4ft (SC) CLAYEY SAND, fine and coarse grained, gap graded, medium plasticity, trace fine gravel, light tan, homogeneous, moist, very dense
91											
92	6506										
93											
94	6504										
95			SC		95.0-95.4	SS-20	SS	50/5"	Refusal	0.40 0.40	95.0-95.4ft (SC) CLAYEY SAND, fine and coarse grained, gap graded, medium plasticity, trace fine gravel, light tan, homogeneous, moist, very dense
96	6502										
97											
98	6500										
99											
100	6498										

⛆	Topsoil
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
░	USCS Well-graded Sand (SW)
▥	USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-04

SHEET 6 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: 70.0 ft
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/17/2013 2:01:11 PM	N: 232,606.08 E: 701,381.52	ELEVATION W.L.: 6527.9 ft
	DRILLED DEPTH: 100.9 ft	GS ELEVATION: 6597.9 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
100			SC	▨	100.0-100.9	SS-21	SS	22-50/5"	Refusal	0.90 0.90	100.0-100.9ft (SC) CLAYEY SAND, fine and coarse grained, gap graded, medium plasticity, trace fine gravel, light tan, homogeneous, moist, very dense
		Borehole terminated at 100.9-ft depth.									

⁝ Topsoil	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)	⁘ USCS Well-graded Sand (SW)	▯ USCS Silty Sand (SM)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME 75	DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-05

SHEET 1 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/26/2013 8:14:56 AM	N: 232,672.02 E: 702,081.89	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.9 ft	GS ELEVATION: 6587.4 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
0		0.0-0.4ft (OL) TOPSOIL	OL	▭							
1	6586	0.4-9.0ft (SW) SAND	SW	⁘	0.0-2.0	SS-1	SS	6-4-3-3	7	1.50 / 2.00	0.4-1.5ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, some silty clay, dark tan, homogeneous, dry, loose
2 3 4	6584			⁘	2.0-18.0	G-1	GRAB			16.00	2.0-18.0ft Composite grab sample collected from auger cuttings.
5 6 7 8	6582 6580			⁘	4.0-6.0	SS-2	SS	13-21-18-22	39	1.40 / 2.00	4.0-5.4ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, some silty clay, dark orange tan, homogeneous, dry, dense
9 10	6578	9.0-10.3ft (CL) SILTY CLAY	CL	▨	9.0-11.0	SS-3	SS	8-17-25-44	42	2.00 / 2.00	9.0-10.3ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, dark orange tan, homogeneous, dry, hard 10.3-11.0ft (SW) SAND, fine to coarse grained, well graded, some silty clay, some fine to coarse gravel, tan, dry, dense
11 12 13 14 15	6576 6574 6572	10.3-24.0ft (SW) SAND	SW	⁘	14.0-16.0	SS-4	SS	18-26-18-19	44	2.00 / 2.00	14.0-16.0ft (SW) SAND, fine to coarse grained, well graded, orange tan, homogeneous, dry, dense
16 17 18 19 20	6570 6568			⁘	19.0-20.5	SS-5	SS	19-26-50	76	1.40 / 1.50	19.0-20.4ft (SW) SAND, fine to coarse grained, well graded, orange tan, homogeneous, dry, very dense

▭ Topsoil

⁘ USCS Well-graded Sand (SW)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

░ USCS Poorly-graded Sand (SP)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanagan	CHECKED BY: Rusch
DRILL RIG:	DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-05

SHEET 2 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/26/2013 8:14:56 AM	N: 232,672.02 E: 702,081.89	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.9 ft	GS ELEVATION: 6587.4 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
20			SW		19.0-20.5	SS-5	SS	19-26-50	76	1.40 1.50	
21	6566										
22											
23	6564										
24		24.0-24.5ft (CL) SILTY CLAY	CL		24.0-25.0	SS-6	SS	17-50	Refusal	1.00 1.00	24.0-24.5ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, dark orange tan, homogeneous, dry, hard 24.5-25.0ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, dry, dense
		24.5-29.0ft (SC) CLAYEY SAND	SC		23.0-36.0	G-2	GRAB			13.00	23.0-36.0ft Composite grab sample collected from auger cuttings.
25	6562										
26											
27	6560										
28											
29	6558	29.0-34.0ft (CL) SILTY CLAY	CL		29.0-29.5	MC-1	MC	50/6"	Refusal	0.30 0.50	29.0-29.3ft (CL) sandy SILTY CLAY, medium plasticity, some fine gravel, light brown, homogeneous, dry, hard
30											
31	6556										
32											
33	6554										
34		34.0-39.0ft (CL) SILTY CLAY	CL		34.0-34.8	SS-7	SS	18-50/3"	Refusal	0.80 0.80	34.0-34.8ft (CL) SILTY CLAY, medium plasticity, some fine sand, dark orange tan, homogeneous, dry, hard
35	6552										
36											
37	6550										
38											
39	6548	39.0-39.5ft (SW) SAND	SW CL		39.0-40.9	SS-8	SS	28-22-38-50/4.8"	60	1.90 1.90	39.0-39.5ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, dry, very dense
40											

Topsoil

USCS Well-graded Sand (SW)

USCS Low Plasticity Clay (CL)

USCS Clayey Sand (SC)

USCS Poorly-graded Sand (SP)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanagan	CHECKED BY: Rusch
DRILL RIG:	DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-05

SHEET 3 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/26/2013 8:14:56 AM
DRILLED DEPTH: 99.9 ft

COORDINATES:
N: 232,672.02 E: 702,081.89
GS ELEVATION: 6587.4 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
40		39.5-69.0ft (CL) SILTY CLAY		▨	39.0-40.9	SS-8	SS	28-22-38-50/4.8"	60	1.90 1.90	39.5-40.9ft (CL) sandy SILTY CLAY, medium plasticity, dark tan, homogeneous, dry, hard
41	6546										
42											
43	6544										
44					44.0-44.6	SS-9	SS	12-50/1.2"	Refusal	0.60 0.60	44.0-44.5ft (CL) sandy SILTY CLAY, medium plasticity, dark orange brown, homogeneous, dry, hard 44.5-44.6ft (CL) sandy SILTY CLAY, low plasticity, trace fine gravel, light tan, heterogeneous, dry, hard
45	6542										
46											
47	6540										
48											
49	6538				49.0-49.8	SS-10	SS	26-50/3"	Refusal	0.80 0.80	49.0-49.8ft (CL) gravelly SILTY CLAY, medium plasticity, some fine to coarse sand, light brown, homogeneous, moist, hard
50			CL								
51	6536										
52											
53	6534										
54					54.0-54.1	MC-2	SS	50/1.2"	Refusal	0.00 0.10	54.0ft Refusal, no recovery
55	6532										
56											
57	6530										
58											
59	6528				59.0-59.2	SS-11	SS	50/1.8"	Refusal	0.20 0.20	59.0-59.2ft (CL) sandy SILTY CLAY, low plasticity, light tan, heterogeneous, dry, hard
60											

▤	Topsoil
⁘	USCS Well-graded Sand (SW)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
░	USCS Poorly-graded Sand (SP)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-05

SHEET 4 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/26/2013 8:14:56 AM	N: 232,672.02 E: 702,081.89	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.9 ft	GS ELEVATION: 6587.4 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
60			CL	▨							
61	6526			▨							
62				▨							
63	6524			▨							
64				▨	64.0-66.0	SS-12	SS	11-19-40-50	59	2.00 2.00	64.0-66.0ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, some fine to coarse gravel, light brown, homogeneous, moist, hard
65	6522			▨							
66				▨							
67	6520			▨							
68				▨							
69	6518	69.0-84.0ft (SW) SAND	SW	⁙	69.0-69.5	SS-13	SS	50/6"	Refusal	0.50 0.50	69.0-69.5ft (SW) SAND, fine to coarse grained, well graded, some fine gravel, some silty clay, tan, homogeneous, dry, very dense
70				⁙							
71	6516			⁙							
72				⁙							
73	6514			⁙							
74				⁙	74.0-74.5	SS-14	SS	50/6"	Refusal	0.50 0.50	74.0-74.5ft (SW) SAND, fine to coarse grained, well graded, some fine gravel, some silty clay, tan, homogeneous, dry, compact
75	6512			⁙							
76				⁙							
77	6510			⁙							
78				⁙							
79	6508			⁙	79.0-79.1	None	SS	50/1.2"	Refusal	0.00 0.10	79.0ft Refusal, no recovery
80											

░ Topsoil	⁙ USCS Well-graded Sand (SW)	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)	░ USCS Poorly-graded Sand (SP)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanagan	CHECKED BY: Rusch
DRILL RIG:	DATE: 9/1/2013

RECORD OF BOREHOLE GBH-2013-05

SHEET 5 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/26/2013 8:14:56 AM
DRILLED DEPTH: 99.9 ft

COORDINATES:
N: 232,672.02 E: 702,081.89
GS ELEVATION: 6587.4 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
80 81 82 83	6506 6504		SW	⁘							
84 85 86 87 88	6502 6500	84.0-99.9ft (SC) CLAYEY SAND	SC	▨	84.0-85.0	SS-15	SS	25-50	Refusal	1.00 / 1.00	84.0-85.0ft (SC) CLAYEY SAND, fine grained, poorly graded, light brown, homogeneous, moist, dense
89 90 91 92 93	6498 6496 6494			▨	89.0-89.5	SS-16	SS	50/6"	Refusal	0.40 / 0.50	89.0-89.4ft (SC) CLAYEY SAND, fine grained, poorly graded, trace fine gravel, light brown, homogeneous, moist, very dense
94 95 96 97 98	6492 6490			▨	94.0-94.1	None	SS	50/1.2"	Refusal	0.00 / 0.10	94.0ft Refusal, no recovery
99	6488			▨	99.0-99.9	SS-17	SS	18-50/4.8"	Refusal	0.90 / 0.90	99.0-99.9ft (SC) CLAYEY SAND, fine grained, poorly graded, some fine to coarse gravel, light tan, homogeneous, moist, very dense

Borehole terminated at 99.9-ft depth.

⁘ Topsoil	⁘ USCS Well-graded Sand (SW)	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)	⁘ USCS Poorly-graded Sand (SP)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-06

SHEET 1 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/21/2013 8:52:18 AM	N: 233,412.96 E: 700,677.93	ELEVATION W.L.: NA
	DRILLED DEPTH: 101.0 ft	GS ELEVATION: 6567.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
0 1	6566	0.0-4.0ft (CL) SILTY CLAY	CL	▨	0.0-2.0	SS-1	SS	5-6-7-9	13	1.00 2.00	0.0-1.0ft (CL) SILTY CLAY, medium plasticity, trace coarse sand, dark brown, homogeneous, dry, firm
2 3	6564										
4 5	6562	4.0-14.0ft (SC) CLAYEY SAND	SC	▨	3.0-15.0 4.0-6.0	G-1 SS-2	GRAB SS	9-22-20-24	42	12.00 1.50 2.00	4.0-5.5ft (SC) CLAYEY SAND, low plasticity, some silt, light brown, homogeneous, dry, hard 3.0-15.0ft Composite grab sample collected from auger cuttings.
6 7 8	6560										
9 10	6558				9.0-10.3	SS-3	SS	11-26-50/4"	Refusal	1.30 1.30	9.0-9.5ft (SC) CLAYEY SAND, medium to coarse grained, poorly graded, medium plasticity, some silt, light brown, homogeneous, dry, very dense 9.5-10.3ft (SC) CLAYEY SAND, medium to coarse grained, poorly graded, medium plasticity, some fine gravel, some silt, tan, homogeneous, dry, very dense
11 12 13	6556 6554										
14 15	6552	14.0-19.0ft (SP) SAND	SP	░	14.0-16.0	SS-4	SS	13-27-34-35	61	2.00 2.00	14.0-16.0ft (SP) SAND, coarse grained, poorly graded, trace fine gravel, trace silt, tan, homogeneous, dry, very dense
16 17 18	6550										
19 20	6548	19.0-24.0ft (CL) SILTY CLAY	CL	▨	19.0-21.0	SS-5	SS	9-20-30-38	50	2.00 2.00	19.0-21.0ft (CL) SILTY CLAY, medium plasticity, some coarse sand, dark tan, homogeneous, moist, hard

▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)
░ USCS Poorly-graded Sand (SP)
▨ USCS High Plasticity Clay (CH)
░ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME-75	DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-06

SHEET 2 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/21/2013 8:52:18 AM	N: 233,412.96 E: 700,677.93	ELEVATION W.L.: NA
	DRILLED DEPTH: 101.0 ft	GS ELEVATION: 6567.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
20 21 22 23	6546 6544		CL	▨	19.0-21.0	SS-5	SS	9-20-30-38	50	2.00 2.00	19.0-21.0ft (CL) SILTY CLAY, medium plasticity, some coarse sand, dark tan, homogeneous, moist, hard
					21.0-40.0	G-2	GRAB			19.00	21.0-40.0ft Composite grab sample collected from auger cuttings.
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38	6542 6540 6538 6536 6534 6532 6530	24.0-39.0ft (SC) CLAYEY SAND	SC	▨	24.0-25.3	MC-1	MC	15-39-50/4"	Refusal	1.30 1.30	24.0-25.3ft (SC) CLAYEY SAND, low plasticity, tan, homogeneous, moist, hard
					29.0-30.9	SS-6	SS	16-26-32-50/5"	58	1.90 1.90	29.0-30.9ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some gravel, trace silt, light tan, homogeneous, moist, dense
					34.0-35.5	SS-7	SS	12-28-50	78	1.50 1.50	34.0-35.5ft (SC) CLAYEY SAND, medium plasticity, dark tan, homogeneous, moist, hard
39	6528	39.0-39.5ft (SW) SAND	SW	⁘	39.0-41.0	SS-8	SS	16-21-35-38	56	2.00 2.00	39.0-39.5ft (SW) SAND, fine to coarse grained, well graded, trace silt, tan, homogeneous, dry, very dense
40			CL	▨							

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

⁘ USCS Poorly-graded Sand (SP)

▨ USCS High Plasticity Clay (CH)

⁘ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-06

SHEET 3 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/21/2013 8:52:18 AM	N: 233,412.96 E: 700,677.93	ELEVATION W.L.: NA
	DRILLED DEPTH: 101.0 ft	GS ELEVATION: 6567.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
40		39.5-49.0ft (CL) sandy SILTY CLAY		▨	39.0-41.0	SS-8	SS	16-21-35-38	56	2.00 2.00	39.5-41.0ft (CL) sandy SILTY CLAY, medium plasticity, dark tan, homogeneous, dry, hard
41	6526			▨							
42				▨							
43	6524			▨							
44			CL	▨	44.0-45.0	SS-9	SS	15-50	Refusal	1.00 1.00	44.0-45.0ft (CL) sandy SILTY CLAY, medium plasticity, dark tan, homogeneous, dry, hard
45	6522			▨							
46				▨							
47	6520			▨							
48				▨							
49	6518	49.0-54.0ft (SC) CLAYEY SAND		▨	49.0-49.4	SS-10	SS	50/4"	Refusal	0.40 0.40	49.0-49.4ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine gravel, trace silt, tan, homogeneous, dry, dense
50				▨							
51	6516		SC	▨							
52				▨							
53	6514			▨							
54		54.0-64.0ft (CH) CLAY		▰							
55	6512			▰	54.0-56.0	SS-11	SS	15-27-36-45	63	2.00 2.00	54.0-56.0ft (CH) sandy CLAY, medium plasticity, some silt, dark tan, homogeneous, dry, hard
56				▰							
57	6510		CH	▰							
58				▰							
59	6508			▰	59.0-59.0	MC-2	MC			0.00 0.00	59.0ft Refusal, no sample recovery.
60											

▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)
⬚ USCS Poorly-graded Sand (SP)
▰ USCS High Plasticity Clay (CH)
⬚ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME-75	DATE: 9/1/2013

Golder Associates

RECORD OF BOREHOLE GBH-2013-06

SHEET 4 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/21/2013 8:52:18 AM	N: 233,412.96 E: 700,677.93	ELEVATION W.L.: NA
	DRILLED DEPTH: 101.0 ft	GS ELEVATION: 6567.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
60				▧							
61	6506										
62			CH								
63	6504										
64		64.0-69.0ft (SC) CLAYEY SAND		▨	64.0-65.5	SS-12	SS	17-14-50	64	1.50 / 1.50	64.0-65.5ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine gravel, some silt, tan, homogeneous, dry, very dense
65	6502										
66			SC								
67	6500										
68											
69	6498	69.0-79.0ft (SC) CLAYEY SAND			69.0-70.5	SS-13	SS	24-38-50	88	1.50 / 1.50	69.0-70.5ft (SC) CLAYEY SAND, medium plasticity, some fine gravel, trace silt, tan, homogeneous, moderate HCL reaction, dry, hard
70											
71	6496										
72											
73	6494										
74			SC		74.0-74.9	SS-14	SS	21-50/5"	Refusal	0.90 / 0.90	74.0-74.9ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine gravel, light tan, homogeneous, dry, very dense
75	6492										
76											
77	6490										
78											
79	6488	79.0-84.0ft (CH) CLAY	CH	▧	79.0-81.0	SS-15	SS	10-17-29-40	46	2.00 / 2.00	79.0-81.0ft (CH) sandy CLAY, medium plasticity, trace fine gravel, trace silt, tan, homogeneous, moist, hard
80											

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

⬚ USCS Poorly-graded Sand (SP)

▧ USCS High Plasticity Clay (CH)

⬚ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-06

SHEET 5 of 6

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/21/2013 8:52:18 AM	N: 233,412.96 E: 700,677.93	ELEVATION W.L.: NA
	DRILLED DEPTH: 101.0 ft	GS ELEVATION: 6567.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
80			CH	▨	79.0-81.0	SS-15	SS	10-17-29-40	46	2.00 2.00	79.0-81.0ft (CH) sandy CLAY, medium plasticity, trace fine gravel, trace silt, tan, homogeneous, moist, hard
81 82 83	6486 6484			▨							
84 85		84.0-89.0ft (SC) CLAYEY SAND	SC	▨	84.0-85.3	SS-16	SS	18-33-50/4"	Refusal	1.30 1.30	84.0-85.3ft (SC) CLAYEY SAND, fine to coarse grained, well graded, some fine gravel, tan, homogeneous, dry, very dense
86 87 88	6482 6480			▨							
89	6478	89.0-99.0ft (SW-SC) SAND with CLAY	SW-SC	▨	89.0-89.8	SS-17	SS	27-50/4"	Refusal	0.80 0.80	89.0-89.8ft (SW-SC) SAND with CLAY, fine to coarse grained, well graded, light tan, homogeneous, dry, very dense
90 91 92 93	6476 6474			▨							
94				▨	94.0-95.0	SS-18	SS	27-50	Refusal	1.00 1.00	94.0-95.0ft (SW-SC) SAND with CLAY, fine to coarse grained, well graded, trace fine gravel, light tan, homogeneous, dry, very dense
95 96 97 98	6472 6470			▨							
99 100	6468	99.0-101.0ft (CH) CLAY	CH	▨	99.0-101.0	SS-19	SS	15-15-20-39	35	2.00 2.00	99.0-101.0ft (CH) CLAY, high plasticity, some fine gravel, some fine to coarse sand, light brown, homogeneous, moist, hard

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

▨ USCS Poorly-graded Sand (SP)

▨ USCS High Plasticity Clay (CH)

▨ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-06

SHEET 6 of 6

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/21/2013 8:52:18 AM
DRILLED DEPTH: 101.0 ft

COORDINATES:
N: 233,412.96 E: 700,677.93
GS ELEVATION: 6567.3 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
100			CH	▨	99.0-101.0	SS-19	SS	15-15-20-39	35	2.00 / 2.00	99.0-101.0ft (CH) CLAY, high plasticity, some fine gravel, some fine to coarse sand, light brown, homogeneous, moist, hard
101		Borehole terminated at 101-ft depth.									

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

▨ USCS Poorly-graded Sand (SP)

▨ USCS High Plasticity Clay (CH)

▨ USCS Well-graded Sand with Clay (SW-SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME-75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-07

SHEET 1 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/24/2013 8:22:15 AM	N: 233,217.26 E: 701,326.65	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.3 ft	GS ELEVATION: 6589.3 ft	INCLINATION: -90

SOIL PROFILE

DEPTH (ft)	ELEVATION (ft)
0	
1	6588
2	
3	6586
4	
5	6584
6	
7	6582
8	
9	6580
10	
11	6578
12	
13	6576
14	
15	6574
16	
17	6572
18	
19	6570
20	

LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG
0.0-0.5ft (CL) SILTY CLAY	CL	▨
0.5-10.0ft (SW) SAND	SW	⁘
10.0-14.0ft (CH) CLAY	CH	▨
14.0-24.0ft (CL) SILTY CLAY	CL	▨

SAMPLE INFORMATION

SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
0.0-2.0	SS-1	SS	5-8-10-8	18	1.60 2.00	0.0-0.5ft (CL) SILTY CLAY, medium plasticity, trace coarse sand, some fine to coarse gravel, dark brown, homogeneous, dry, stiff 0.5-1.6ft (SW) gravelly SAND, fine to coarse grained, well graded, some silt, dark tan, homogeneous, dry, compact
2.0-4.0	G-1	GRAB			2.00	2.0-4.0ft Composite grab sample collected from auger cuttings.
4.0-6.0	SS-2	SS	9-16-23-25	39	1.50 2.00	4.0-5.5ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, trace silt, tan, homogeneous, dry, dense
9.0-11.0	SS-3	SS	7-17-15-13	32	1.60 2.00	9.0-10.2ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, trace silt, tan, homogeneous, dry, dense 10.2-10.6ft (CH) CLAY, high plasticity, some fine to coarse sand, some silt, dark orange tan, homogeneous, dry, hard
14.0-16.0	SS-4	SS	39-34-29-33	63	2.00 2.00	14.0-16.0ft (CL) SILTY CLAY, medium plasticity, light brown, homogeneous, dry, hard
19.0-20.5	MC-1	MC	12-25-30	55	1.50 1.50	19.0-20.5ft (CL) SILTY CLAY, medium plasticity, dark tan, homogeneous, moist, hard

- ▨ USCS Low Plasticity Clay (CL)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS High Plasticity Clay (CH)
- ‖ USCS Elastic Silt (MH)
- ▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-07

SHEET 2 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/24/2013 8:22:15 AM
DRILLED DEPTH: 99.3 ft

COORDINATES:
N: 233,217.26 E: 701,326.65
GS ELEVATION: 6589.3 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
20				▨	19.0-20.5	MC-1	MC	12-25-30	55	1.50 1.50	
21	6568										
22			CL								
23	6566										
24		24.0-34.0ft (MH) CLAYEY SILT		▥	22.0-24.0	G-2	GRAB			2.00	22.0-24.0ft Composite grab sample collected from auger cuttings.
25	6564				24.0-26.0	SS-5	SS	16-31-37-48	68	2.00 2.00	24.0-26.0ft (MH) CLAYEY SILT, medium plasticity, trace fine to coarse sand, dark tan, homogeneous, dry, hard
26											
27	6562										
28											
29	6560		MH								
30					29.0-30.9	SS-6	SS	9-18-21-50/5"	39	1.90 1.90	29.0-30.9ft (MH) CLAYEY SILT, medium plasticity, trace fine to coarse sand, dark tan, homogeneous, dry, hard
31	6558										
32											
33	6556										
34		34.0-39.0ft (CL) SILTY CLAY		▨	34.0-35.4	SS-7	SS	9-37-50/5"	Refusal	1.40 1.40	34.0-35.3ft (CL) SILTY CLAY, medium plasticity, trace fine to coarse sand, dark tan, homogeneous, dry, hard 35.3-35.4ft (CL) SILTY CLAY, medium plasticity, trace fine to coarse sand, light tan, homogeneous, dry, hard
35	6554										
36			CL								
37	6552										
38											
39	6550	39.0-44.0ft (SC) CLAYEY SAND	SC	▨	39.0-41.0	SS-8	SS	12-23-27-31	50	2.00 2.00	39.0-41.0ft (SC) CLAYEY SAND, medium plasticity, dark tan, homogeneous, dry, hard
40											

▨ USCS Low Plasticity Clay (CL)
⁘ USCS Well-graded Sand (SW)
▧ USCS High Plasticity Clay (CH)
▥ USCS Elastic Silt (MH)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-07

SHEET 3 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/24/2013 8:22:15 AM	N: 233,217.26 E: 701,326.65	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.3 ft	GS ELEVATION: 6589.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
40			SC	▨	39.0-41.0	SS-8	SS	12-23-27-31	50	2.00 2.00	39.0-41.0ft (SC) CLAYEY SAND, medium plasticity, dark tan, homogeneous, dry, hard
41 42 43	6548 6546										
44		44.0-49.0ft (CL) SILTY CLAY	CL	▨	44.0-44.9	MC-2	MC	24-50/5"	Refusal	0.90 0.90	44.0-44.9ft (CL) gravelly SILTY CLAY, medium plasticity, some fine to coarse sand, tan, homogeneous, moist, hard
45 46 47 48	6544 6542										
49	6540	49.0-54.0ft (SC) CLAYEY SAND	SC	▨	49.0-50.0	SS-9	SS	29-50	Refusal	1.00 1.00	49.0-50.0ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine to coarse gravel, trace silt, light tan, homogeneous, dry, very dense
50 51 52 53	6538 6536										
54		54.0-64.0ft (CL) SILTY CLAY	CL	▨	54.0-54.9	SS-10	SS	32-5.0/4"	Refusal	0.90 0.90	54.0-54.9ft (CL) sandy SILTY CLAY, medium plasticity, light brown, homogeneous, moist, hard
55 56 57 58	6534 6532										
59 60	6530				59.0-61.0	SS-11	SS	10-19-24-44	43	2.00 2.00	59.0-61.0ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, trace fine gravel, dark tan, homogeneous, moist, hard

- ▨ USCS Low Plasticity Clay (CL)
- ░ USCS Well-graded Sand (SW)
- ▩ USCS High Plasticity Clay (CH)
- ‖ USCS Elastic Silt (MH)
- ▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-07

SHEET 4 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/24/2013 8:22:15 AM
DRILLED DEPTH: 99.3 ft

COORDINATES:
N: 233,217.26 E: 701,326.65
GS ELEVATION: 6589.3 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
60 61 62 63	6528 6526		CL	▨	59.0-61.0	SS-11	SS	10-19-24-44	43	2.00 2.00	59.0-61.0ft (CL) SILTY CLAY, medium plasticity, some fine to coarse sand, trace fine gravel, dark tan, homogeneous, moist, hard
64 65 66 67 68	6524 6522	64.0-69.0ft (SW) SAND	SW	░	64.0-64.9	SS-12	SS	32-50/5"	Refusal	0.90 0.90	64.0-64.9ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, trace silt, light tan, homogeneous, strong HCL reaction, dry, very dense
69 70 71 72 73	6520 6518 6516	69.0-79.0ft (CL) SILTY CLAY	CL	▨	69.0-70.9	SS-13	SS	18-31-41-50/5"	72	1.90 1.90	69.0-70.9ft (CL) SILTY CLAY, low plasticity, some fine to medium sand, dark tan, homogeneous, moist, hard
74 75 76 77 78	6514 6512				74.0-74.1	None	SS	50/1"	Refusal	0.00 0.10	74.0ft Refusal, no recovery
79 80	6510	79.0-84.0ft (SC) CLAYEY SAND	SC	▨	79.0-80.4	SS-14	SS	20-34-50/5"	Refusal	1.40 1.40	79.0-80.4ft (SC) CLAYEY SAND, fine grained, poorly graded, low plasticity, trace coarse sand, light brown, homogeneous, moist, very dense

▨ USCS Low Plasticity Clay (CL)
░ USCS Well-graded Sand (SW)
▨ USCS High Plasticity Clay (CH)
▥ USCS Elastic Silt (MH)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanogan
DRILL RIG: CME 75

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-07

SHEET 5 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/24/2013 8:22:15 AM	N: 233,217.26 E: 701,326.65	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.3 ft	GS ELEVATION: 6589.3 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
80				▨	79.0-80.4	SS-14	SS	20-34-50/5"	Refusal		
81	6508			▨							
82			SC	▨							
83	6506			▨							
84		84.0-99.3ft (CL) SILTY CLAY		▨	84.0-84.7	SS-15	SS	37-50/2"	Refusal	0.70 / 0.70	84.0-84.7ft (CL) sandy SILTY CLAY, med-high plasticity, trace fine gravel, dark tan, homogeneous, moist, hard
85	6504			▨							
86				▨							
87	6502			▨							
88				▨							
89	6500			▨	89.0-90.5	SS-16	SS	17-34-50	84	1.50 / 1.50	89.0-90.5ft (CL) sandy SILTY CLAY, low plasticity, trace fine gravel, light brown, homogeneous, moist, hard
90				▨							
91	6498		CL	▨							
92				▨							
93	6496			▨							
94				▨	94.0-95.8	SS-17	SS	13-29-37-50/3"	66	1.80 / 1.80	94.0-95.8ft (CL) sandy SILTY CLAY, low plasticity, trace fine gravel, light brown, homogeneous, moist, hard
95	6494			▨							
96				▨							
97	6492			▨							
98				▨							
99				▨	99.0-99.3	SS-18	SS	50/3"	Refusal	0.30 / 0.30	99.0-99.3ft (CL) sandy SILTY CLAY, trace fine to coarse gravel, light brown, homogeneous, moist, very dense

Borehole terminated at 99.3-ft depth.

▨ USCS Low Plasticity Clay (CL)
░ USCS Well-graded Sand (SW)
▨ USCS High Plasticity Clay (CH)
‖ USCS Elastic Silt (MH)
▨ USCS Clayey Sand (SC)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanogan	CHECKED BY: Rusch
DRILL RIG: CME 75	DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-08

SHEET 1 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/25/2013 8:05:51 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 233,484.24 E: 701,486.69
GS ELEVATION: 6583.6 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
0		0.0-0.7ft (CL) SILTY CLAY	CL	▨	0.0-2.0	SS-1	SS	6-8-5-3	13	1.40 2.00	0.0-0.7ft (CL) SILTY CLAY, medium plasticity, trace coarse sand, trace fine gravel, dark brown, homogeneous, dry, firm 0.7-1.4ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, some clay, light brown, homogeneous, dry, compact
1 2 3	6582 6580	0.7-4.0ft (SW) SAND	SW	⁘							
4		4.0-4.6ft (SC) CLAYEY SAND	SC	▧	2.0-4.0	G-1	GRAB			2.00	2.0-4.0ft Composite grab sample collected from auger cuttings.
5	6578	4.6-19.0ft (SW) SAND	SW	⁘	4.0-6.0	SS-2	SS	3-6-16-26	22	2.00 2.00	4.0-4.6ft (SC) CLAYEY SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, dry, compact 4.6-6.0ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, light tan, homogeneous, dry, compact
6 7 8	6576			⁘							
9 10	6574			⁘	9.0-10.5	SS-3	SS	17-29-50	79	1.50 1.50	9.0-10.5ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, dry, very dense
11 12 13	6572 6570			⁘							
14				⁘	14.0-14.5	SS-4	SS	50/6"	Refusal	0.50 0.50	14.0-14.5ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, tan, homogeneous, dry, very dense
15 16 17 18	6568 6566			⁘							
19 20	6564	19.0-29.0ft (SC) CLAYEY SAND	SC	▧	19.0-20.5	MC-1	MC	13-26-42	68	1.50 1.50	19.0-20.5ft (SC) CLAYEY SAND, fine grained, poorly graded, dark tan, homogeneous, dry, very dense

▨ USCS Low Plasticity Clay (CL)
⁘ USCS Well-graded Sand (SW)
▧ USCS Clayey Sand (SC)
■ USCS High Plasticity Clay (CH)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-08

SHEET 2 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/25/2013 8:05:51 AM	N: 233,484.24 E: 701,486.69	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6583.6 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
20			SC	▨	19.0-20.5	MC-1	MC	13-26-42	68	1.50 / 1.50	
21 22 23	6562 6560			▨	20.0-24.0	G-2	GRAB			4.00	20.0-24.0ft Composite grab sample collected from auger cuttings.
24 25	6558			▨	24.0-25.9	SS-5	SS	13-29-22-50/4.8"	51	1.90 / 1.90	24.0-25.9ft (SC) CLAYEY SAND, fine grained, poorly graded, trace fine gravel, dark tan, homogeneous, dry, very dense
26 27 28	6556			▨							
29 30	6554	29.0-34.0ft (SW) SAND	SW	⁘	29.0-31.0	SS-6	SS	33-37-38-30	75	2.00 / 2.00	29.0-31.0ft (SW) SAND, fine to coarse grained, well graded, trace fine gravel, light tan, homogeneous, dry, very dense
31 32 33	6552 6550			⁘							
34		34.0-39.0ft (SC) CLAYEY SAND	SC	▨	34.0-35.0	SS-7	SS	27-50	Refusal	1.00 / 1.00	34.0-35.0ft (SC) CLAYEY SAND, fine grained, poorly graded, orange tan, homogeneous, dry, very dense
35 36 37 38	6548 6546			▨							
39 40	6544	39.0-44.0ft (CL) SILTY CLAY	CL	▨	39.0-40.9	SS-8	SS	10-20-30-50/4.8"	50	1.90 / 1.90	39.0-40.9ft (CL) sandy SILTY CLAY, medium plasticity, some fine gravel, light brown, homogeneous, dry, hard

▨ USCS Low Plasticity Clay (CL) ⁘ USCS Well-graded Sand (SW) ▨ USCS Clayey Sand (SC) ▰ USCS High Plasticity Clay (CH)

DRILLING CONTRACTOR: Drilling Engineers	LOGGED BY: Steed
DRILLER: Flanagan	CHECKED BY: Rusch
DRILL RIG:	DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-08

SHEET 3 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/25/2013 8:05:51 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 233,484.24 E: 701,486.69
GS ELEVATION: 6583.6 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC ATT (ft)	SAMPLE DESCRIPTION
40					39.0-40.9	SS-8	SS	10-20-30-50/4.8"	50	1.90 1.90	39.0-40.9ft (CL) sandy SILTY CLAY, medium plasticity, some fine gravel, light brown, homogeneous, dry, hard
41	6542										
42			CL								
43	6540										
44		44.0-50.1ft (SW) SAND			44.0-44.9	SS-9	SS	38-50/4.2"	Refusal	0.90 0.90	44.0-44.9ft (SW) SAND, fine to coarse grained, well graded, some fine gravel, light tan, homogeneous, dry, very dense
45	6538										
46											
47	6536		SW								
48											
49	6534				49.0-51.0	SS-10	SS	27-33-31-33	64	2.00 2.00	49.0-50.1ft (SW) SAND, fine to coarse grained, well graded, some fine gravel, light tan, homogeneous, dry, very dense 50.1-51.0ft (CH) sandy CLAY, high plasticity, orange brown, homogeneous, dry, hard
50		50.1-54.0ft (CH) CLAY									
51	6532										
52			CH								
53	6530										
54		54.0-59.0ft (SC) CLAYEY SAND			54.0-54.9	MC-2	MC	28-50/4.2"	Refusal	0.50 0.90	54.0-54.5ft (SC) CLAYEY SAND, fine grained, poorly graded, trace fine gravel, tan, homogeneous, dry, very dense
55	6528										
56			SC								
57	6526										
58											
59	6524	59.0-64.0ft (SW) SAND	SW		59.0-59.9	SS-11	SS	41-50/4.2"	Refusal	0.90 0.90	59.0-59.8ft (SW) SAND, fine to coarse grained, well graded, trace fine to coarse gravel, some clay, light tan, homogeneous, dry, very dense
60											

▨ USCS Low Plasticity Clay (CL)
⁘ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)
▨ USCS High Plasticity Clay (CH)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-08

SHEET 4 of 5

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971

DRILL METHOD: HSA
DATE/TIME STARTED: 6/25/2013 8:05:51 AM
DRILLED DEPTH: 99.4 ft

COORDINATES:
N: 233,484.24 E: 701,486.69
GS ELEVATION: 6583.6 ft

DEPTH W.L.: NA
ELEVATION W.L.: NA
INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
60 61 62 63	6522 6520		SW	⁘							
64 65 66 67 68	6518 6516	64.0-79.0ft (SC) CLAYEY SAND	SC	▨	64.0-64.2	SS-12	SS	50/1.8"	Refusal	0.20 / 0.20	64.0-64.2ft (SC) CLAYEY SAND, fine to medium grained, poorly graded, trace fine to coarse gravel, very light tan, homogeneous, dry, very dense
69 70 71 72 73	6514 6512 6510			▨	69.0-69.0	None	SS	50/0"	Refusal	0.00 / 0.00	69.0ft Refusal, no sample recovery
74 75 76 77 78	6508 6506			▨	74.0-75.4	SS-13	SS	17-40-50/4.8"	Refusal	1.40 / 1.40	74.0-75.4ft (SC) CLAYEY SAND, fine grained, poorly graded, trace medium to coarse sand, trace fine gravel, tan, homogeneous, dry, very dense
79 80	6504	79.0-84.0ft (SP) SAND	SP	▨	79.0-80.4	SS-14	SS	21-47-50/4.8"	Refusal	1.40 / 1.40	79.0-80.4ft (SP) SAND, fine to medium grained, poorly graded, trace fine to coarse gravel, some clay, tan, homogeneous, moist, very dense

▨ USCS Low Plasticity Clay (CL)

⁘ USCS Well-graded Sand (SW)

▨ USCS Clayey Sand (SC)

▰ USCS High Plasticity Clay (CH)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF BOREHOLE GBH-2013-08

SHEET 5 of 5

PROJECT: Happy Jack Landfill	DRILL METHOD: HSA	COORDINATES:	DEPTH W.L.: NA
PROJECT NUMBER: 123-81971	DATE/TIME STARTED: 6/25/2013 8:05:51 AM	N: 233,484.24 E: 701,486.69	ELEVATION W.L.: NA
	DRILLED DEPTH: 99.4 ft	GS ELEVATION: 6583.6 ft	INCLINATION: -90

SOIL PROFILE					SAMPLE INFORMATION						
DEPTH (ft)	ELEVATION (ft)	LITHOLOGY DESCRIPTION	USCS	GRAPHIC LOG	SAMPLE DEPTH (ft)	NUMBER	SAMPLE TYPE	BLOWS per 6 in	N	REC / ATT (ft)	SAMPLE DESCRIPTION
80				▨	79.0-80.4	SS-14	SS	21-47-50/4.8"	Refusal		
81	6502			▨							
82			SP	▨							
83	6500			▨							
84		84.0-89.0ft (SW) SAND		⁘	84.0-84.1	SS-15	SS	50/1.2"	Refusal	0.10 / 0.10	84.0-84.1ft (SW) gravelly SAND, fine to coarse grained, well graded, some clay, light tan, homogeneous, moist, very dense
85	6498			⁘							
86			SW	⁘							
87	6496			⁘							
88				⁘							
89	6494	89.0-99.4ft (SC) CLAYEY SAND		▨							
90				▨	89.0-91.0	SS-16	SS	15-22-43-50	65	2.00 / 2.00	89.0-91.0ft (SC) CLAYEY SAND, fine grained, poorly graded, some medium to coarse sand, trace fine gravel, tan, homogeneous, moist, very dense
91	6492			▨							
92				▨							
93	6490			▨							
94			SC	▨	94.0-94.5	SS-17	SS	50	Refusal	0.50 / 0.50	94.0-94.5ft (SC) CLAYEY SAND, fine grained, poorly graded, some medium to coarse sand, trace fine gravel, tan, homogeneous, dry, very dense
95	6488			▨							
96				▨							
97	6486			▨							
98				▨							
99				▨	99.0-99.4	SS-18	SS	50/4.2"	Refusal	0.40 / 0.40	99.0-99.4ft (SC) CLAYEY SAND, fine to coarse grained, poorly graded, some fine to coarse gravel, dark tan, homogeneous, moist, very dense

Borehole terminated at 99.4-ft depth.

▨ USCS Low Plasticity Clay (CL)

⁘ USCS Well-graded Sand (SW)

▨ USCS Clayey Sand (SC)

▩ USCS High Plasticity Clay (CH)

DRILLING CONTRACTOR: Drilling Engineers
DRILLER: Flanagan
DRILL RIG:

LOGGED BY: Steed
CHECKED BY: Rusch
DATE: 9/1/2013

Golder Associates

DF-SOIL BORING LOG IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

APPENDIX B
WELL CONSTRUCTION LOGS

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 1 of 12

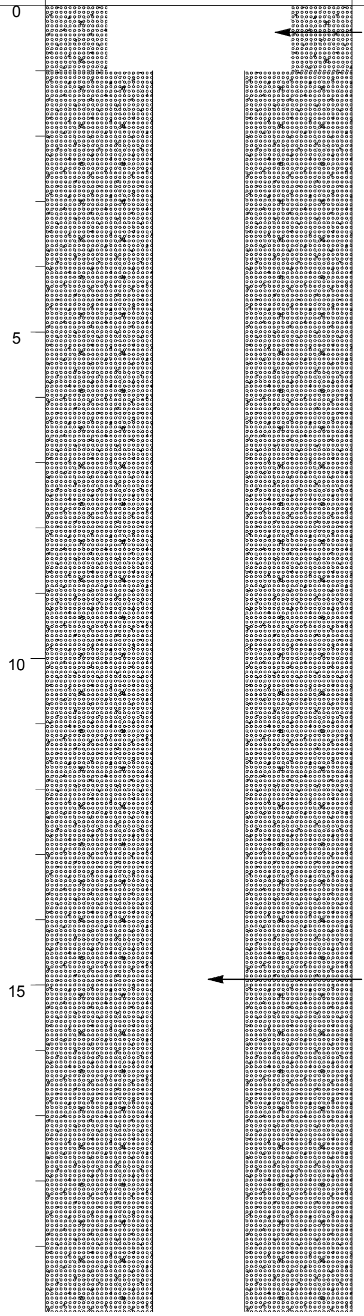
PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
0		0.0-1.5ft (OL) ORGANIC SILT, brown	☰	OL
	6595	1.5-6.0ft (CL) SILTY CLAY, some fine to coarse sand, light tan	▨	CL
5	6590	6.0-10.0ft (SP) SAND, poorly graded, some fine gravel, pale tan	⋯	SP
10	6585	10.0-13.0ft (CL) SILTY CLAY, brown	▨	CL
15	6580	13.0-22.0ft (CL) SILTY CLAY, some fine to coarse sand, light tan	▨	CL
20				

Log continued on next page

WELL DETAILS



WELL CONSTRUCTION DETAILS

Cement Pad for Stickup

2" PVC, Threaded, Flush Joint

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 18	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 4	Material: 10/20 washed silica sand, 50lb bags Quantity: 4	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)

▨ USCS Low Plasticity Clay (CL)

⋯ USCS Poorly-graded Sand (SP)

⁘ USCS Well-graded Sand (SW)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 2 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 236

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/15/2013 4:20:26 PM

COORDS: N: 232,717.22 E: 700,342.20
GS ELEVATION (ft): 6596.90
TOC ELEVATION (ft): 6599.54

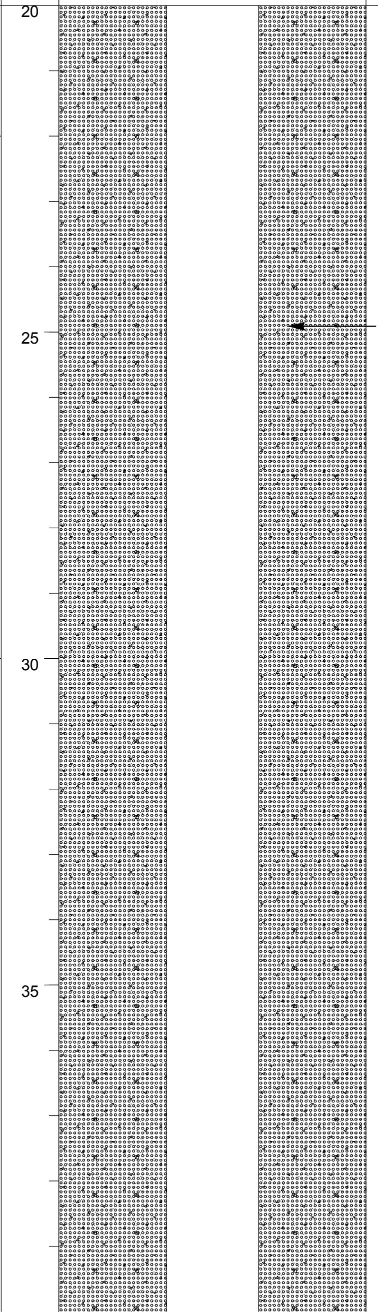
DEPTH TO WATER (ft): 215.76
W.L. ELEVATION (ft): 6381.14

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
20			▨	CL
	6575	22.0-30.0ft (SW) SAND, well graded, some fine gravel, tan	⁘	SW
25				
	6570			
30		30.0-50.0ft (CL) SILTY CLAY, some fine to coarse sand, some fine to coarse gravel, tan	▨	CL
	6565			
35				
	6560			
40				

Log continued on next page

WELL DETAILS



WELL CONSTRUCTION DETAILS

Portland/Bentonite Grout

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
░ USCS Poorly-graded Sand (SP)
⁘ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 3 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 236

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/15/2013 4:20:26 PM

COORDS: N: 232,717.22 E: 700,342.20
GS ELEVATION (ft): 6596.90
TOC ELEVATION (ft): 6599.54

DEPTH TO WATER (ft): 215.76
W.L. ELEVATION (ft): 6381.14

SOIL PROFILE				
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
40			▨	
	6555		▨	
45			▨	CL
	6550		▨	
50		50.0-55.0ft (SP) SAND, tan	░	
	6545		░	SP
55		55.0-60.0ft (CL) SILTY CLAY, some fine to coarse sand, tan	▨	
	6540		▨	CL
60				

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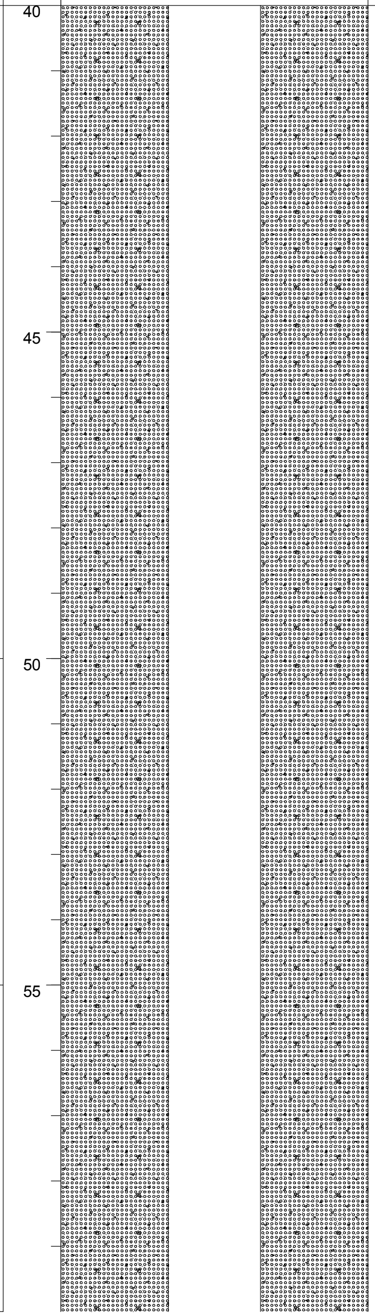
WELL DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 18

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 4

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 4

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	░ USCS Poorly-graded Sand (SP)	⁘ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)			

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 4 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	

DEPTH ft	ELEVATION ft	SOIL PROFILE LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
60		60.0-65.0ft (SC) CLAYEY SAND, some fine gravel, dark tan	▨	SC
	6535			
65		65.0-78.0ft (CL) SILTY CLAY, some fine to coarse sand, trace fine gravel, brown	▨	CL
	6530			
70				
	6525			
75				
	6520			
		78.0-88.0ft (SP) SAND, poorly graded, some silty clay, some fine gravel, tan	░	SP
80				

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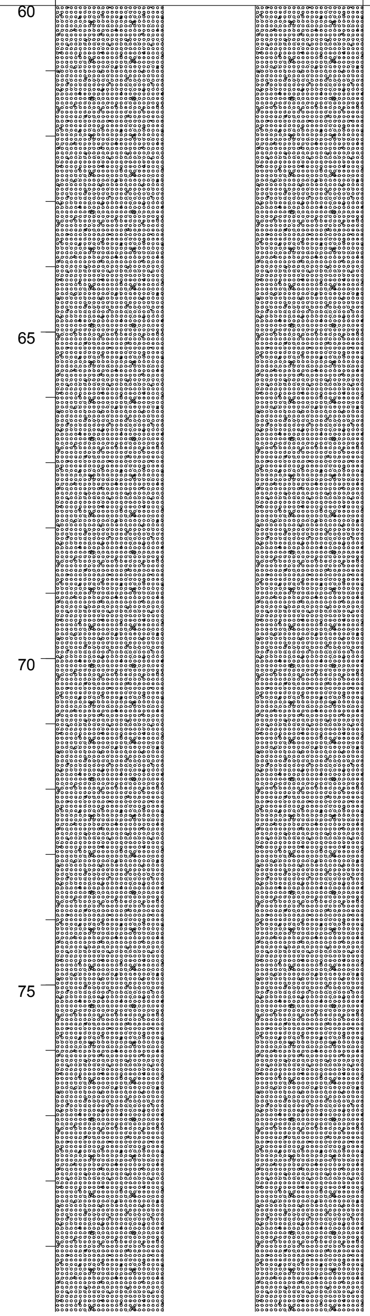
WELL DETAILS



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ░ USCS Poorly-graded Sand (SP)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

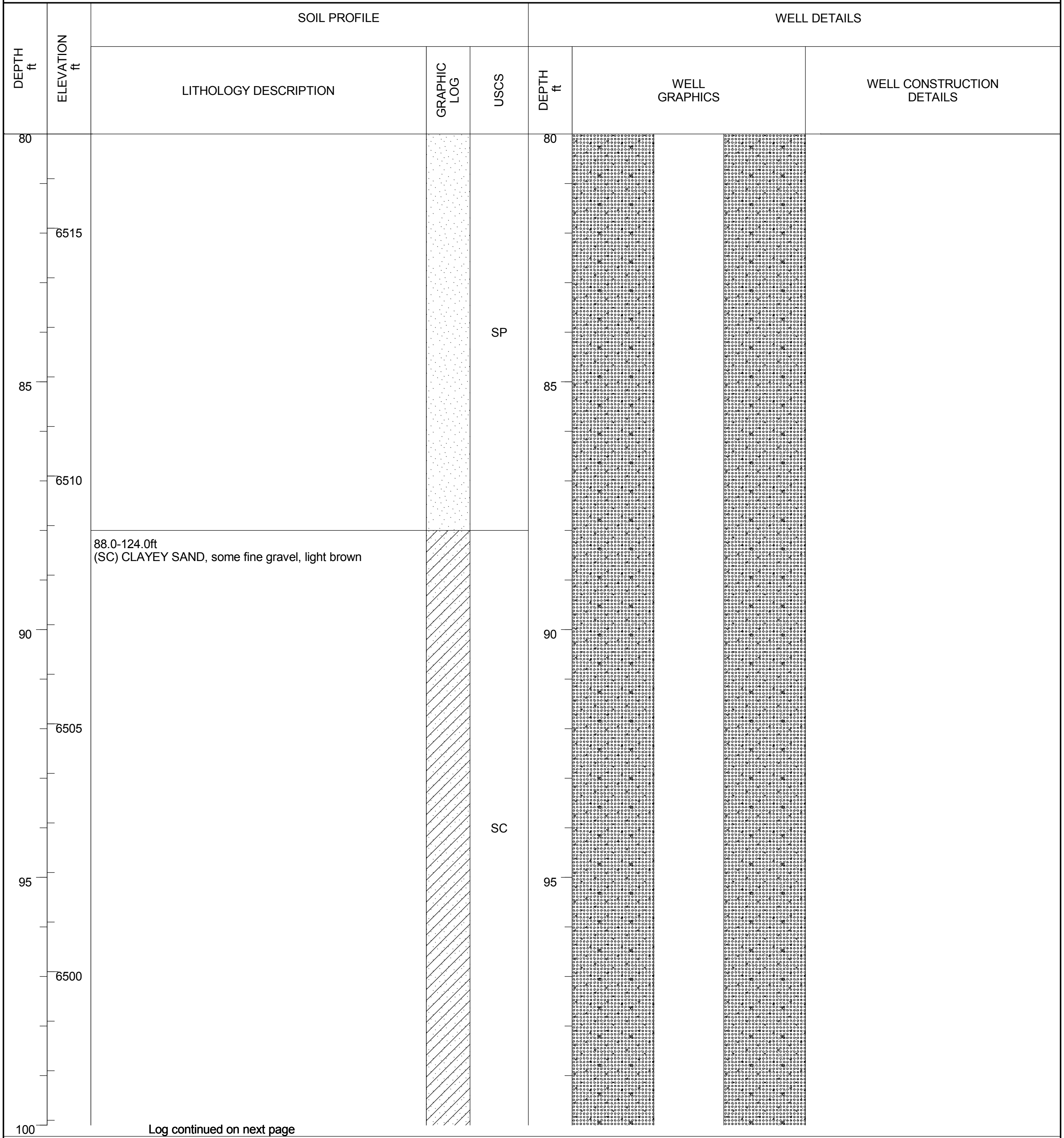
Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 5 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	



88.0-124.0ft
(SC) CLAYEY SAND, some fine gravel, light brown

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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 18	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 4	Material: 10/20 washed silica sand, 50lb bags Quantity: 4	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	░ USCS Poorly-graded Sand (SP)	⁘ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)			

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-01

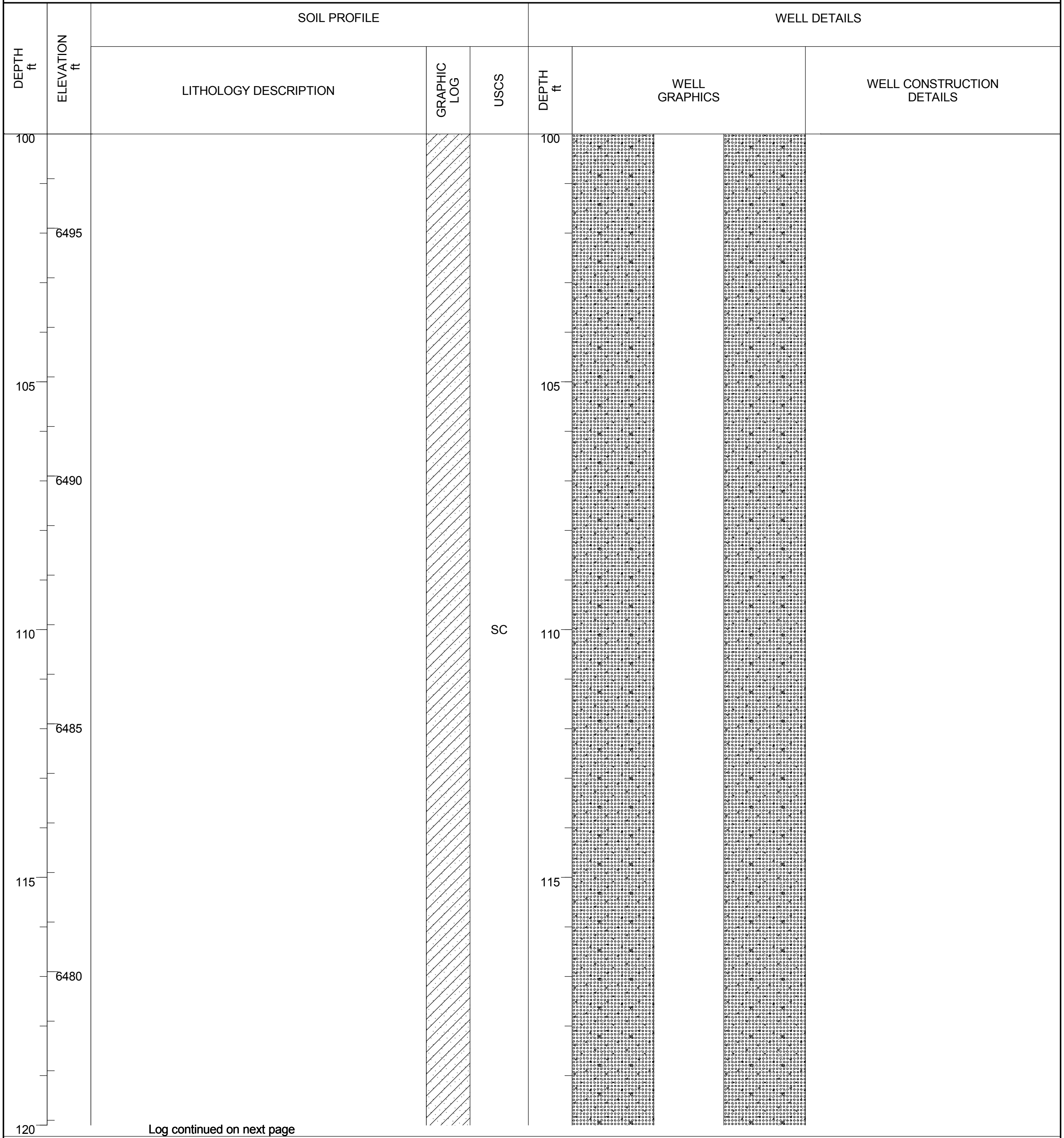
SHEET 6 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 236

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/15/2013 4:20:26 PM

COORDS: N: 232,717.22 E: 700,342.20
GS ELEVATION (ft): 6596.90
TOC ELEVATION (ft): 6599.54

DEPTH TO WATER (ft): 215.76
W.L. ELEVATION (ft): 6381.14



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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
▨	USCS Low Plasticity Clay (CL)
⠂	USCS Poorly-graded Sand (SP)
⁘	USCS Well-graded Sand (SW)
▨	USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 7 of 12

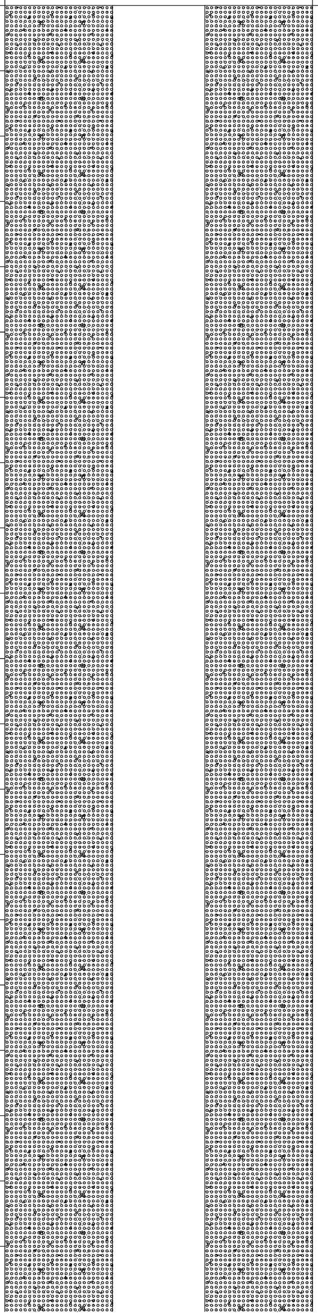
PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
120			▨	
	6475		▨	SC
		124.0-129.0ft (CL) SILTY CLAY, some fine sand, brown	▨	
125			▨	
	6470		▨	CL
		129.0-142.0ft (SC) CLAYEY SAND, well graded, tan, dense to very dense	▨	
130			▨	
	6465		▨	
			▨	SC
135			▨	
	6460		▨	
140		Log continued on next page	▨	

WELL DETAILS

DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
120		
125		
130		
135		



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ░ USCS Poorly-graded Sand (SP)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.	GA INSPECTOR: Steed
DRILLER: Adams	CHECKED BY:
	DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 8 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
140			▨	SC
	6455	142.0-151.0ft (SP) SAND, poorly graded, trace fine to coarse gravel, tan	⬚	SP
145	6450			
150				
	6445	151.0-159.0ft (CL) SILTY CLAY, brown	▨	CL
155	6440			
		159.0-178.0ft (SP) SAND, poorly graded, some fine to coarse gravel, tan	⬚	SP
160				

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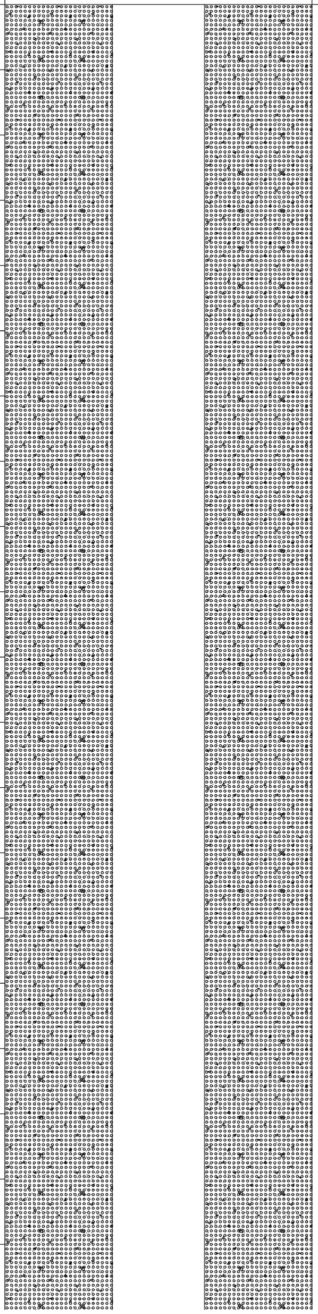
WELL DETAILS

DEPTH ft: 140, 145, 150, 155



WELL CONSTRUCTION DETAILS

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 18	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 4	Material: 10/20 washed silica sand, 50lb bags Quantity: 4	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)

▨ USCS Low Plasticity Clay (CL)

⬚ USCS Poorly-graded Sand (SP)

⁘ USCS Well-graded Sand (SW)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.

DRILLER: Adams

GA INSPECTOR: Steed

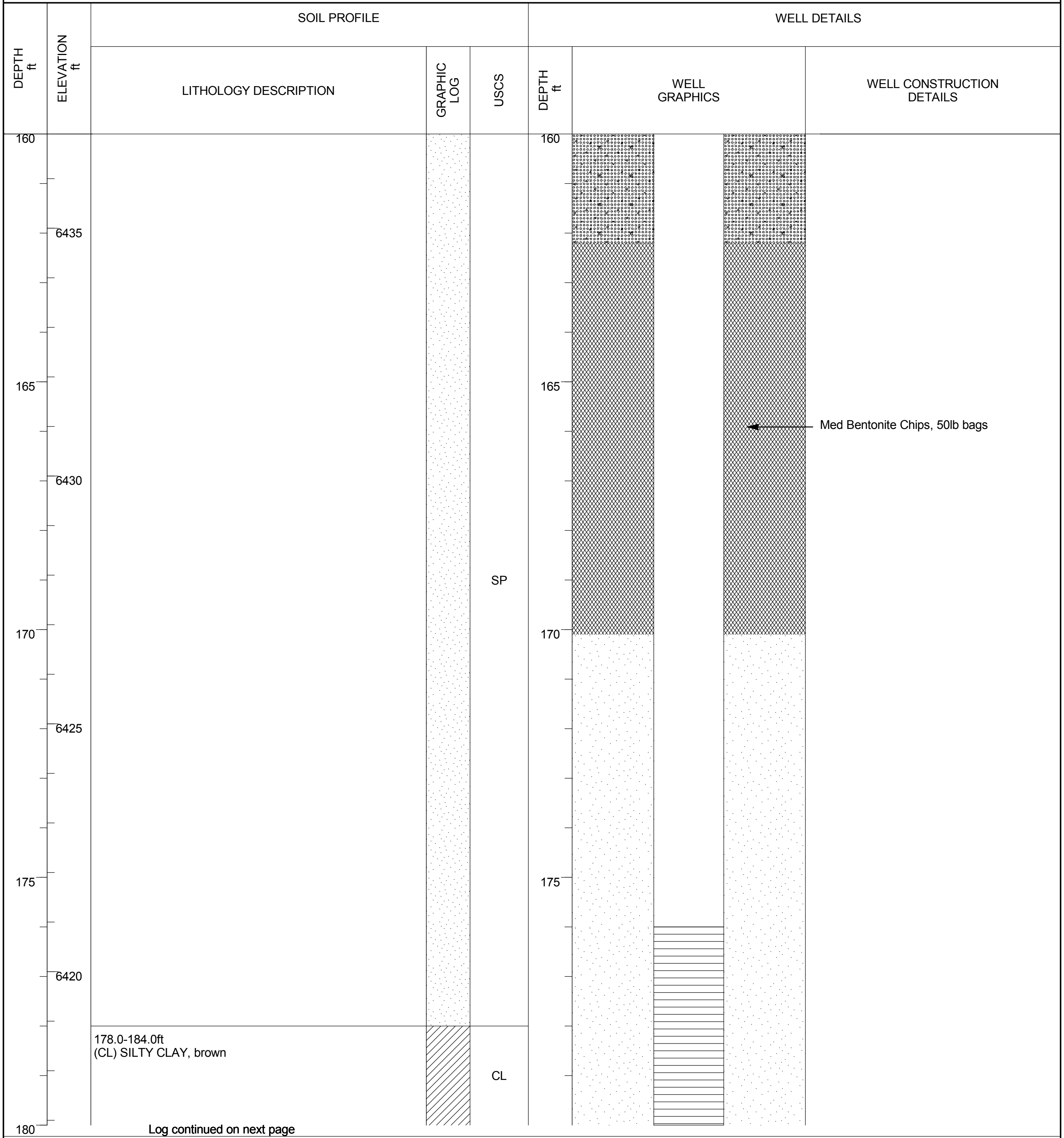
CHECKED BY:

DATE:

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 9 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	



178.0-184.0ft
(CL) SILTY CLAY, brown

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	⬚ USCS Poorly-graded Sand (SP)	⁘ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)			

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 10 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,717.22 E: 700,342.20	DEPTH TO WATER (ft): 215.76
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6596.90	W.L. ELEVATION (ft): 6381.14
DRILLED DEPTH (ft): 236	DRILL DATE: 8/15/2013 4:20:26 PM	TOC ELEVATION (ft): 6599.54	

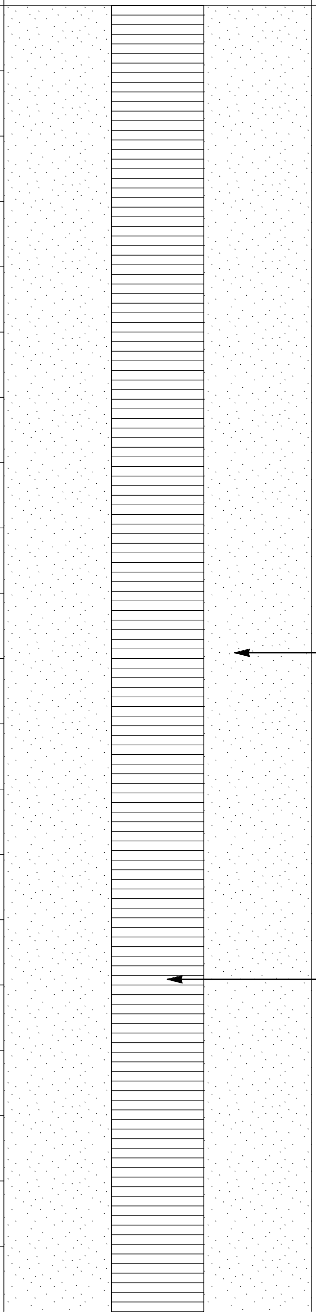
SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
180			▨	
	6415		▨	CL
185		184.0-186.0ft (SW) gravelly SAND, well graded, tan	⁘	SW
	6410	186.0-196.0ft (CL) SILTY CLAY, brown	▨	
190	6405		▨	CL
195			▨	
	6400	196.0-200.0ft (CL) gravelly SILTY CLAY, some fine to coarse sand, brown	▨	CL
200				

Log continued on next page

WELL DETAILS

DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
180		
185		
190		10/20 washed silica sand, 50lb bags
195		2" PVC, Threaded, Flush Joint, 0.01" Slotted



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 18	Quantity: 4	Quantity: 4	Quantity: 2	Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ⁚ USCS Poorly-graded Sand (SP)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 11 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 236

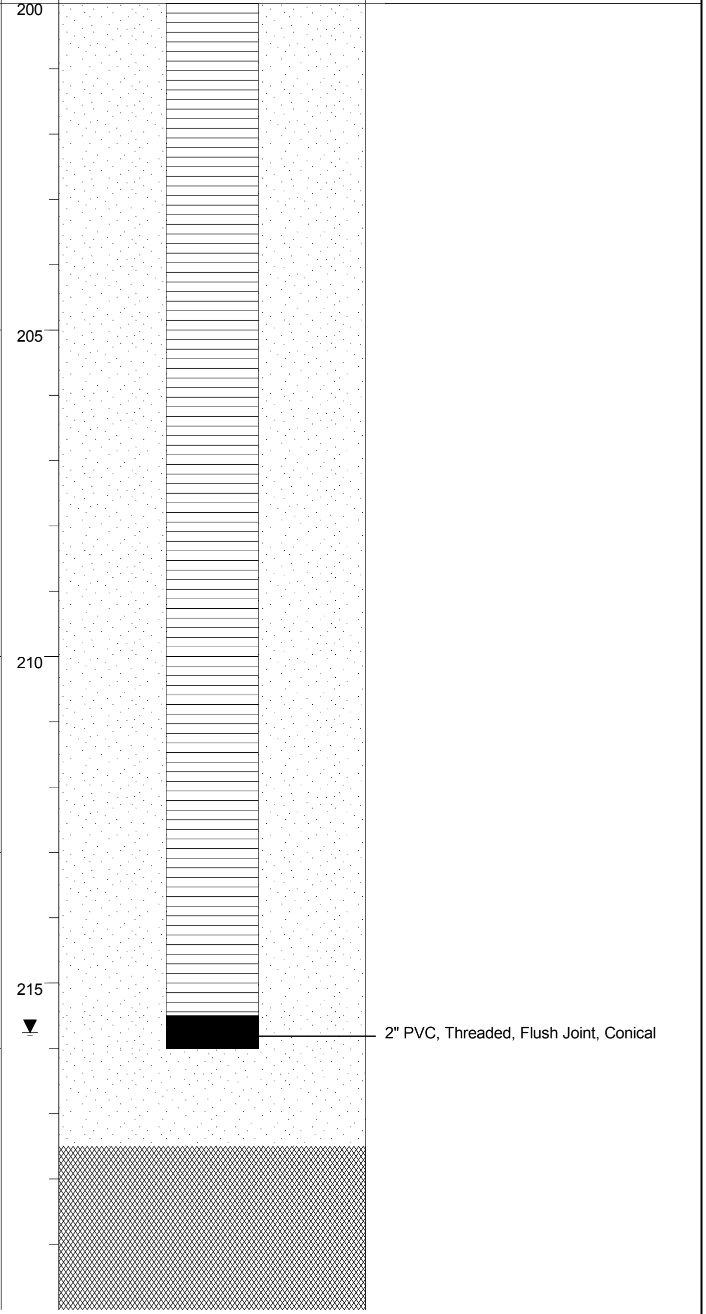
DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/15/2013 4:20:26 PM

COORDS: N: 232,717.22 E: 700,342.20
GS ELEVATION (ft): 6596.90
TOC ELEVATION (ft): 6599.54

DEPTH TO WATER (ft): 215.76
W.L. ELEVATION (ft): 6381.14

DEPTH ft	ELEVATION ft	SOIL PROFILE: LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
200	6395	200.0-205.0ft (CL) SILTY CLAY, brown	▨	CL
205	6390	205.0-210.0ft (CL) SILTY CLAY, some fine to coarse sand, brown	▨	CL
210	6385	210.0-213.0ft (SC) CLAYEY SAND, some fine gravel, brown	▨	SC
215 ▼		213.0-216.0ft (CL) SILTY CLAY, some fine to coarse sand, pale tan	▨	CL
220	6380	216.0-224.0ft (CL) SILTY CLAY, brown	▨	CL

WELL DETAILS



2" PVC, Threaded, Flush Joint, Conical

Log continued on next page

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 18

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 4

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 4

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ░ USCS Poorly-graded Sand (SP)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-01

SHEET 12 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 236

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/15/2013 4:20:26 PM

COORDS: N: 232,717.22 E: 700,342.20
GS ELEVATION (ft): 6596.90
TOC ELEVATION (ft): 6599.54

DEPTH TO WATER (ft): 215.76
W.L. ELEVATION (ft): 6381.14

DEPTH ft	ELEVATION ft	SOIL PROFILE: LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	WELL DETAILS: DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
220			▨		220		
	6375		▨	CL			
		224.0-233.0ft (CL) SILTY CLAY, some fine to coarse sand, trace fine gravel, light brown	▨				
225			▨		225		
	6370		▨				Med Bentonite Chips, 50lb bags
			▨	CL			
230			▨		230		
	6365		▨				
		233.0-236.0ft (CL) SILTY CLAY, light brown	▨				
			▨	CL			
235			▨		235		
240							

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 18

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 4

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 4

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
⁘ USCS Poorly-graded Sand (SP)
⁙ USCS Well-graded Sand (SW)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 1 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

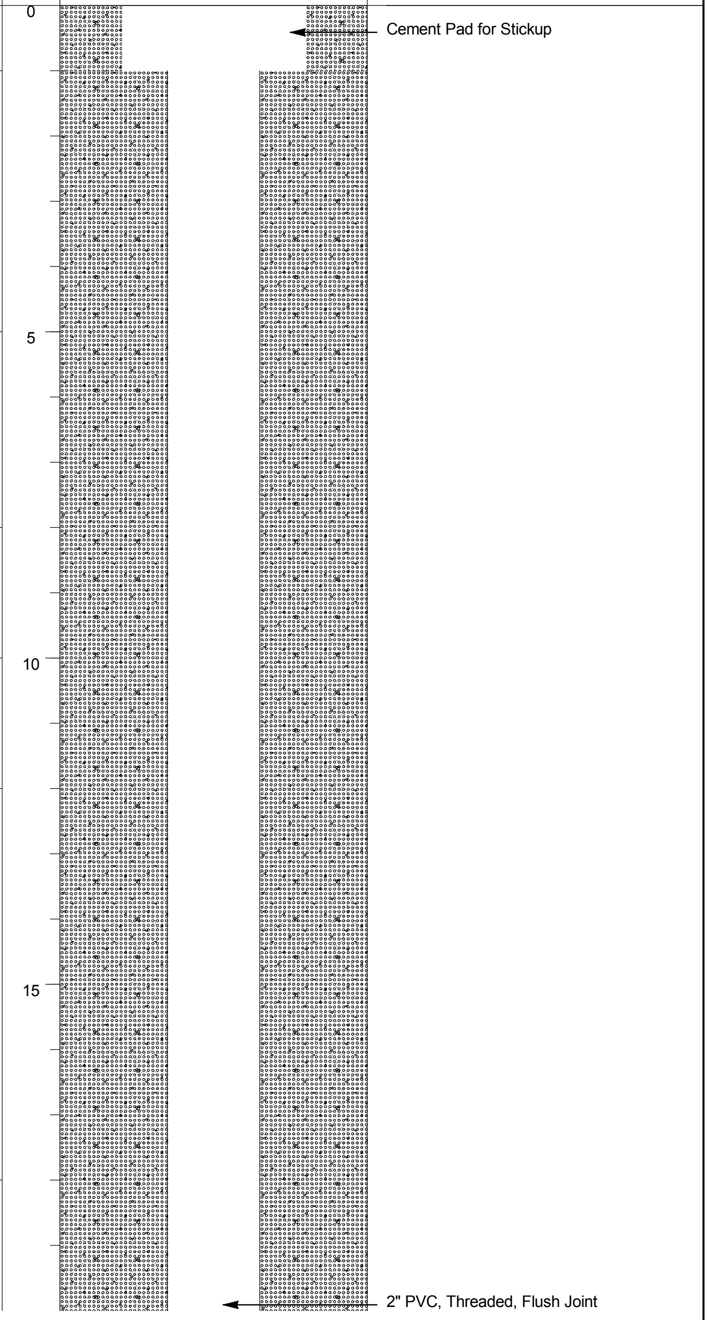
COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
0		0.0-1.0ft (OL/OH) ORGANIC SILT, dark brown		OL/OH
	6575	1.0-5.0ft (SP) SAND, tan	░	SP
5		5.0-8.0ft (CL) SILTY CLAY, dark orange tan	▨	CL
	6570	8.0-10.0ft (CL) SILTY CLAY, orange tan	▨	CL
10		10.0-12.0ft (CL) SILTY CLAY, pale gray	▨	CL
15	6565	12.0-18.0ft (CL) SILTY CLAY, trace fine to medium sand, light orange brown	▨	CL
20	6560	18.0-39.0ft (SP) SAND, poorly graded, trace fine gravel, tan	░	SP

WELL DETAILS



Log continued on next page

WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

░ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

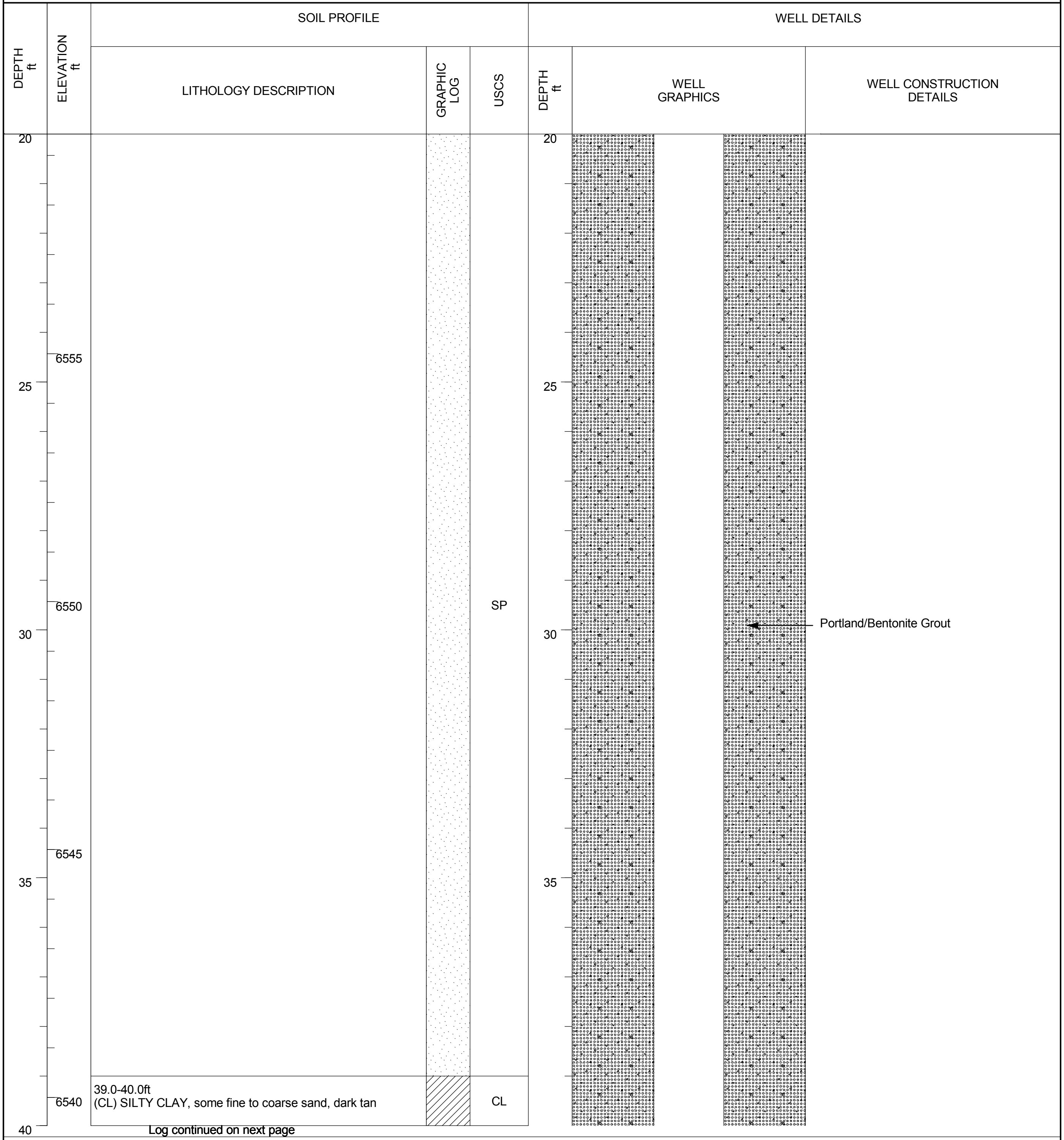
GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 2 of 11

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 233,652.22 E: 701,399.46	DEPTH TO WATER (ft): 199.6
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6579.43	W.L. ELEVATION (ft): 6379.83
DRILLED DEPTH (ft): 216	DRILL DATE: 9/4/2013 12:15:10 PM	TOC ELEVATION (ft): 6581.44	



39.0-40.0ft
(CL) SILTY CLAY, some fine to coarse sand, dark tan

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material:	Material:	Material:	Material:	Material:
Quantity:	Quantity:	Quantity:	Quantity:	Quantity:

░ USCS Poorly-graded Sand (SP)	▨ USCS Low Plasticity Clay (CL)	▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 3 of 11

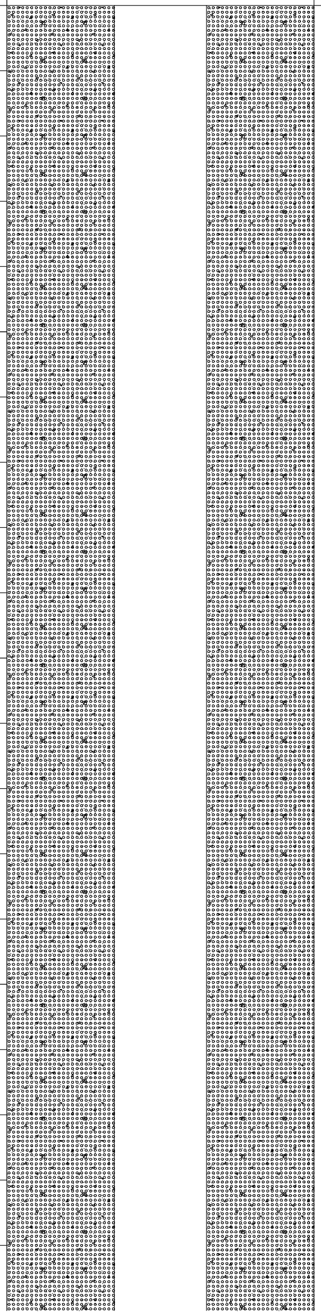
PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

DEPTH ft	ELEVATION ft	SOIL PROFILE: LITHOLOGY DESCRIPTION	SOIL PROFILE: GRAPHIC LOG	SOIL PROFILE: USCS	WELL DETAILS: DEPTH ft	WELL DETAILS: WELL GRAPHICS	WELL DETAILS: WELL CONSTRUCTION DETAILS
40		40.0-66.0ft (SP) SAND, poorly graded, some fine to medium gravel, some clay, tan	⬚		40		
	6535						
45					45		
	6530						
50				SP	50		
	6525						
55					55		
	6520						
60							



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WELL CASING	**WELL SCREEN**	**FILTER PACK**	**FILTER PACK SEAL**	**PROTECTIVE CASING**
Material:	Material:	Material:	Material:	Material:
Quantity:	Quantity:	Quantity:	Quantity:	Quantity:

- ⬚ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 4 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

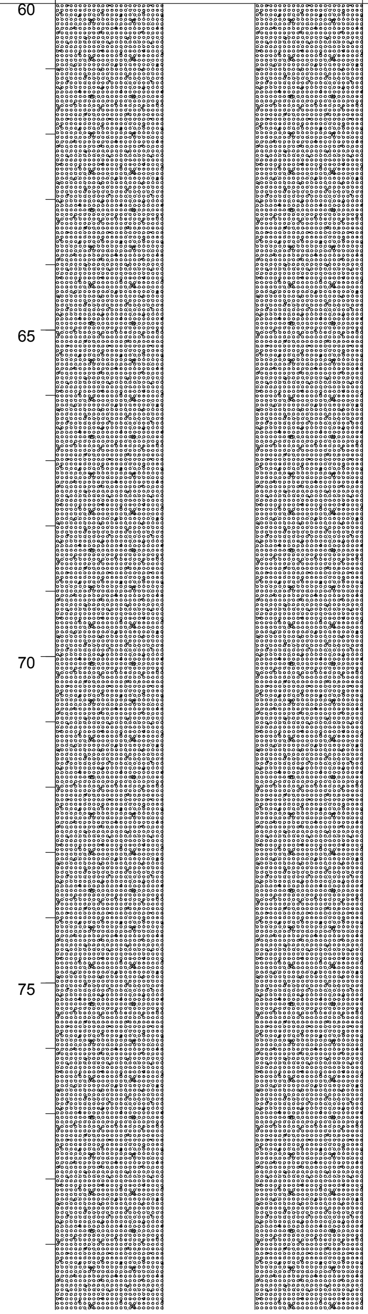
SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
60 65	6515		░	SP
	6510	66.0-70.0ft (SP) SAND, poorly graded, trace medium to coarse sand, dark tan	░	SP
70		70.0-71.0ft (CL) SILTY CLAY, light tan	▨	CL
75 80	6505 6500	71.0-83.0ft (SC) CLAYEY SAND, dark tan	▨	SC

Log continued on next page

WELL DETAILS

DEPTH ft | WELL GRAPHICS | WELL CONSTRUCTION DETAILS



WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

░ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 5 of 11

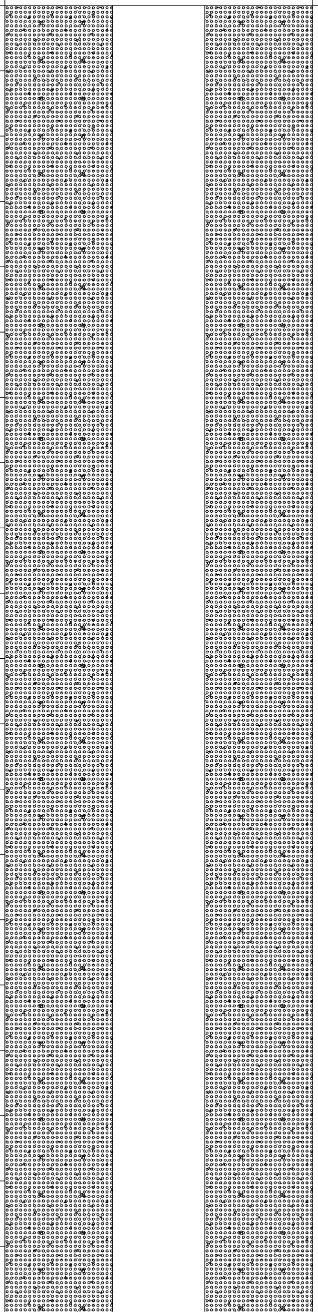
PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

		SOIL PROFILE			WELL DETAILS		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
80			▨	SC	80		
	6495	83.0-89.0ft (SC) CLAYEY SAND, some fine to medium gravel, dark tan	▨	SC			
85					85		
	6490	89.0-96.0ft (SP) SAND, poorly graded, some fine to medium gravel, tan	⁙	SP			
90					90		
	6485						
95					95		
		96.0-135.0ft (SP) SAND, poorly graded, trace fine to medium gravel, tan, Only 2 feet recovered, cuttings/material/core washed away with drill water.	⁙	SP			
	6480						
100							



Log continued on next page

WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

⁙ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-03

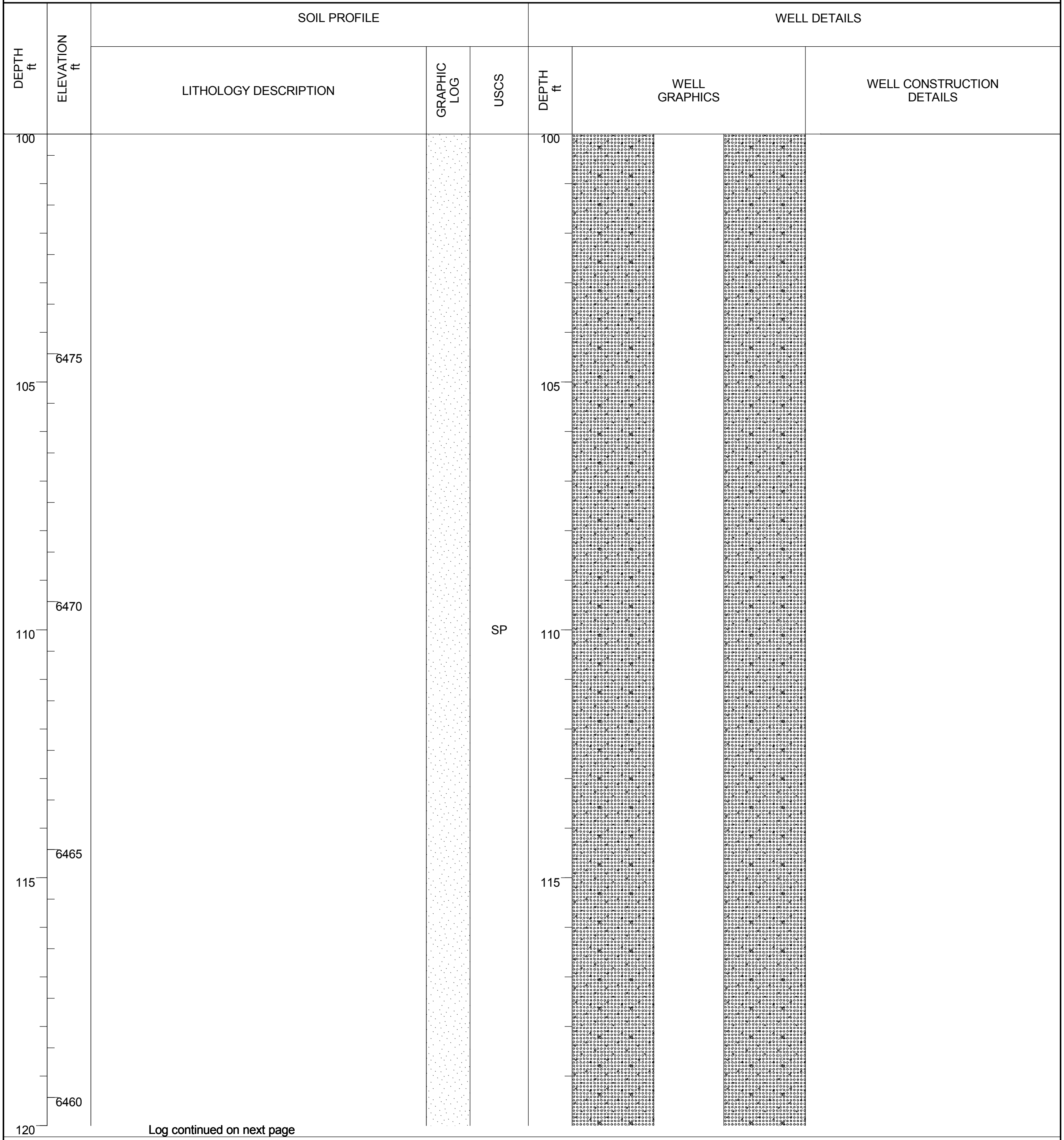
SHEET 6 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83



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WELL CASING	**WELL SCREEN**	**FILTER PACK**	**FILTER PACK SEAL**	**PROTECTIVE CASING**
Material:	Material:	Material:	Material:	Material:
Quantity:	Quantity:	Quantity:	Quantity:	Quantity:

░ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 7 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

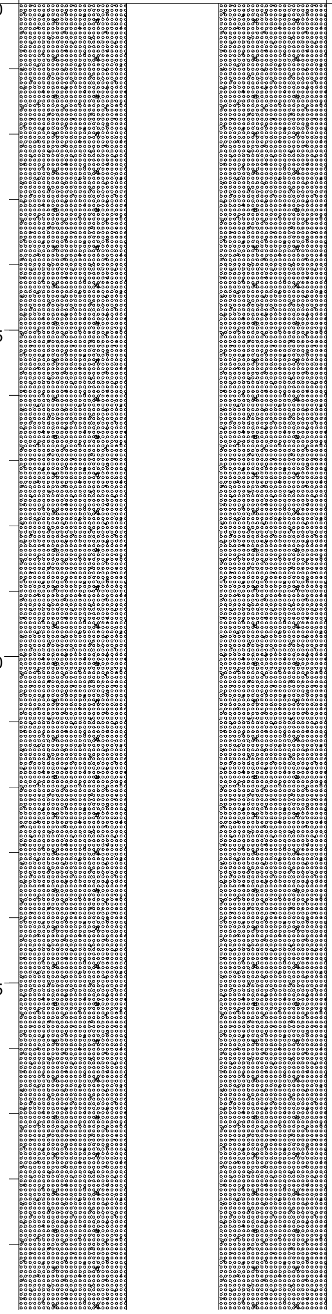
SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
120			⋯	
	6455		⋯	
125			⋯	
			⋯	SP
	6450		⋯	
130			⋯	
	6445		⋯	
135		135.0-137.0ft (CL) SILTY CLAY, some fine to medium gravel, orange brown	▨	CL
		137.0-142.0ft (SP) SAND, poorly graded, some clay, some fine to medium gravel, gray tan	⋯	SP
	6440		⋯	
140				

Log continued on next page

WELL DETAILS

DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
120		
125		
130		
135		



WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

⋯ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

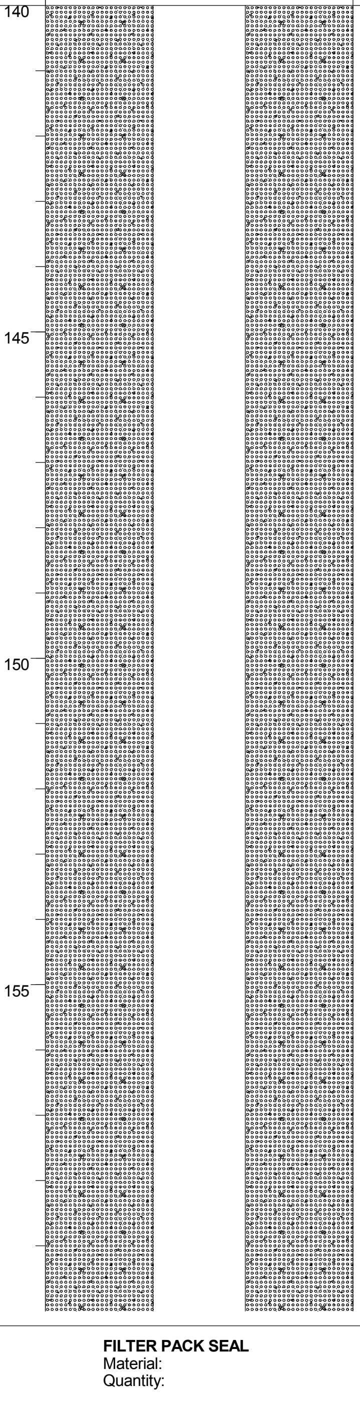
SHEET 8 of 11

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 233,652.22 E: 701,399.46	DEPTH TO WATER (ft): 199.6
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6579.43	W.L. ELEVATION (ft): 6379.83
DRILLED DEPTH (ft): 216	DRILL DATE: 9/4/2013 12:15:10 PM	TOC ELEVATION (ft): 6581.44	

DEPTH ft	ELEVATION ft	SOIL PROFILE LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
140			░	SP
		142.0-147.0ft (SP) SAND, poorly graded, some fine to medium gravel, orange tan	░	SP
145	6435			
		147.0-149.0ft (CL) SILTY CLAY, tan	▨	CL
150	6430	149.0-160.0ft (CL) SILTY CLAY, trace medium sand, trace fine gravel, orange brown	▨	CL
155	6425			
160	6420	Log continued on next page		

WELL DETAILS

DEPTH ft | WELL GRAPHICS | WELL CONSTRUCTION DETAILS



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material:	Material:	Material:	Material:	Material:
Quantity:	Quantity:	Quantity:	Quantity:	Quantity:

░ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

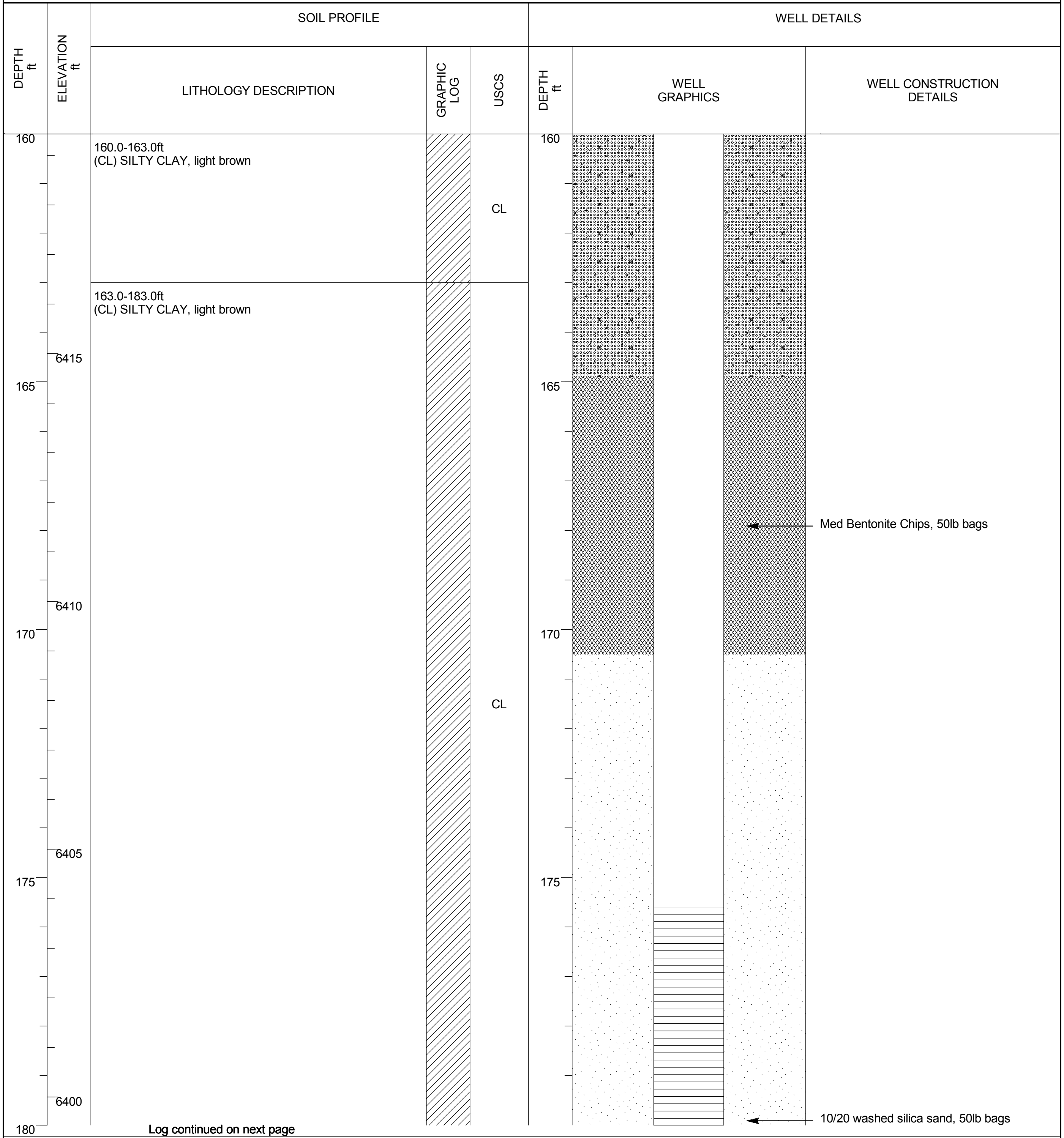
SHEET 9 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83



160.0-163.0ft
(CL) SILTY CLAY, light brown

163.0-183.0ft
(CL) SILTY CLAY, light brown

Med Bentonite Chips, 50lb bags

10/20 washed silica sand, 50lb bags

Log continued on next page

WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

░ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 10 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

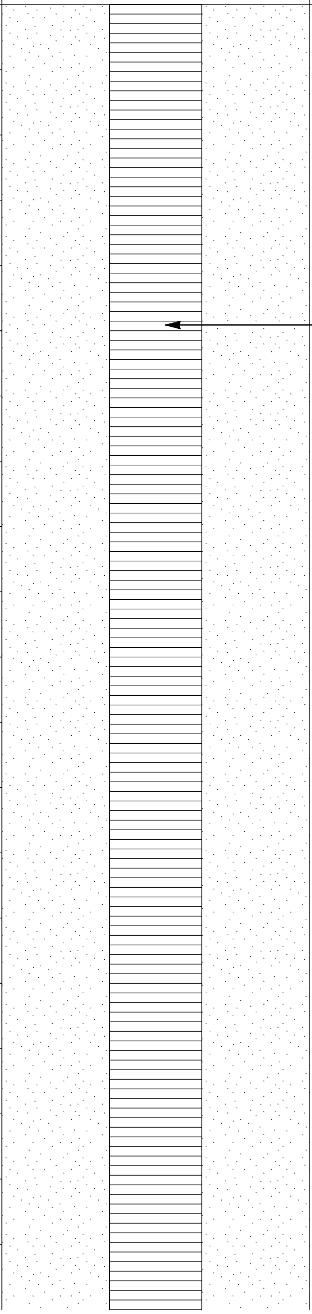
DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
180			▨	CL
		183.0-185.0ft (SP) SAND, poorly graded, some clay, dark tan	⋯	SP
	6395			
185		185.0-198.0ft (CL) SILTY CLAY, pale brown	▨	
	6390			
190				CL
	6385			
195				
		198.0-202.0ft (SP) SAND, poorly graded, some fine to coarse gravel, tan	⋯	SP
▼	6380			
200		Log continued on next page		

WELL DETAILS

DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
180		
185		2" PVC, Threaded, Flush Joint, 0.01" Slotted
190		
195		
▼		



WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

⋯ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-03

SHEET 11 of 11

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 216

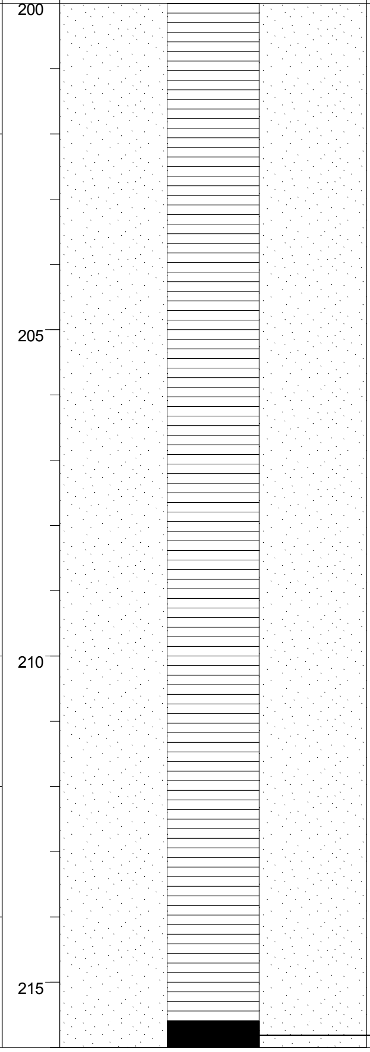
DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 9/4/2013 12:15:10 PM

COORDS: N: 233,652.22 E: 701,399.46
GS ELEVATION (ft): 6579.43
TOC ELEVATION (ft): 6581.44

DEPTH TO WATER (ft): 199.6
W.L. ELEVATION (ft): 6379.83

DEPTH ft	ELEVATION ft	SOIL PROFILE LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
200			░	SP
		202.0-210.0ft (CL) SILTY CLAY, some fine sand, brown	▨	CL
205	6375			
210	6370	210.0-212.0ft (SP) SAND, poorly graded, some clay, dark tan	░	SP
		212.0-214.0ft (CL) SILTY CLAY, brown	▨	CL
215	6365	214.0-216.0ft (SP) SAND, poorly graded, dark tan	░	SP
220				

WELL DETAILS



WELL CONSTRUCTION DETAILS

2" PVC, Threaded, Flush Joint, Conical

WELL CASING
Material:
Quantity:

WELL SCREEN
Material:
Quantity:

FILTER PACK
Material:
Quantity:

FILTER PACK SEAL
Material:
Quantity:

PROTECTIVE CASING
Material:
Quantity:

░	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Williams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 1 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

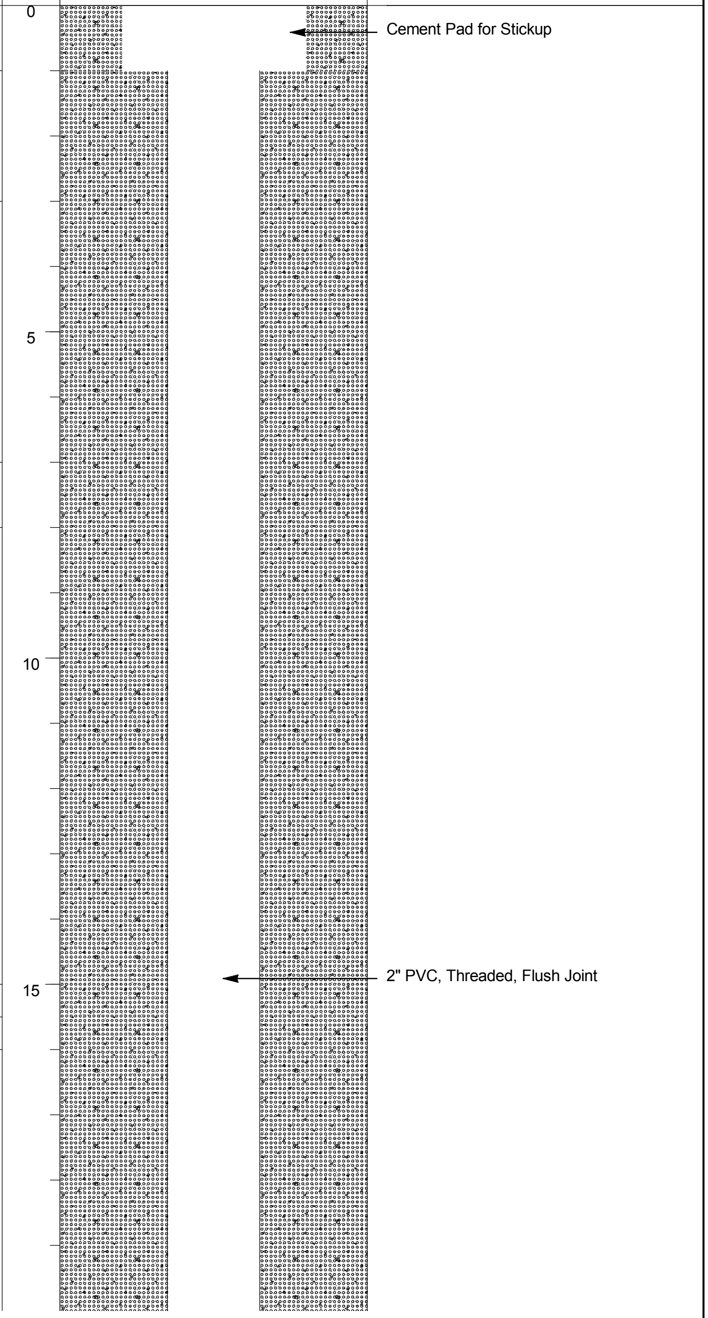
DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	USCS
0		0.0-1.0ft (OL) ORGANIC SILT, brown	OL
	6580	1.0-3.0ft (CL) CLAYEY SILT, low plasticity, some fine to coarse sand, brown	CL
5		3.0-7.0ft (SM) SILTY SAND, some fine gravel, light brown	SM
	6575	7.0-8.0ft (SP) SAND, poorly graded, trace silt, trace fine gravel, light brown	SP
10	6570	8.0-15.0ft (CL) SILTY CLAY, medium plasticity, brown	CL
15		15.0-15.5ft (SC) CLAYEY SAND, poorly graded, very light brown	SC
		15.5-16.0ft (CL) SILTY CLAY, medium plasticity, brown	CL
20	6565	16.0-59.0ft (CL) CLAYEY SILT, medium plasticity, light brown	CL

Log continued on next page

WELL DETAILS



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 3	Material: 10/20 washed silica sand, 50lb bags Quantity: 3	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ▥ USCS Silty Sand (SM)
- ░ USCS Poorly-graded Sand (SP)
- ▨ USCS Clayey Sand (SC)
- ⁘ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-04

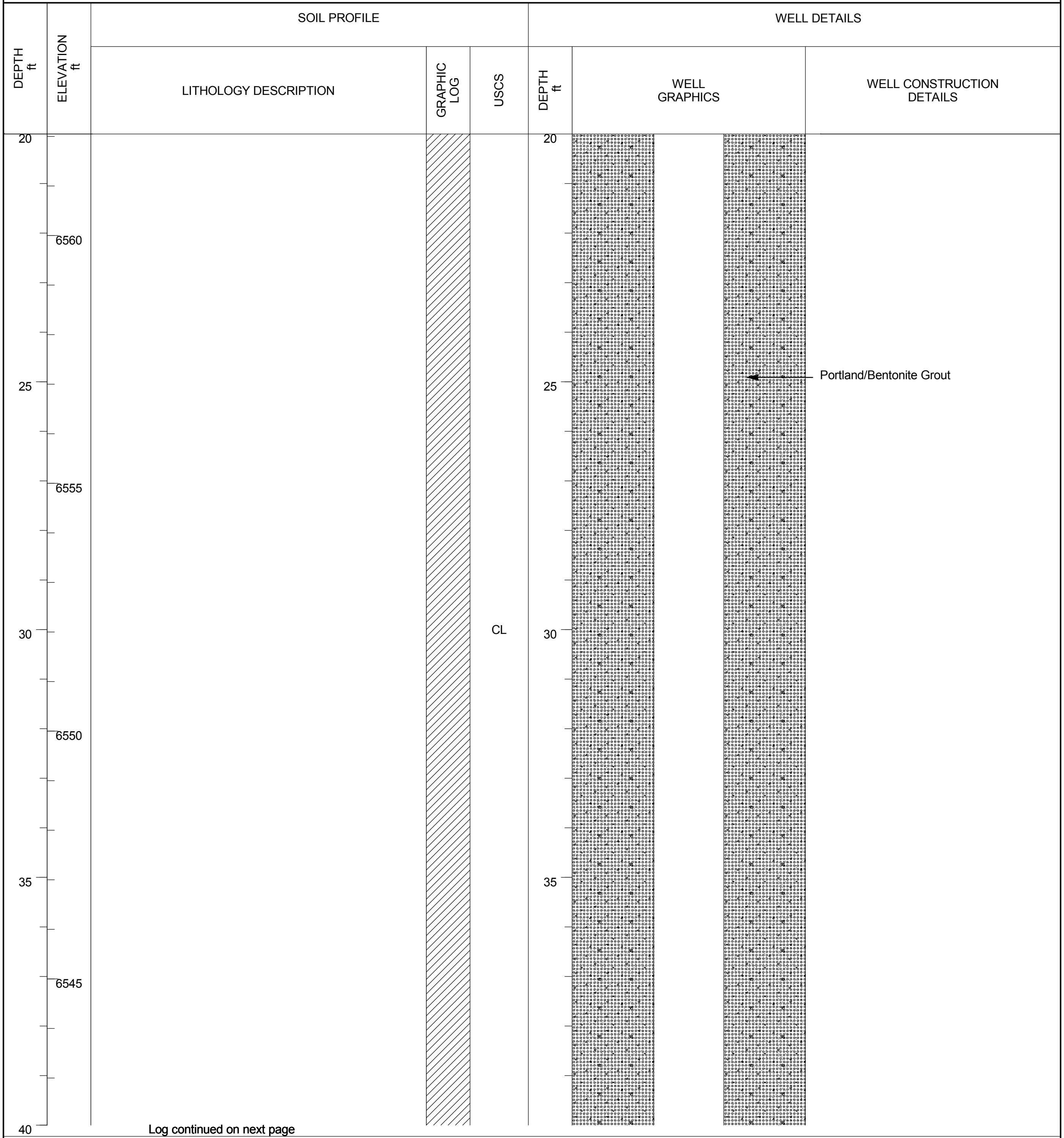
SHEET 2 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19



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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 3	Material: 10/20 washed silica sand, 50lb bags Quantity: 3	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
▨	USCS Low Plasticity Clay (CL)
▥	USCS Silty Sand (SM)
░	USCS Poorly-graded Sand (SP)
▨	USCS Clayey Sand (SC)
⁘	USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 3 of 12

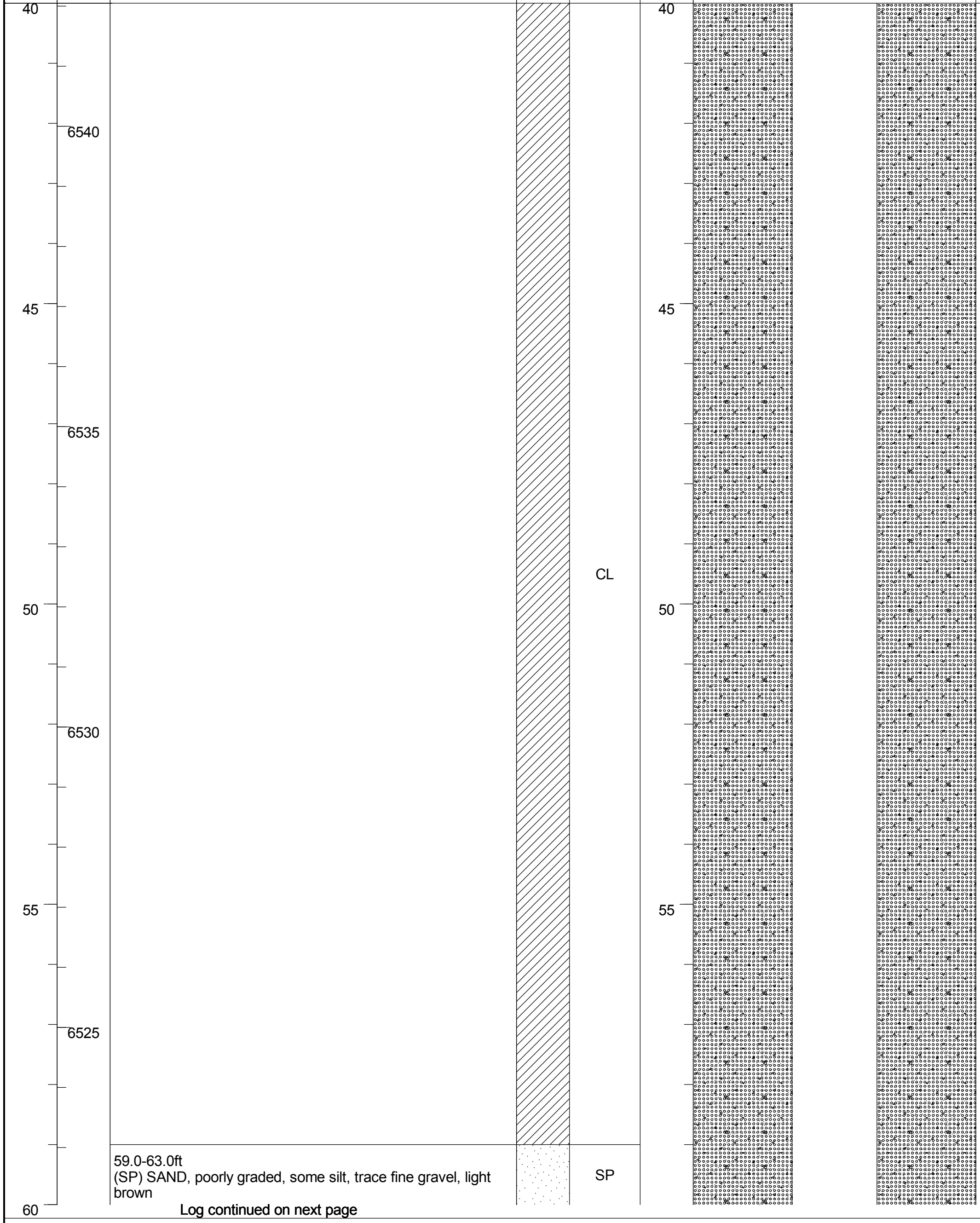
PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19

DEPTH ft	ELEVATION ft	SOIL PROFILE: LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	WELL DETAILS: DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
40–59			▨	CL			
59–60		59.0-63.0ft (SP) SAND, poorly graded, some silt, trace fine gravel, light brown	⁘	SP			



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WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
▨	USCS Low Plasticity Clay (CL)
▥	USCS Silty Sand (SM)
⁘	USCS Poorly-graded Sand (SP)
▨	USCS Clayey Sand (SC)
⁘	USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 4 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 233,307.56 E: 702,002.92	DEPTH TO WATER (ft): 201.86
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6582.05	W.L. ELEVATION (ft): 6380.19
DRILLED DEPTH (ft): 226	DRILL DATE: 8/22/2013 8:02:58 AM	TOC ELEVATION (ft): 6584.26	

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
60	6520			SP
		63.0-66.0ft (CL) SILTY CLAY, medium plasticity, trace fine sand, light brown		CL
65	6515	66.0-84.0ft (SP) SAND, poorly graded, some silt, light brown		SP
70	6510			
75	6505			
80				

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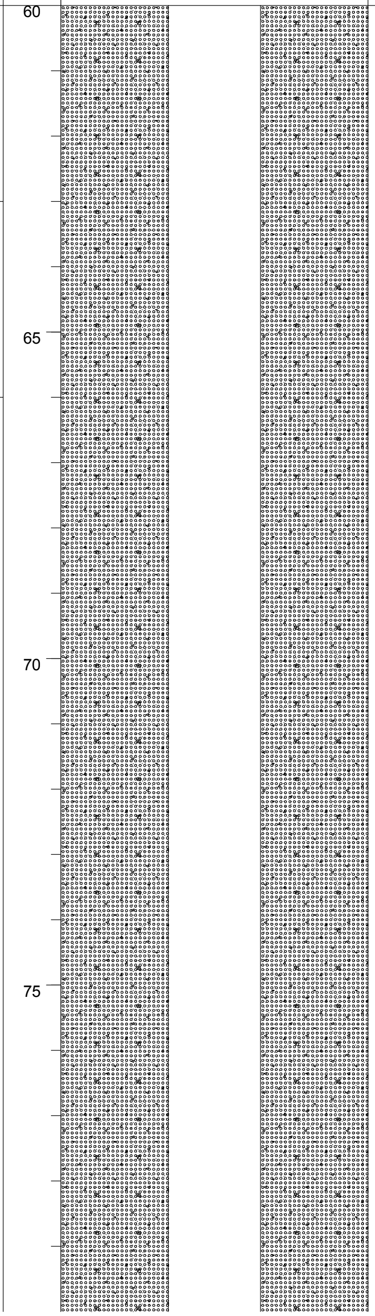
WELL DETAILS

DEPTH ft — WELL GRAPHICS — WELL CONSTRUCTION DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ▥ USCS Silty Sand (SM)
- ⬚ USCS Poorly-graded Sand (SP)
- ▨ USCS Clayey Sand (SC)
- ⁘ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 5 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
80				
	6500			SP
		84.0-96.0ft (CL) SILTY CLAY, low plasticity, some fine to medium sand, light brown		
85				
	6495			
90				CL
	6490			
95				
		96.0-120.0ft (SW) SAND, well graded, some silt, trace fine gravel, light brown		
	6485			
				SW
100				

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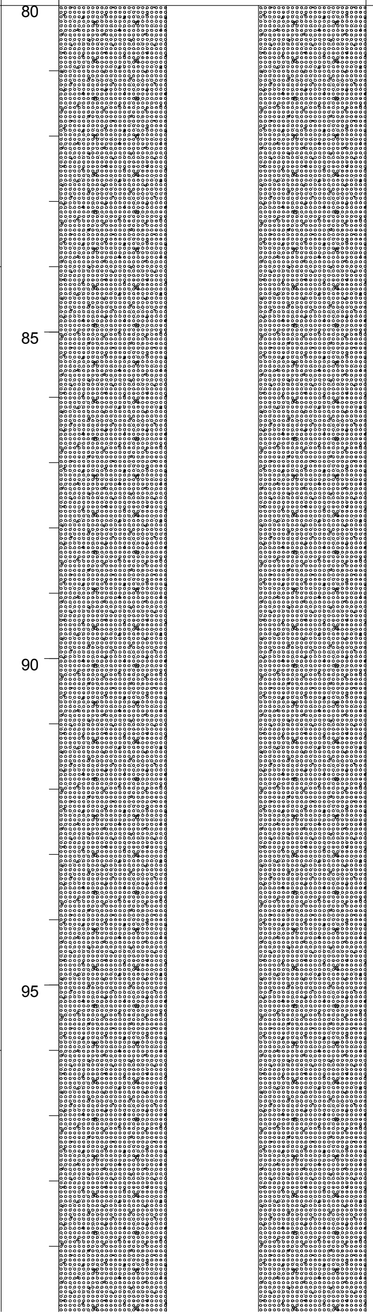
WELL DETAILS

DEPTH ft

WELL GRAPHICS

WELL CONSTRUCTION DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
⁘ USCS Poorly-graded Sand (SP)
▨ USCS Clayey Sand (SC)
⁘ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

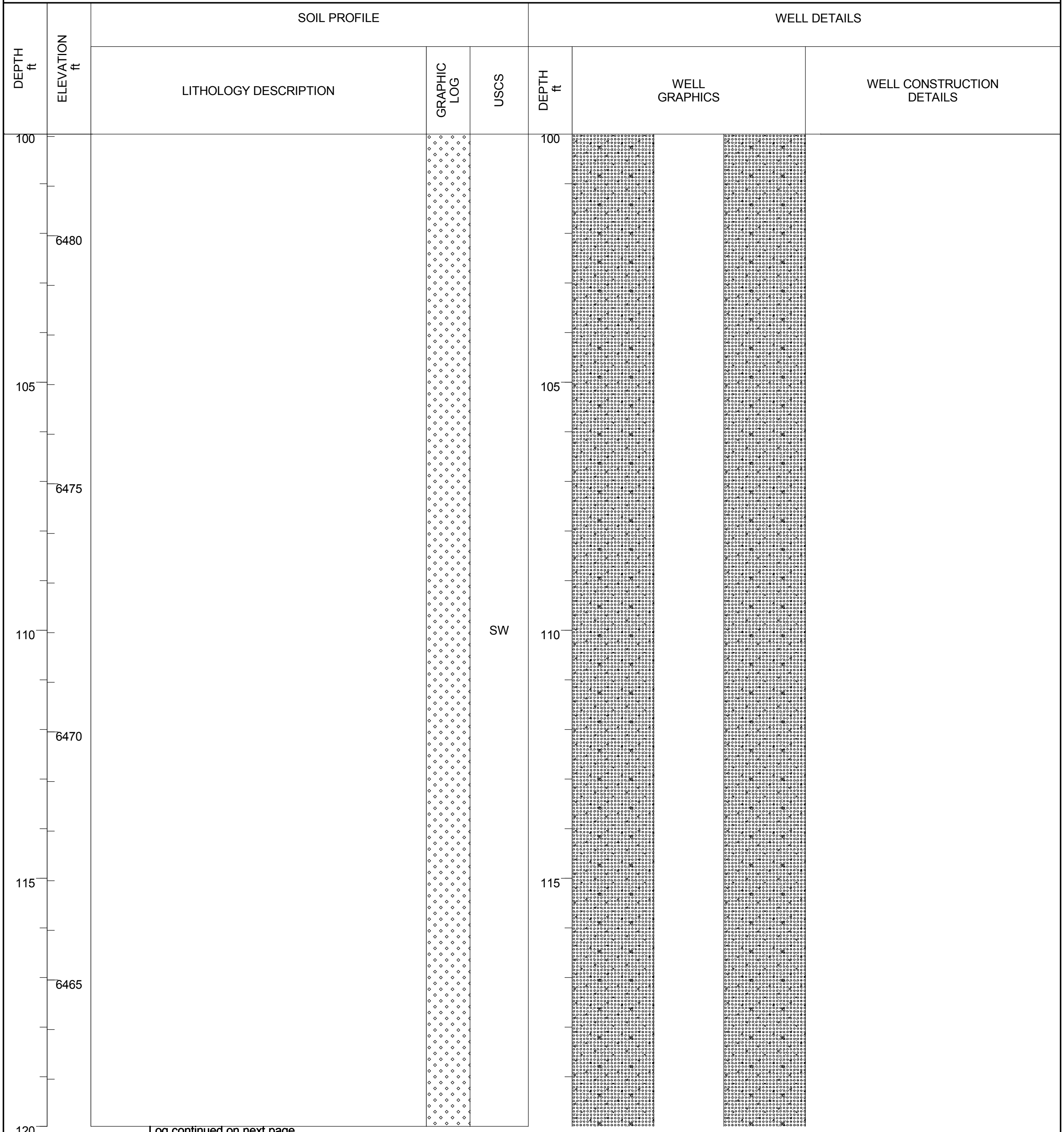
SHEET 6 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19



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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 3	Material: 10/20 washed silica sand, 50lb bags Quantity: 3	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)

▨ USCS Low Plasticity Clay (CL)

▥ USCS Silty Sand (SM)

⬚ USCS Poorly-graded Sand (SP)

▨ USCS Clayey Sand (SC)

⁘ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 7 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
120	6460	120.0-124.0ft (CL) SILTY CLAY, medium plasticity, some medium to coarse sand, light brown	▨	CL
125		124.0-126.0ft (SC) CLAYEY SAND, well graded, trace fine gravel, light brown	▨	SC
130	6455 6450 6445	126.0-139.0ft (SM) SILTY SAND, fine to coarse grained, trace fine gravel, light brown	▥	SM
140		139.0-146.0ft (SC) CLAYEY SAND, fine to coarse grained, poorly graded, trace fine gravel, light brown	▨	SC

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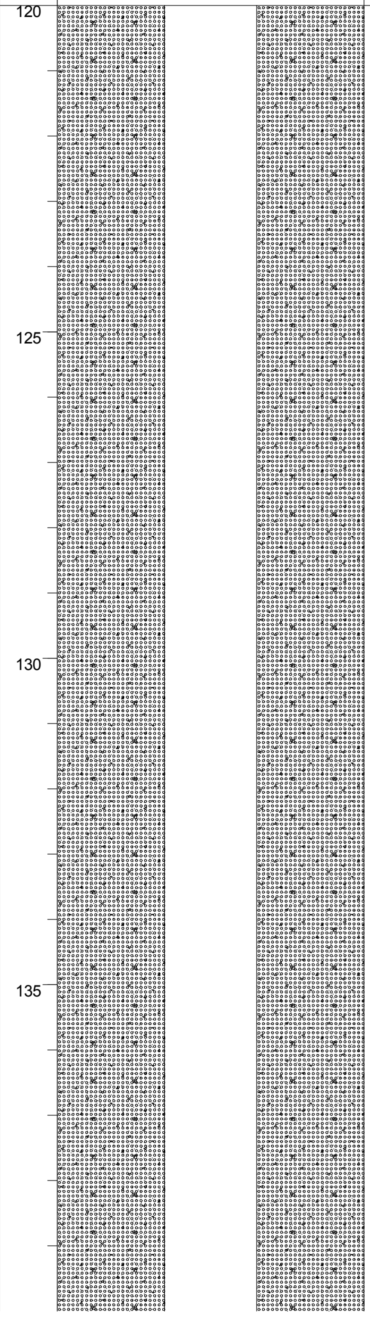
WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
▨	USCS Low Plasticity Clay (CL)
▥	USCS Silty Sand (SM)
⁘	USCS Poorly-graded Sand (SP)
▨	USCS Clayey Sand (SC)
⁘	USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 8 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

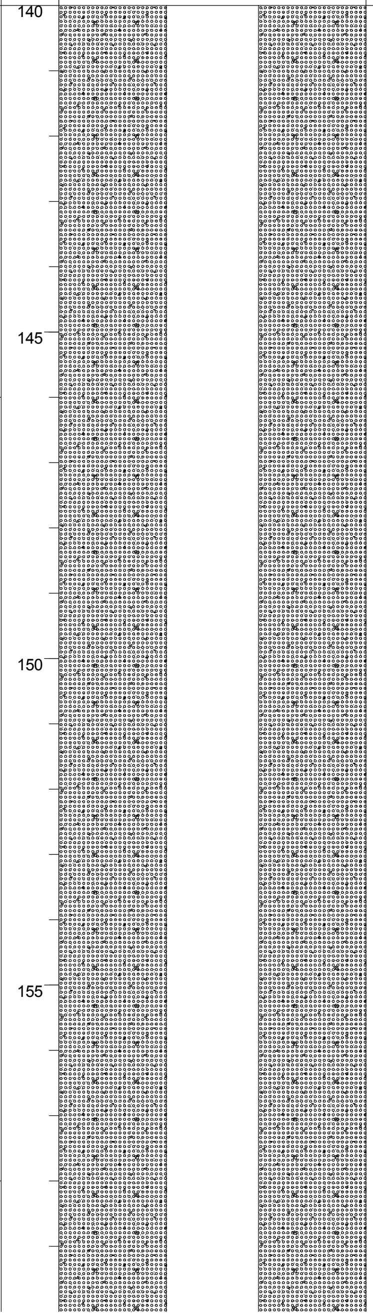
COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
140	6440		▨	SC
145				
	6435	146.0-158.0ft (SW) SAND, well graded, some fine gravel, trace silt, light brown	⁘	SW
150	6430			
155	6425			
		158.0-166.0ft (SW) SAND, well graded, some silt, light brown	⁘	SW
160		Log continued on next page		

WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
⁘ USCS Poorly-graded Sand (SP)
▨ USCS Clayey Sand (SC)
⁘ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

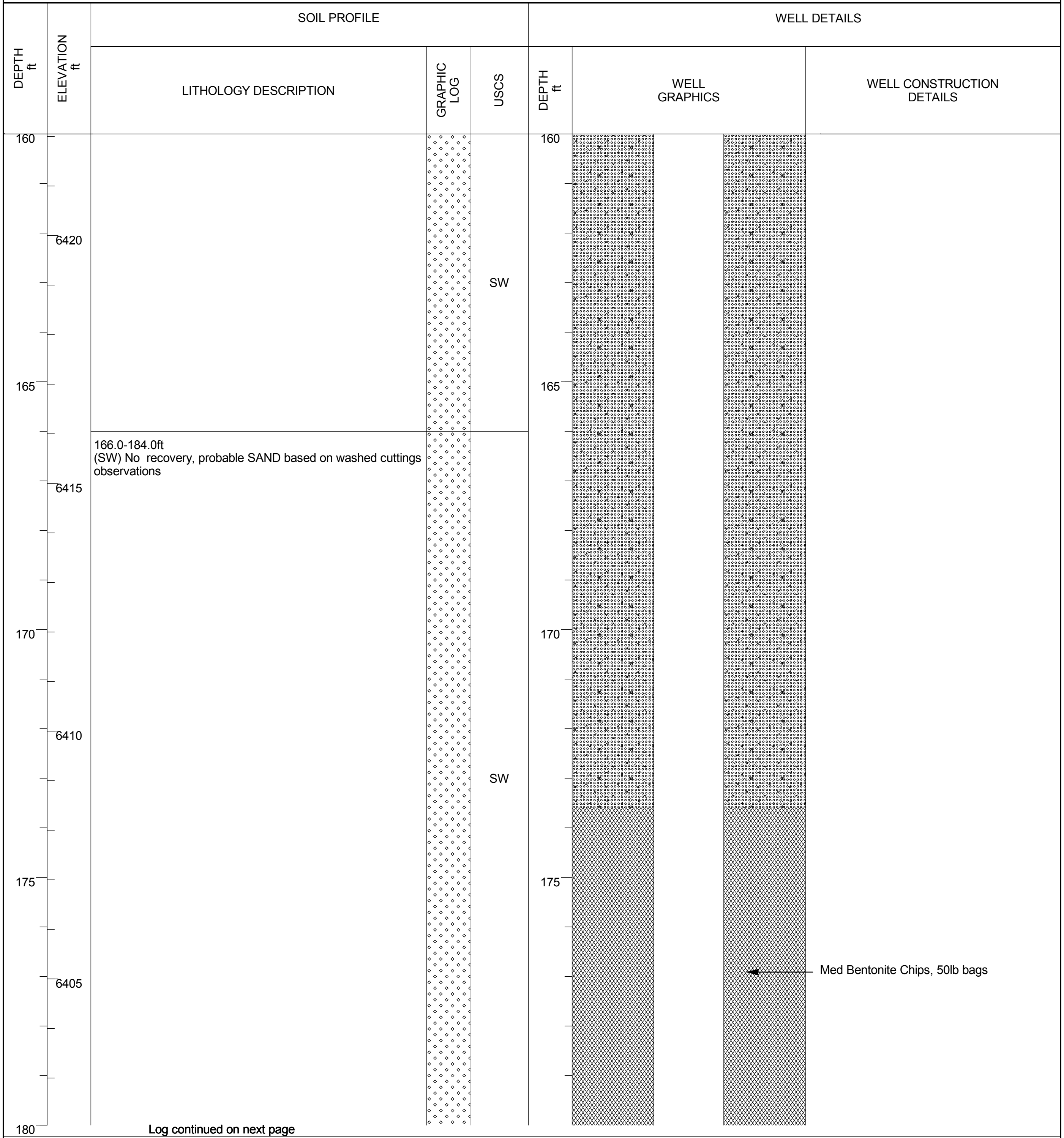
SHEET 9 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19



166.0-184.0ft
(SW) No recovery, probable SAND based on washed cuttings observations

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 3	Material: 10/20 washed silica sand, 50lb bags Quantity: 3	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	▥ USCS Silty Sand (SM)	⛶ USCS Poorly-graded Sand (SP)
▨ USCS Clayey Sand (SC)	⁘ USCS Well-graded Sand (SW)		

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

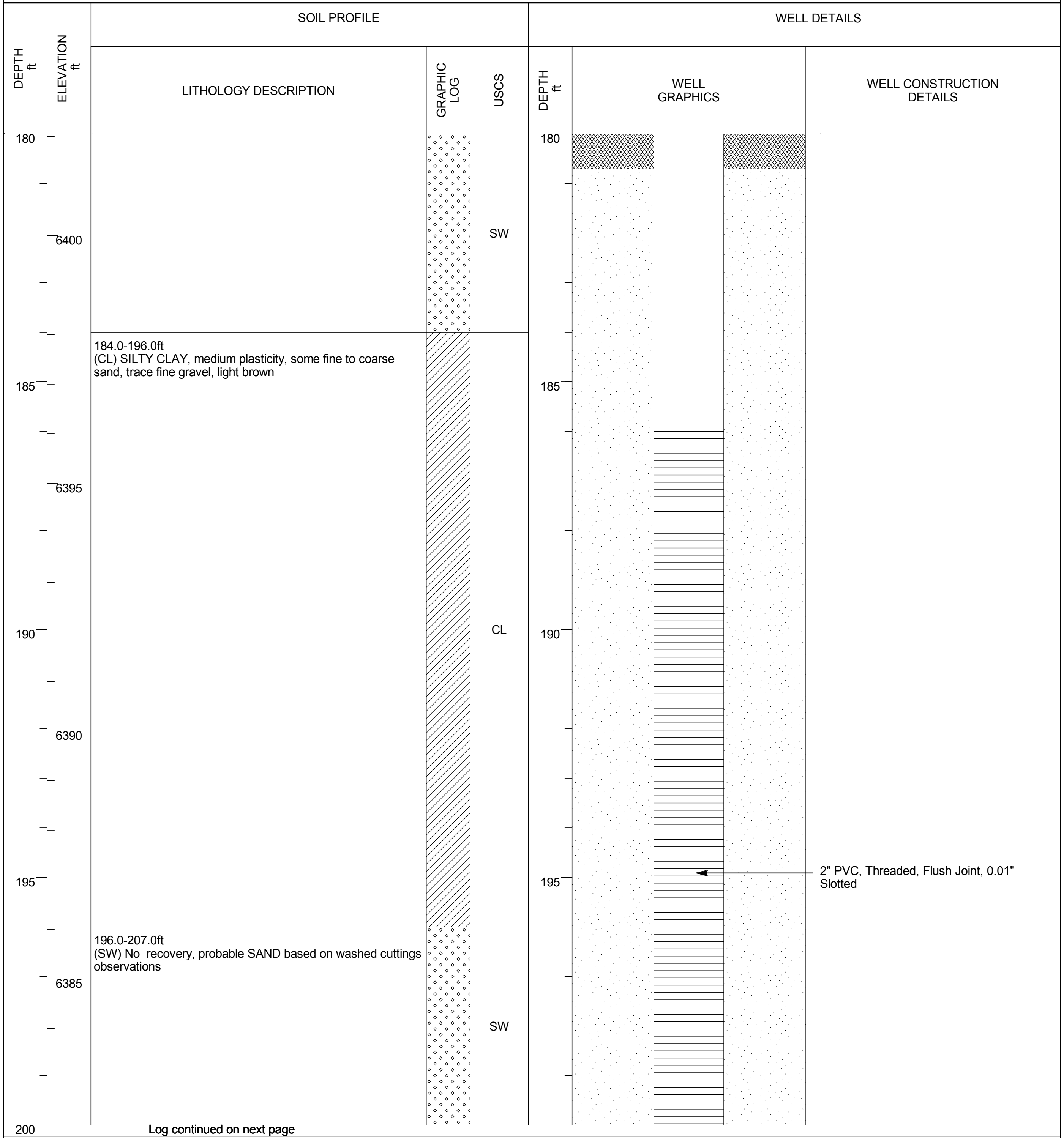
Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

SHEET 10 of 12

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 233,307.56 E: 702,002.92	DEPTH TO WATER (ft): 201.86
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6582.05	W.L. ELEVATION (ft): 6380.19
DRILLED DEPTH (ft): 226	DRILL DATE: 8/22/2013 8:02:58 AM	TOC ELEVATION (ft): 6584.26	



184.0-196.0ft
(CL) SILTY CLAY, medium plasticity, some fine to coarse sand, trace fine gravel, light brown

196.0-207.0ft
(SW) No recovery, probable SAND based on washed cuttings observations

2" PVC, Threaded, Flush Joint, 0.01" Slotted

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 3	Material: 10/20 washed silica sand, 50lb bags Quantity: 3	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	▥ USCS Silty Sand (SM)	⬚ USCS Poorly-graded Sand (SP)
▨ USCS Clayey Sand (SC)	⁘ USCS Well-graded Sand (SW)		

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-04

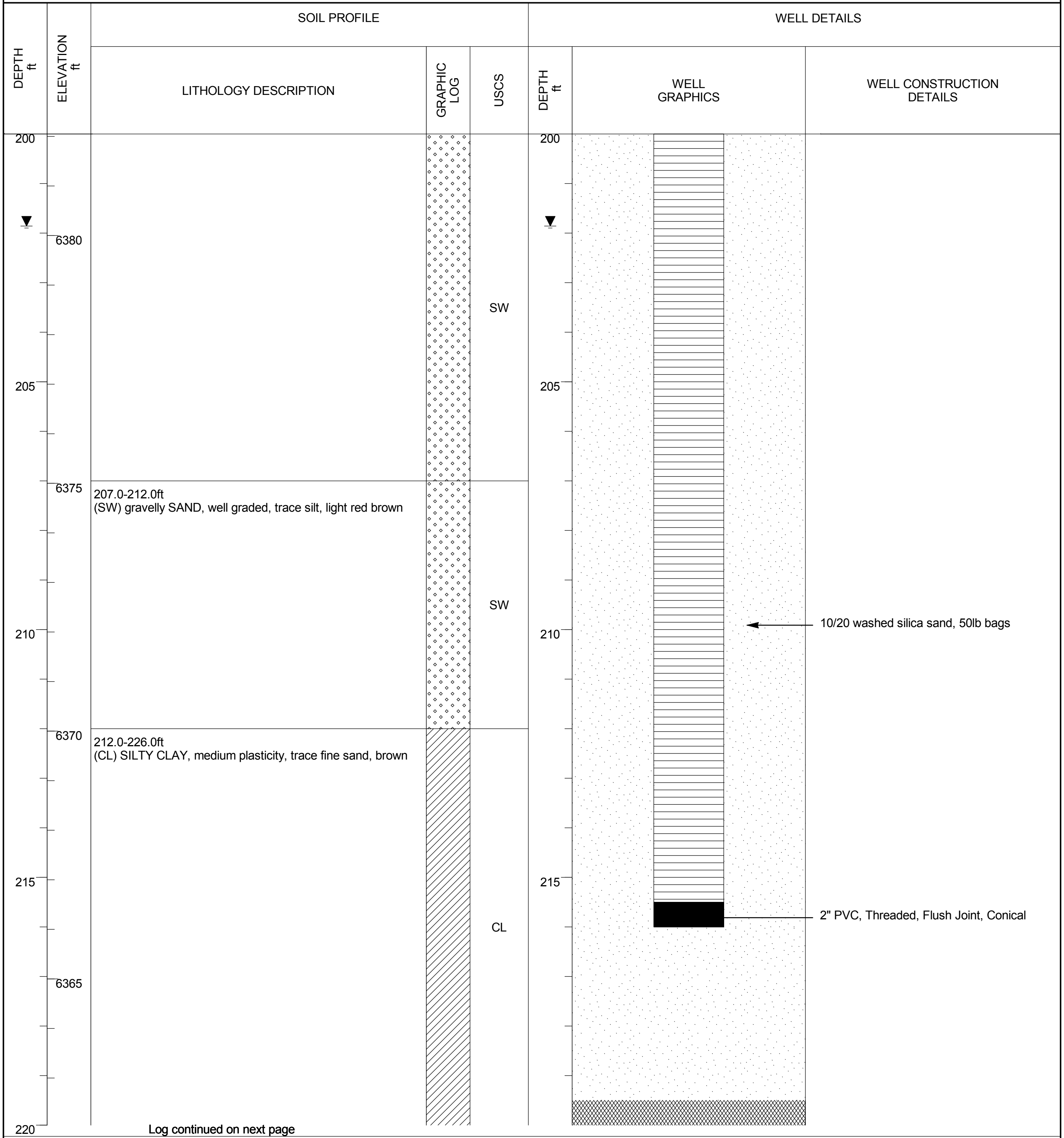
SHEET 11 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19



207.0-212.0ft
(SW) gravelly SAND, well graded, trace silt, light red brown

212.0-226.0ft
(CL) SILTY CLAY, medium plasticity, trace fine sand, brown

10/20 washed silica sand, 50lb bags

2" PVC, Threaded, Flush Joint, Conical

Log continued on next page

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)	▨	USCS Low Plasticity Clay (CL)	▥	USCS Silty Sand (SM)	░	USCS Poorly-graded Sand (SP)
▨	USCS Clayey Sand (SC)	░	USCS Well-graded Sand (SW)				

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

RECORD OF WELL CONSTRUCTION GMW-2013-04

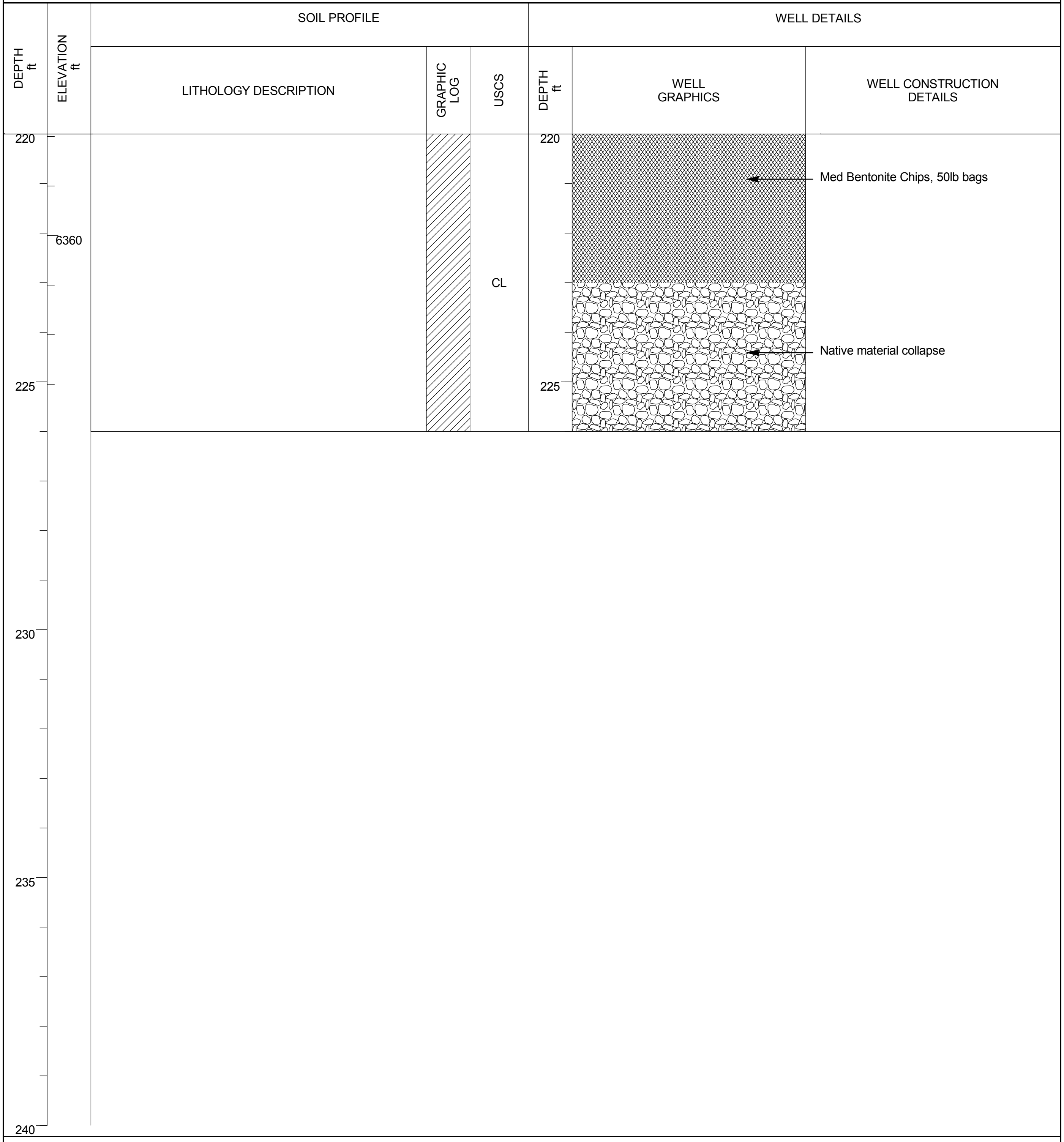
SHEET 12 of 12

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 226

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/22/2013 8:02:58 AM

COORDS: N: 233,307.56 E: 702,002.92
GS ELEVATION (ft): 6582.05
TOC ELEVATION (ft): 6584.26

DEPTH TO WATER (ft): 201.86
W.L. ELEVATION (ft): 6380.19



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 3

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 3

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
░ USCS Poorly-graded Sand (SP)
▨ USCS Clayey Sand (SC)
░ USCS Well-graded Sand (SW)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Pike
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 1 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

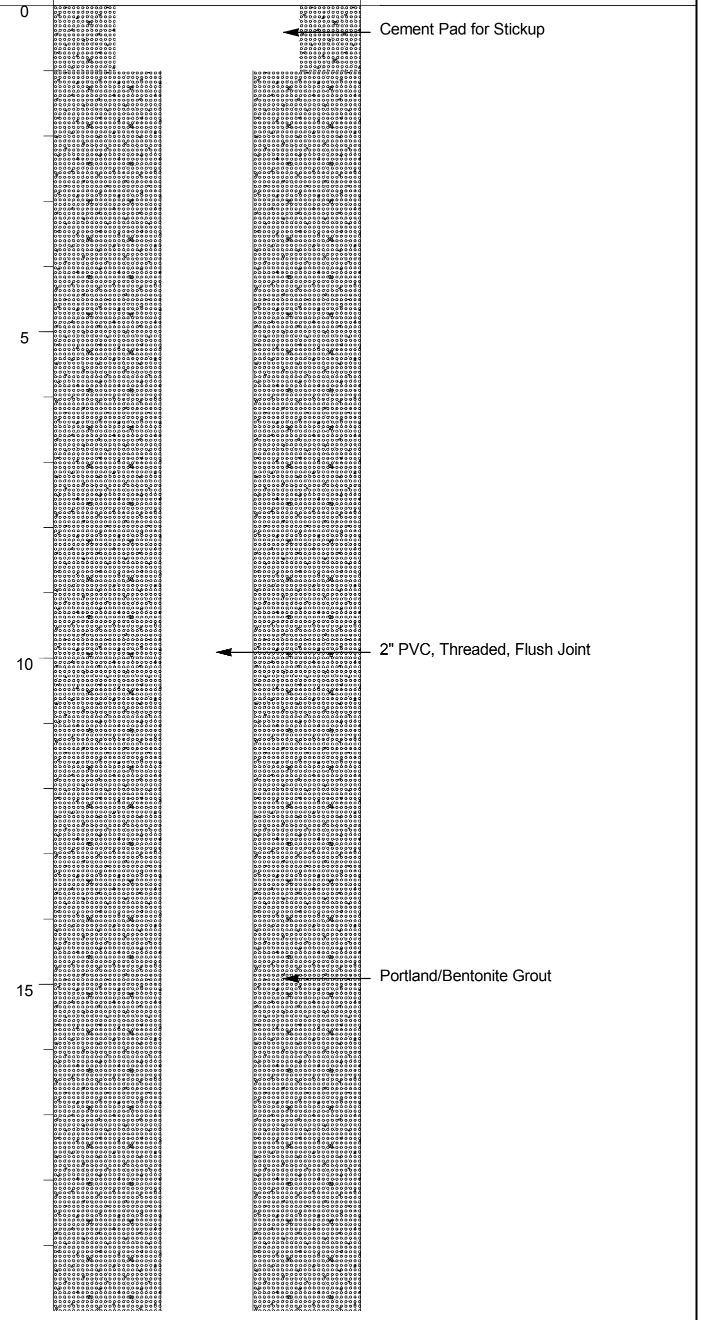
DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
0	6560	0.0-1.0ft (OL) ORGANIC SILT, light brown		OL
		1.0-3.0ft (CL) SILTY CLAY, some fine to coarse sand, tan		CL
5	6555	3.0-8.0ft (SM) SILTY SAND, trace clay, tan		SM
10 15 20	6550 6545	8.0-20.0ft (SC) CLAYEY SAND, some silt, tan		SC

Log continued on next page

WELL DETAILS



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 13	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 2	Material: 10/20 washed silica sand, 50lb bags Quantity: 2	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
▨ USCS Clayey Sand (SC)
░ USCS Poorly-graded Sand (SP)
░ USCS Well-graded Sand (SW)
▨ USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 2 of 10

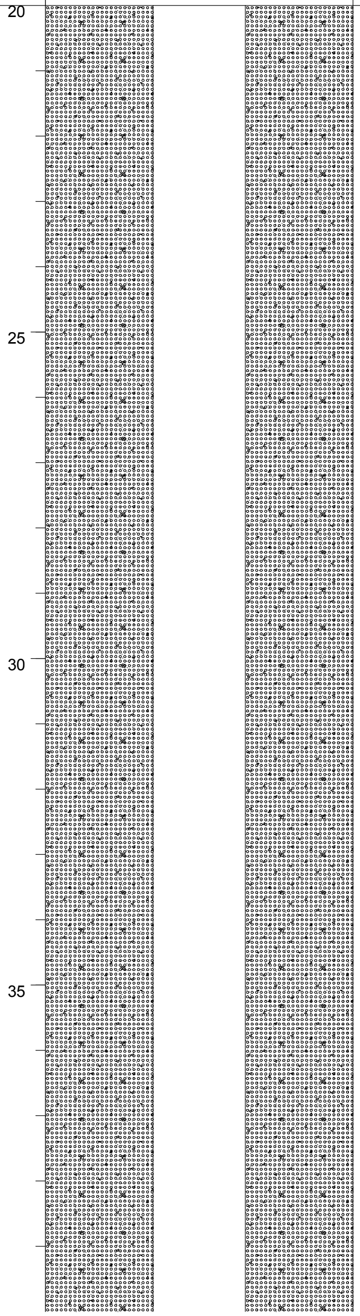
PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 232,172.46 E: 702,171.91	DEPTH TO WATER (ft): 159.34
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6560.67	W.L. ELEVATION (ft): 6401.33
DRILLED DEPTH (ft): 190	DRILL DATE: 8/14/2013 11:44:06 AM	TOC ELEVATION (ft): 6563.09	

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
20	6540	20.0-30.0ft (CL) SILTY CLAY, some fine to coarse sand, dark tan	▨	CL
		24.0-34.0ft (SC) CLAYEY SAND, some fine gravel, tan	▨	SC
25	6535			
30	6530	30.0-34.0ft (CL) SILTY CLAY, some fine to medium sand, light tan	▨	CL
		34.0-40.0ft (SC) CLAYEY SAND, some fine gravel, tan	▨	SC
35	6525			
		38.0-40.0ft (CL) SILTY CLAY, some fine gravel, some fine to coarse sand, tan	▨	CL
40				

Log continued on next page

WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	▥ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)
░ USCS Poorly-graded Sand (SP)	⁘ USCS Well-graded Sand (SW)	▰ USCS High Plasticity Clay (CH)	

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 3 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

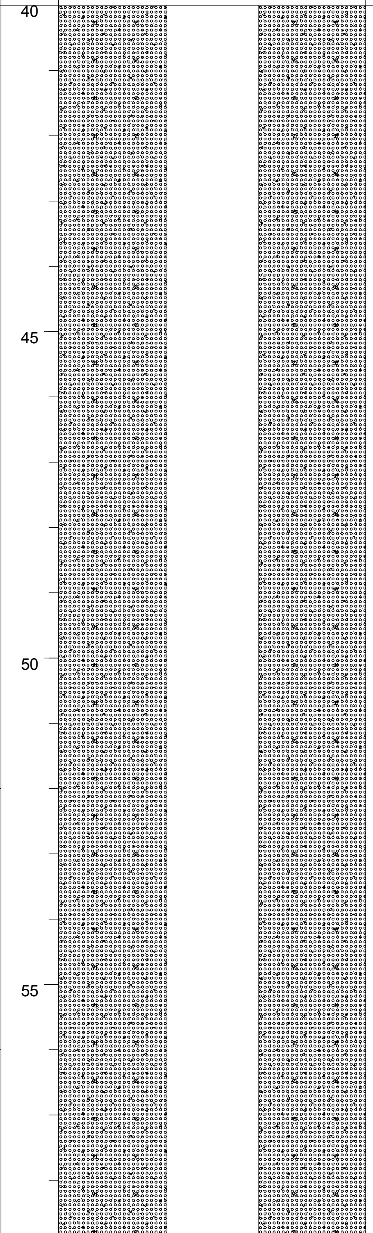
DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
40	6520	40.0-52.0ft (SM) SILTY SAND, poorly graded, tan	▥	SM
45	6515			
50	6510			
		52.0-56.0ft (SM) SILTY SAND, poorly graded, trace fine gravel, light tan	▥	SM
55	6505			
		56.0-65.0ft (SC) CLAYEY SAND, some silt, tan	▨	SC
60		Log continued on next page		

WELL DETAILS

DEPTH ft | WELL GRAPHICS | WELL CONSTRUCTION DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ▤ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ▥ USCS Silty Sand (SM)
- ▨ USCS Clayey Sand (SC)
- ░ USCS Poorly-graded Sand (SP)
- ⁘ USCS Well-graded Sand (SW)
- ▨ USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

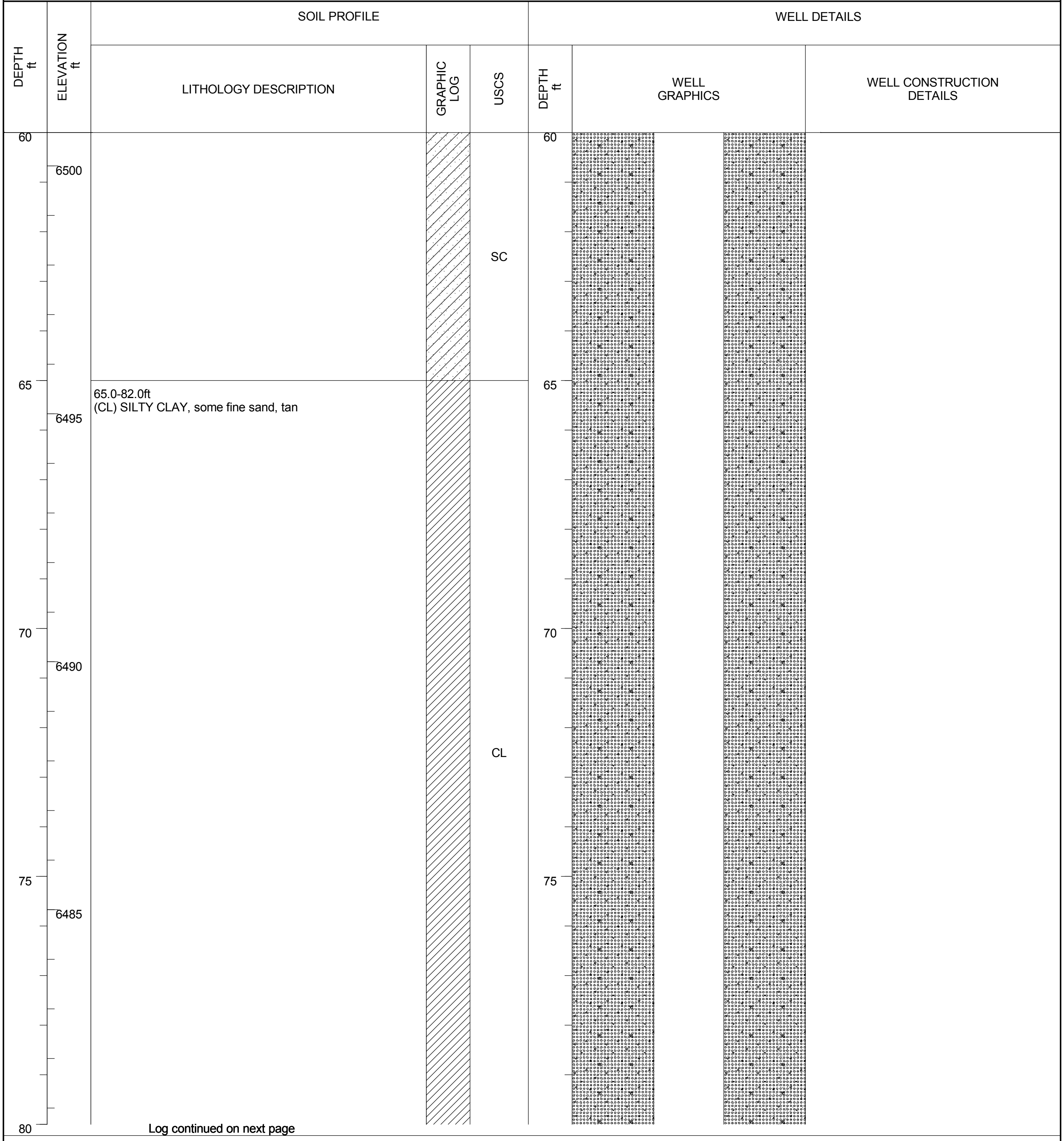
SHEET 4 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33



65.0-82.0ft
(CL) SILTY CLAY, some fine sand, tan

Log continued on next page

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ▨ USCS Low Plasticity Clay (CL)
- ▥ USCS Silty Sand (SM)
- ▨ USCS Clayey Sand (SC)
- ░ USCS Poorly-graded Sand (SP)
- ░ USCS Well-graded Sand (SW)
- ▨ USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 5 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

		SOIL PROFILE		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
80	6480		▨	CL
		82.0-84.0ft (SP) SAND, poorly graded, tan		SP
85	6475	84.0-90.0ft (SW) gravelly SAND, well graded, trace silt, tan		SW
90	6470	90.0-95.0ft (CL) SILTY CLAY, some fine to medium sand, light brown	▨	CL
95	6465	95.0-100.0ft (SW) gravelly SAND, well graded, tan		SW
100				

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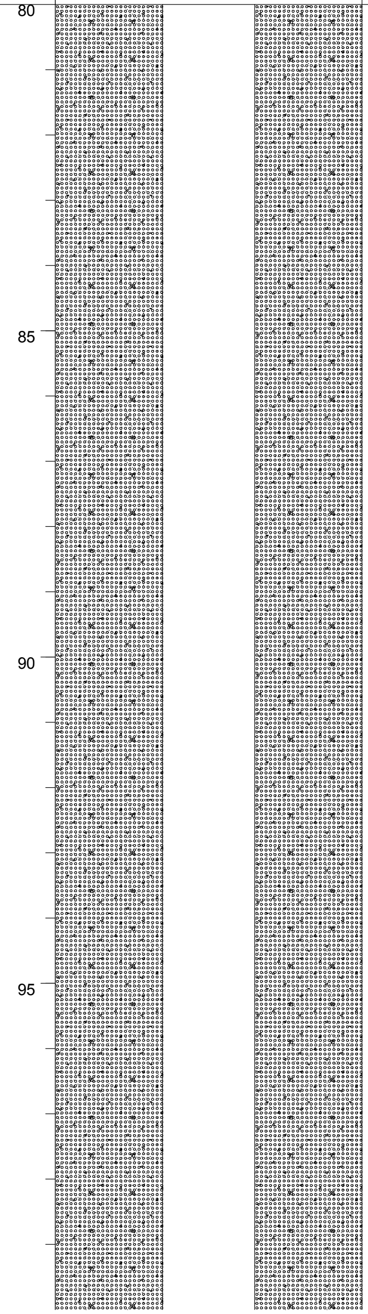
WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)	▨ USCS Low Plasticity Clay (CL)	▥ USCS Silty Sand (SM)	▨ USCS Clayey Sand (SC)
░ USCS Poorly-graded Sand (SP)	⁘ USCS Well-graded Sand (SW)	▩ USCS High Plasticity Clay (CH)	

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 6 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

DEPTH ft	ELEVATION ft	SOIL PROFILE LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
100	6460	100.0-110.0ft (SW) gravelly SAND, well graded, tan		SW
105	6455			
110	6450	110.0-115.0ft (SC) CLAYEY SAND, well graded, some fine gravel, tan		SC
115	6445	115.0-116.0ft (CL) SILTY CLAY, some fine to coarse sand, some medium to coarse gravel, light brown		CL
		116.0-120.0ft (SW) SAND, well graded, tan		SW
120				

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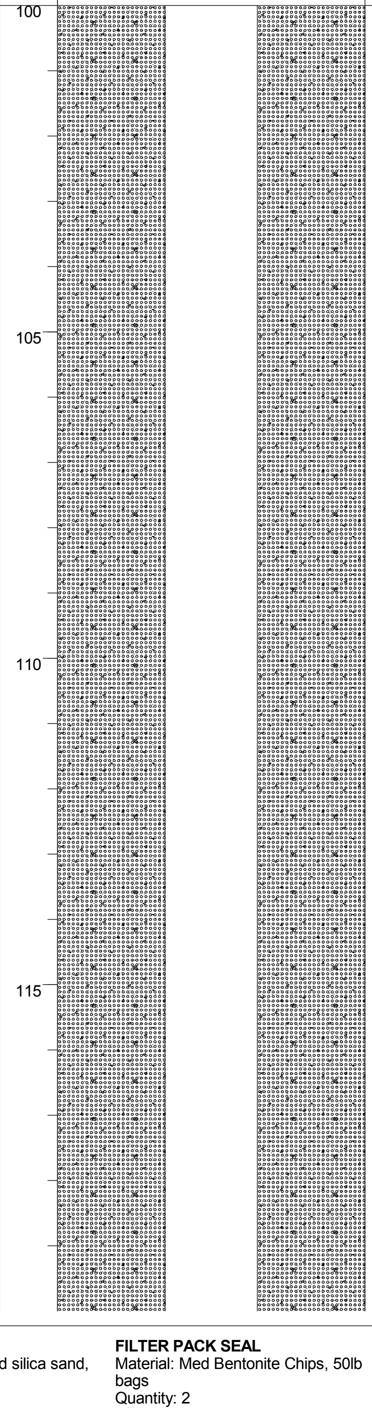
WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
▨	USCS Low Plasticity Clay (CL)
▥	USCS Silty Sand (SM)
▨	USCS Clayey Sand (SC)
░	USCS Poorly-graded Sand (SP)
░	USCS Well-graded Sand (SW)
▨	USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

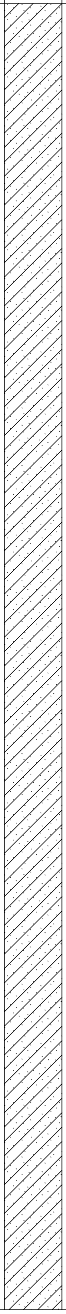
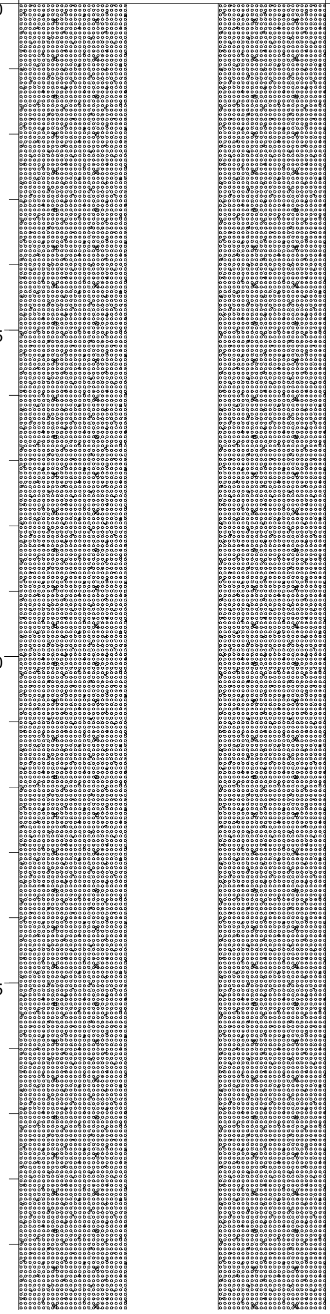
SHEET 7 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

		SOIL PROFILE			WELL DETAILS		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
120		120.0-140.0ft (SC) CLAYEY SAND, some fine gravel, tan			120		
	6440						
125					125		
	6435						
130				SC	130		
	6430						
135					135		
	6425						
140							

Log continued on next page

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

▤	USCS Low Plasticity Organic silt or clay (OL)	▨	USCS Low Plasticity Clay (CL)	▥	USCS Silty Sand (SM)	▨	USCS Clayey Sand (SC)
░	USCS Poorly-graded Sand (SP)	░	USCS Well-graded Sand (SW)	▨	USCS High Plasticity Clay (CH)		

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-06

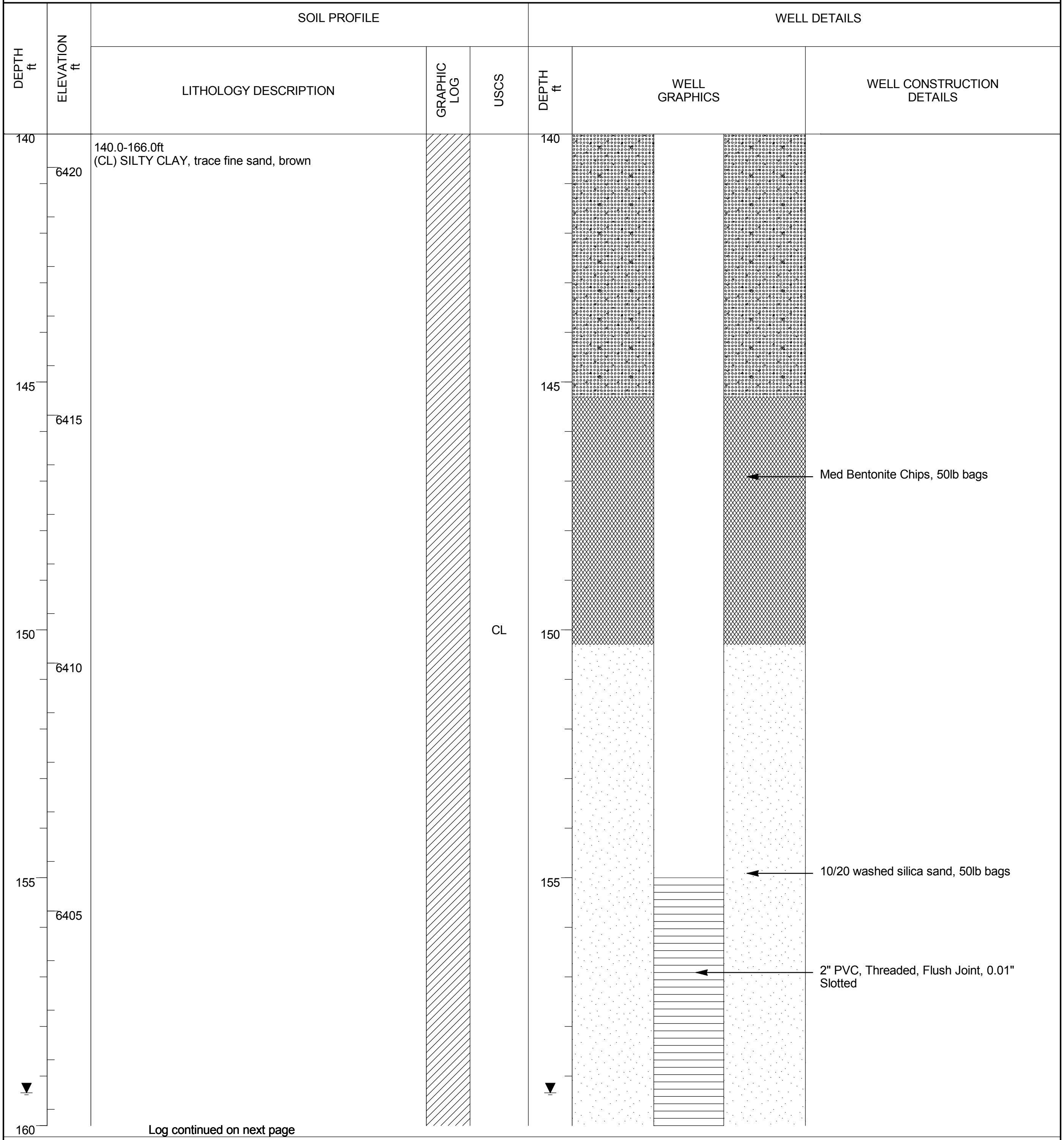
SHEET 8 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33



WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 13	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 2	Material: 10/20 washed silica sand, 50lb bags Quantity: 2	Material: Med Bentonite Chips, 50lb bags Quantity: 2	Material: 6", Stickup, Lockable Steel Quantity: 1

▤ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
▨ USCS Clayey Sand (SC)
░ USCS Poorly-graded Sand (SP)
░ USCS Well-graded Sand (SW)
▰ USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

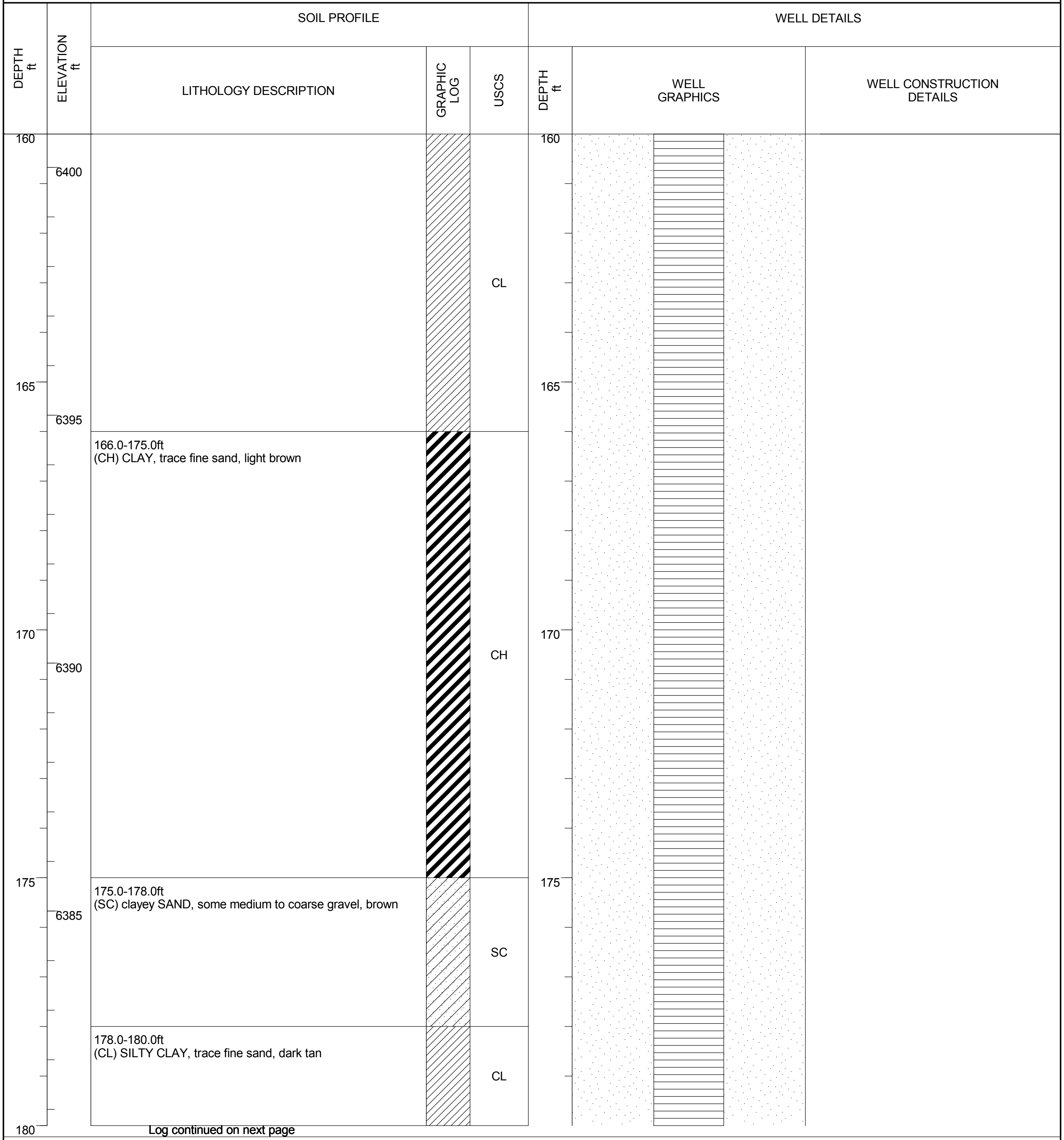
SHEET 9 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33



166.0-175.0ft
(CH) CLAY, trace fine sand, light brown

175.0-178.0ft
(SC) clayey SAND, some medium to coarse gravel, brown

178.0-180.0ft
(CL) SILTY CLAY, trace fine sand, dark tan

Log continued on next page

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
▨ USCS Low Plasticity Clay (CL)
▥ USCS Silty Sand (SM)
▨ USCS Clayey Sand (SC)
⠿ USCS Poorly-graded Sand (SP)
⠿ USCS Well-graded Sand (SW)
▨ USCS High Plasticity Clay (CH)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-06

SHEET 10 of 10

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 190

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/14/2013 11:44:06 AM

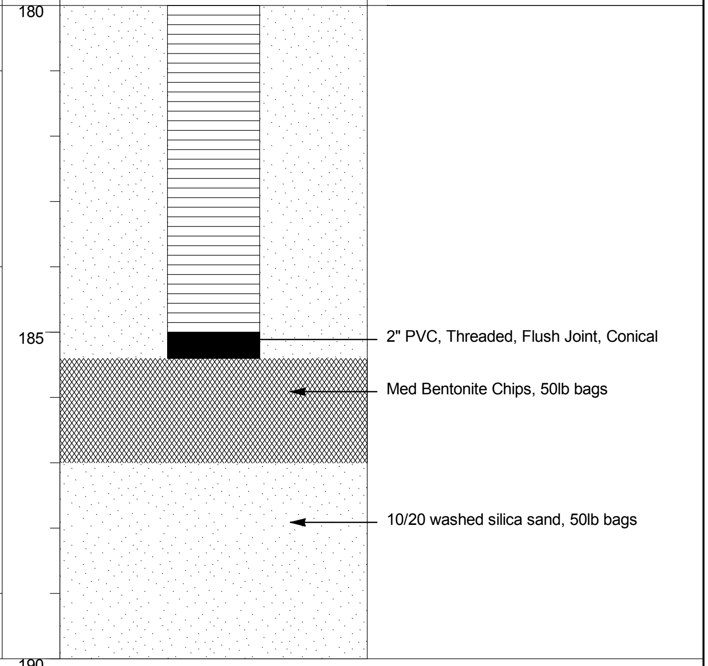
COORDS: N: 232,172.46 E: 702,171.91
GS ELEVATION (ft): 6560.67
TOC ELEVATION (ft): 6563.09

DEPTH TO WATER (ft): 159.34
W.L. ELEVATION (ft): 6401.33

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
180	6380	180.0-181.0ft tan, Cemented sandstone		
		181.0-184.0ft (CL) SILTY CLAY, trace fine to coarse sand, trace fine to medium gravel, tan	▨	CL
185	6375	184.0-189.0ft (CL) SILTY CLAY, trace fine sand, some fine to medium gravel, brown	▨	CL
		189.0-190.0ft (SP) SAND, trace clay, tan, 1 ft zone sandwiched by cementation layers	░	SP
190				
195				
200				

WELL DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 13

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 2

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 2

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 2

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)	▨	USCS Low Plasticity Clay (CL)	▥	USCS Silty Sand (SM)	▨	USCS Clayey Sand (SC)
░	USCS Poorly-graded Sand (SP)	⁘	USCS Well-graded Sand (SW)	▰	USCS High Plasticity Clay (CH)		

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 1 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

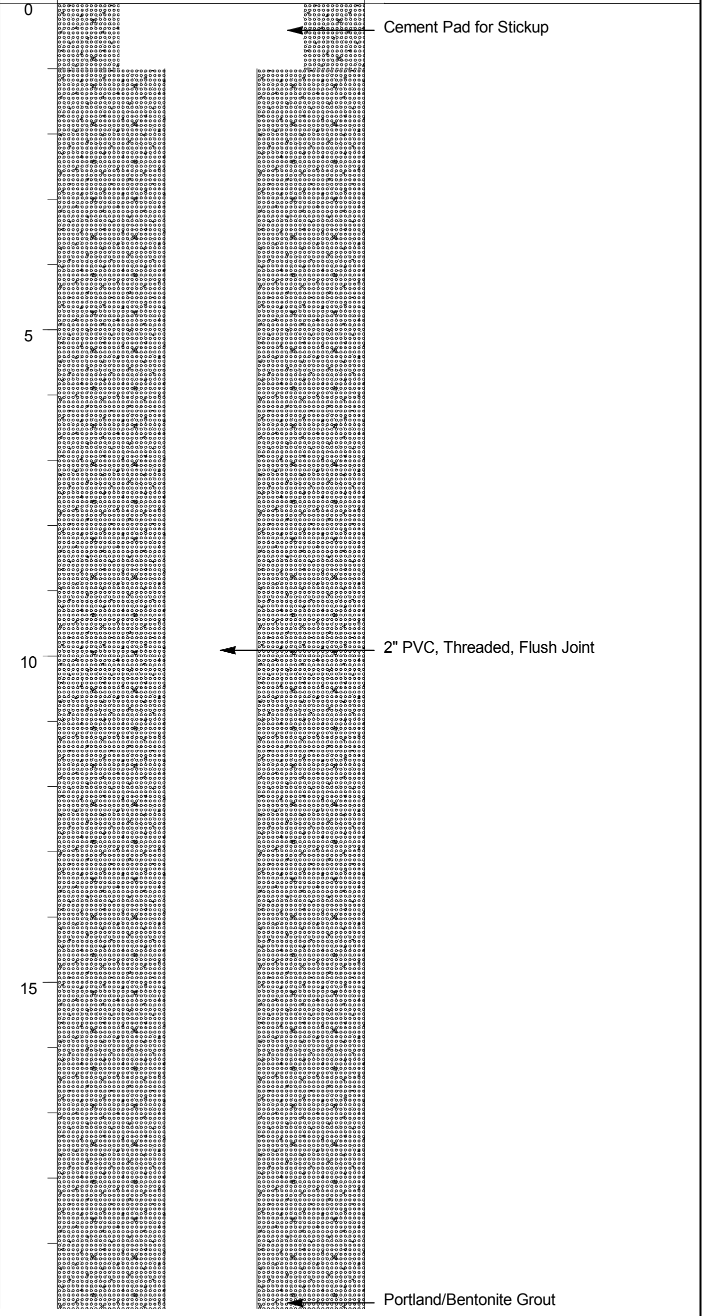
COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
0	6565	0.0-1.0ft (OL) ORGANIC SILT, dark brown	☰	OL
		1.0-4.0ft (SP) SAND, some silty clay, tan	⁘	SP
		4.0-5.0ft (CL) SILTY CLAY, some fine to coarse sand, brown	▨	CL
5	6560	5.0-7.0ft (SP) SAND, poorly graded, some silty clay, tan	⁘	SP
		7.0-11.0ft (CL) SILTY CLAY, trace fine to coarse sand, brown	▨	CL
10	6555	11.0-16.0ft (SP) SAND, poorly graded, some fine to medium gravel, tan	⁘	SP
15	6550	16.0-40.0ft (SP) SAND, poorly graded, tan	⁘	SP
20		Log continued on next page		

WELL DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)

⁘ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 2 of 16

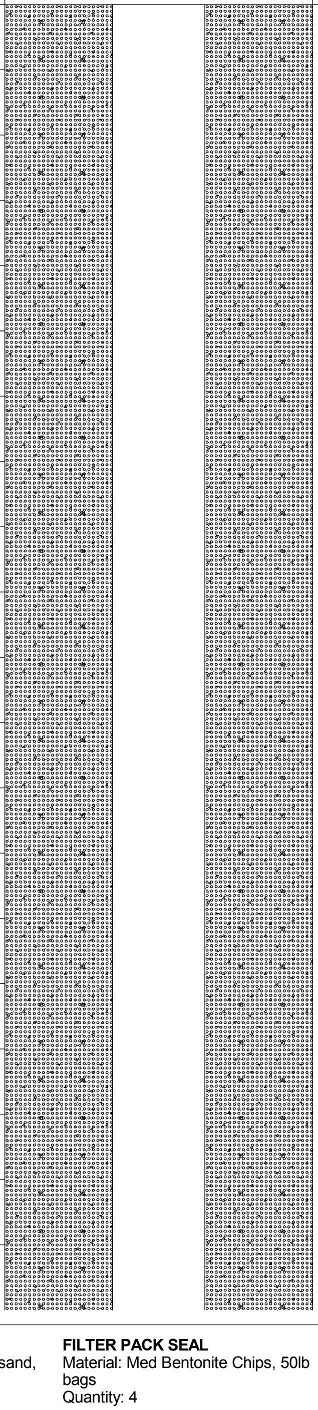
PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

DEPTH ft	ELEVATION ft	SOIL PROFILE LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	WELL DETAILS DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
20	6545		░		20		
25	6540		░		25		
30	6535		░	SP	30		
35	6530		░		35		
40		Log continued on next page					



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)

░ USCS Poorly-graded Sand (SP)

▨ USCS Low Plasticity Clay (CL)

▨ USCS Clayey Sand (SC)

○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 3 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

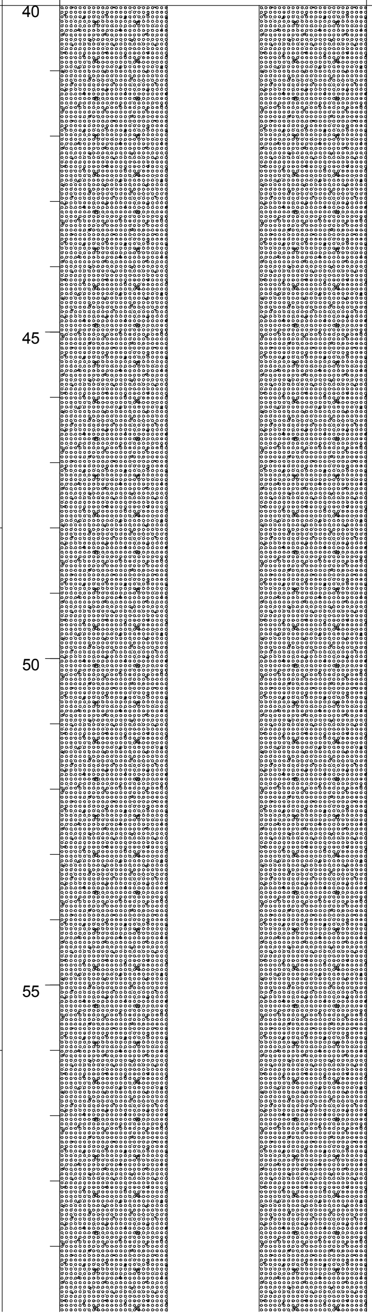
DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
40	6525	40.0-48.0ft (SC) CLAYEY SAND, light brown	▨	SC
45	6520			
48		48.0-56.0ft (SP) SAND, trace fine to medium gravel, light brown	░	SP
50	6515			
55	6510			
56		56.0-78.0ft (CL) sandy SILTY CLAY, some fine gravel, dark tan	▨	CL
60				

Log continued on next page

WELL DETAILS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
░	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

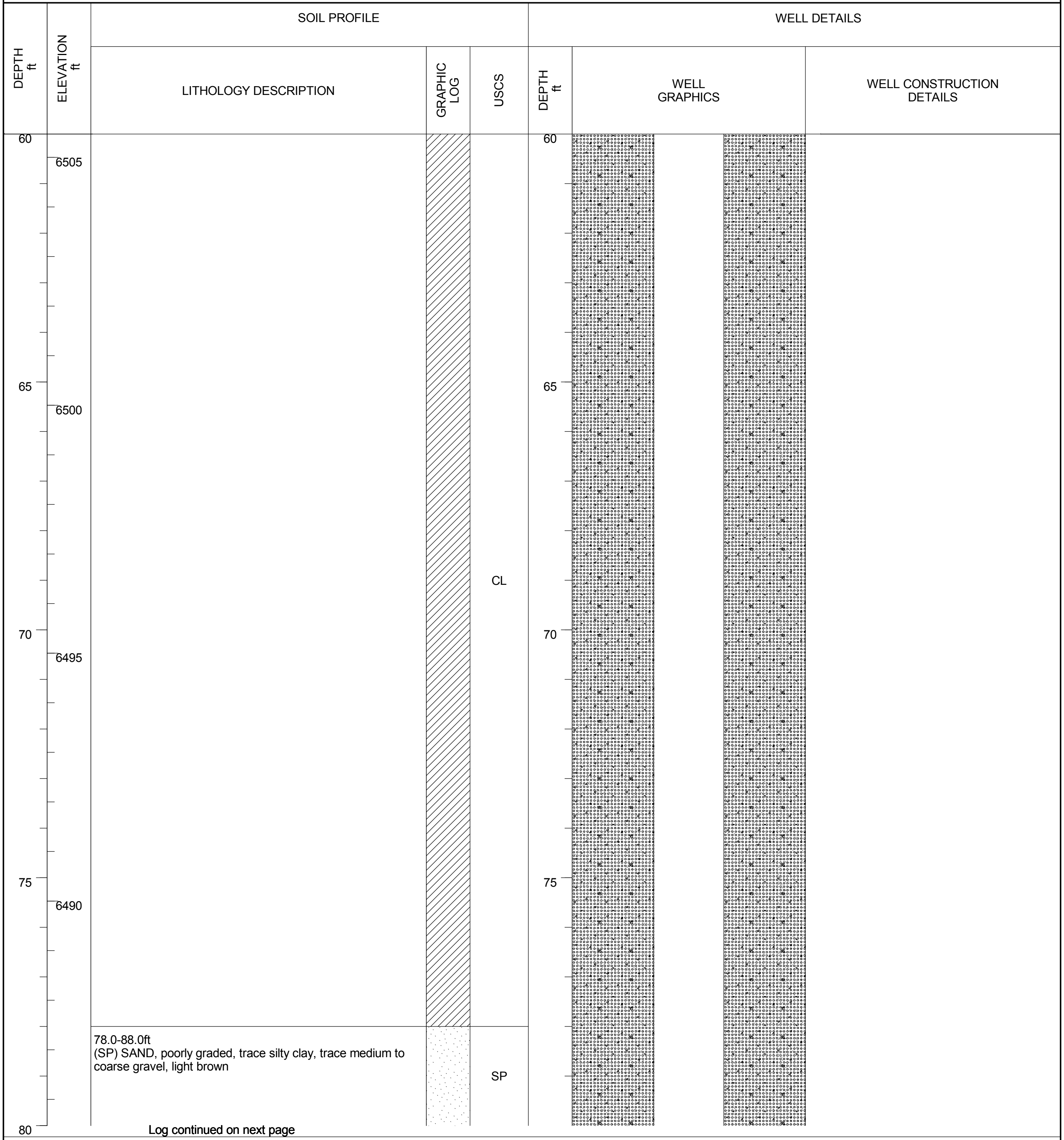
SHEET 4 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1



78.0-88.0ft
(SP) SAND, poorly graded, trace silty clay, trace medium to coarse gravel, light brown

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 19	Quantity: 5	Quantity: 5	Quantity: 4	Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
░ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)
▱ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 5 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

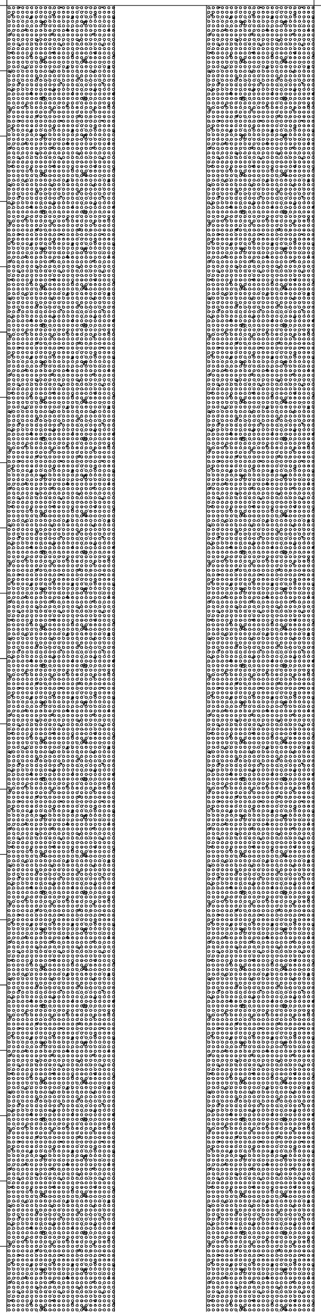
SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
80	6485		░	SP
85	6480		░	
		88.0-89.0ft (CL) SILTY CLAY, light brown	▨	CL
		89.0-97.0ft (CL) gravelly SILTY CLAY, some fine to coarse sand, gray tan	▨	CL
90	6475			
95	6470			
		97.0-102.0ft (SC) CLAYEY SAND, some fine to coarse gravel, tan	▨	SC
100		Log continued on next page		

WELL DETAILS

DEPTH ft: 80, 85, 90, 95

WELL GRAPHICS



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ▤ USCS Low Plasticity Organic silt or clay (OL)
- ░ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)
- ○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 6 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

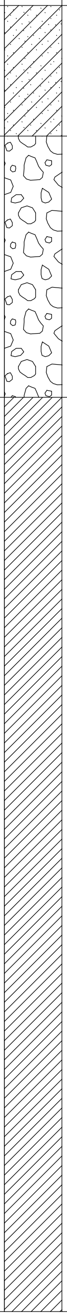
DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	USCS
100	6465		SC
		102.0-106.0ft (GP) GRAVEL, some clay, some fine to coarse sand, tan	GP
105	6460	106.0-120.0ft (CL) SILTY CLAY, trace fine to coarse gravel, light brown	
110	6455		
115	6450		CL
120			



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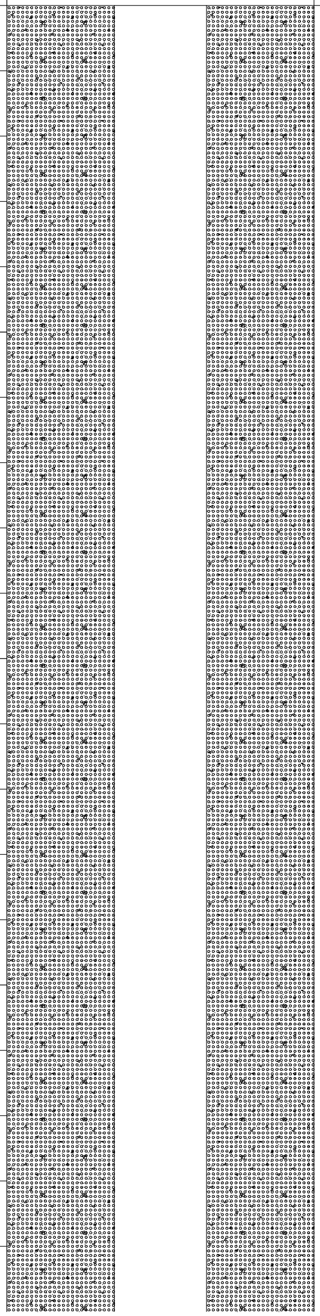
WELL DETAILS

DEPTH ft: 100, 105, 110, 115



WELL CONSTRUCTION DETAILS

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ⁙ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)
- ○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 7 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

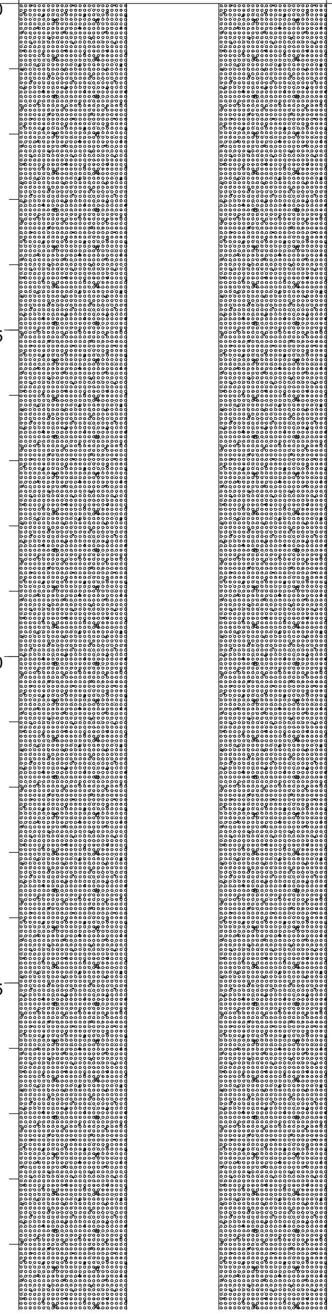
SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
120	6445	120.0-124.0ft (SP) SAND, poorly graded, some fine to coarse gravel, light brown	⠿	SP
125	6440	124.0-136.0ft (CL) SILTY CLAY, some fine sand, light brown	▨	CL
130	6435			
135	6430			
		136.0-151.0ft (CL) SILTY CLAY, light brown	▨	CL
140				

Log continued on next page

WELL DETAILS

DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
120		
125		
130		
135		



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
⠿	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 8 of 16

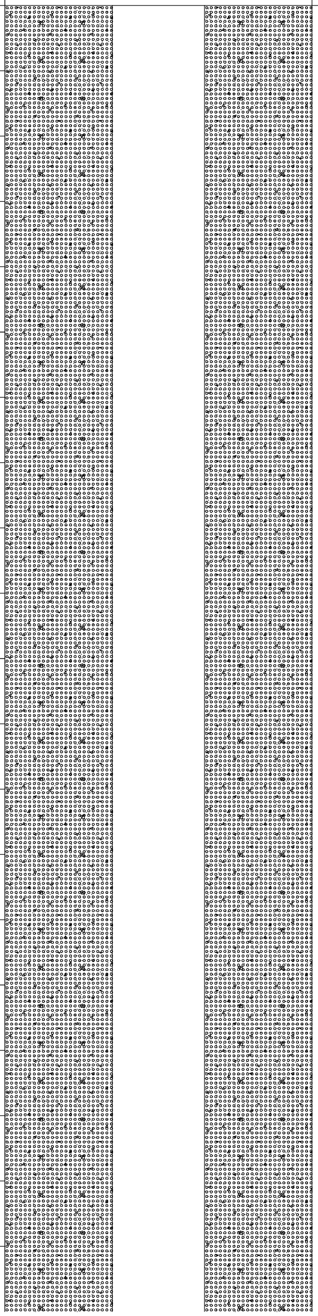
PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE					WELL DETAILS		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
140	6425		▨		140		
145	6420		▨	CL	145		
150	6415		▨		150		
		151.0-156.0ft (SP) SAND, poorly graded, some fine to coarse gravel, light brown	⁘	SP			
155	6410		⁘		155		
		156.0-165.0ft (CL) SILTY CLAY, trace fine to coarse gravel, brown	▨	CL			
160			▨				



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WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ⁘ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)
- ○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 9 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
160	6405		▨	CL
165	6400	165.0-167.0ft (SP) SAND, trace fine to coarse gravel, light tan		SP
		167.0-182.0ft (CL) SILTY CLAY, light brown	▨	
170	6395			
				CL
175	6390			
180				

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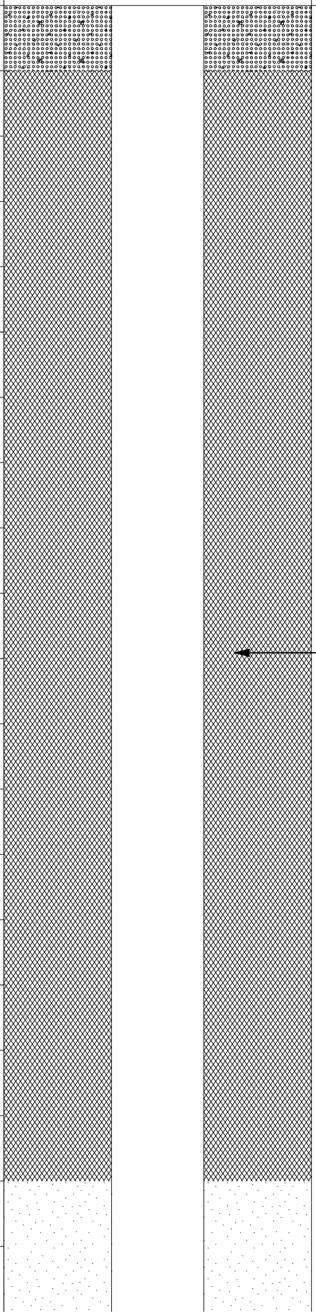
WELL DETAILS

DEPTH ft: 160, 165, 170, 175



WELL CONSTRUCTION DETAILS

Med Bentonite Chips, 50lb bags

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
⋯	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 10 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

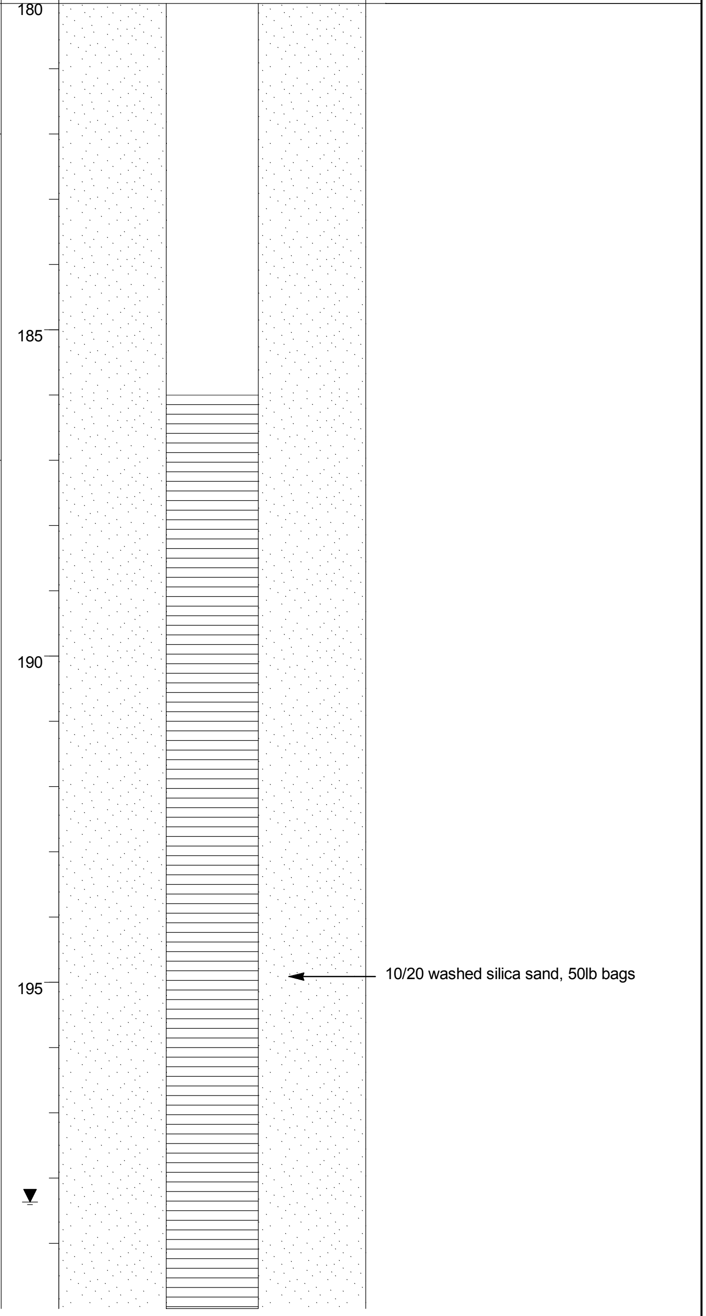
DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE				
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
180	6385		▨	CL
		182.0-187.0ft (SP) SAND, poorly graded, some fine to coarse gravel, tan	░	SP
185	6380			
		187.0-214.0ft (CL) SILTY CLAY, light brown	▨	CL
190	6375			
195	6370			
▼				
200		Log continued on next page		

WELL DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
░	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

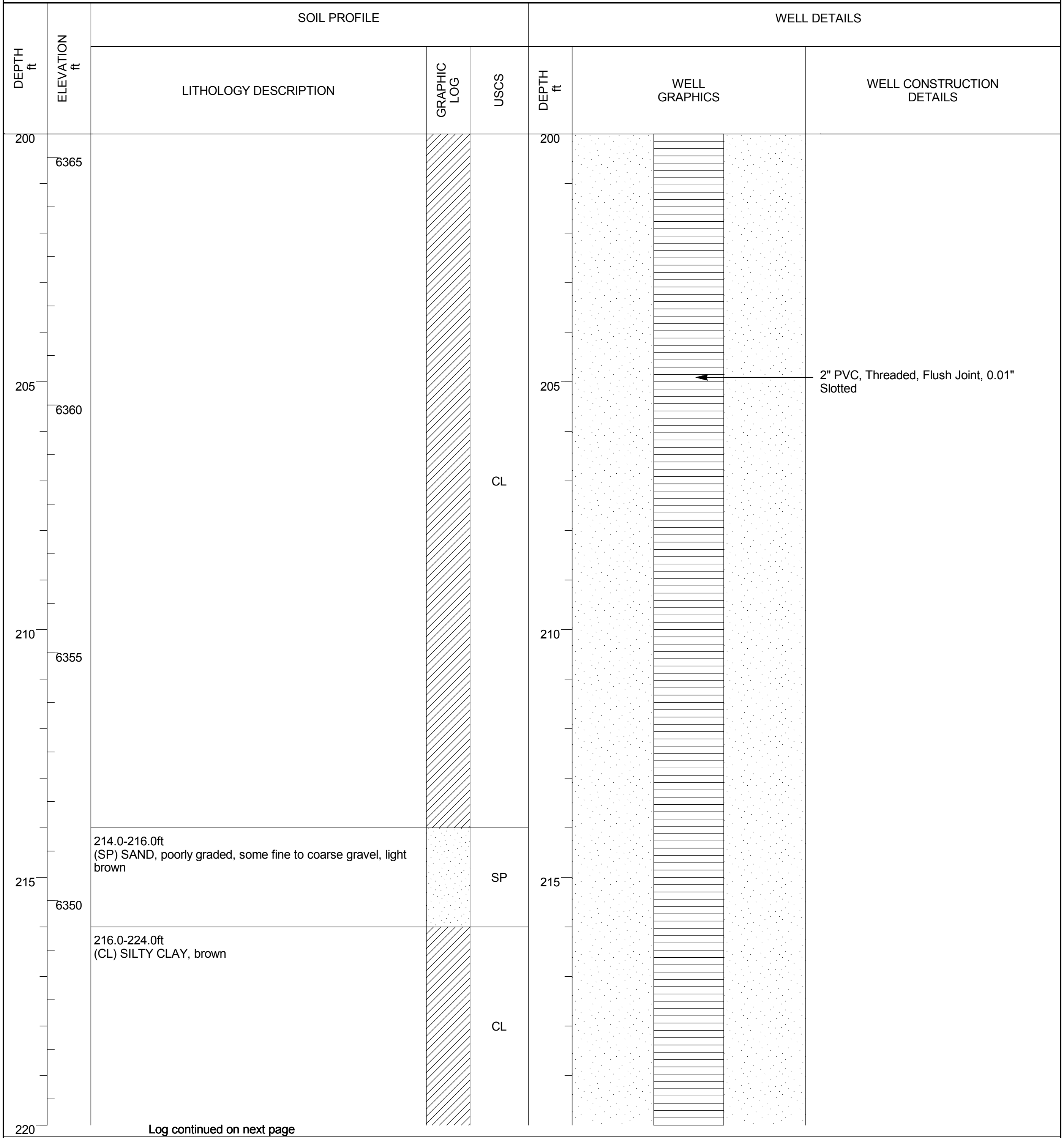
SHEET 11 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1



214.0-216.0ft
(SP) SAND, poorly graded, some fine to coarse gravel, light brown

216.0-224.0ft
(CL) SILTY CLAY, brown

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 5	Material: 10/20 washed silica sand, 50lb bags Quantity: 5	Material: Med Bentonite Chips, 50lb bags Quantity: 4	Material: 6", Stickup, Lockable Steel Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ⁘ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)
- ○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 12 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

SOIL PROFILE

DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS
220	6345		▨	CL
225	6340	224.0-227.0ft (SC) CLAYEY SAND, some fine to medium gravel, tan	▨	SC
		227.0-230.0ft (CL) SILTY CLAY, tan	▨	CL
230	6335	230.0-232.0ft (SC) CLAYEY SAND, light brown	▨	SC
235 240	6330	232.0-280.0ft (CL) SILTY CLAY, light brown	▨	CL

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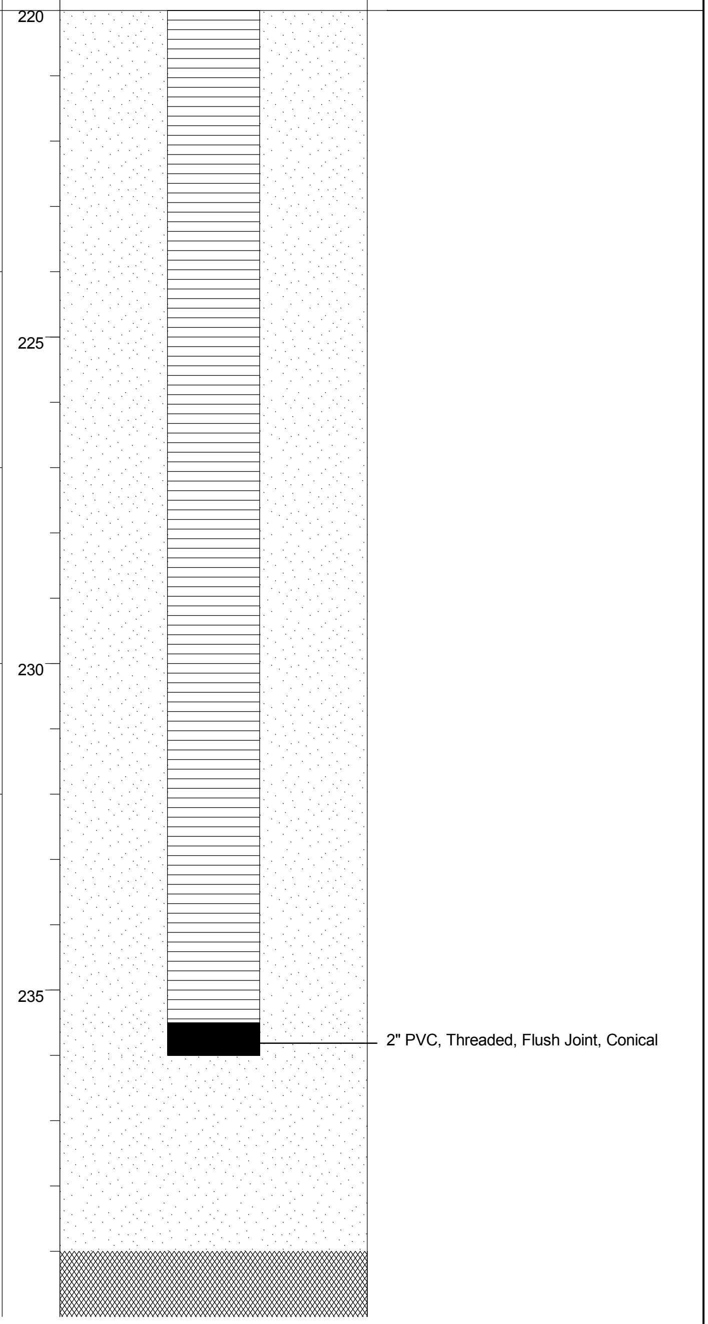
WELL DETAILS



WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
░	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

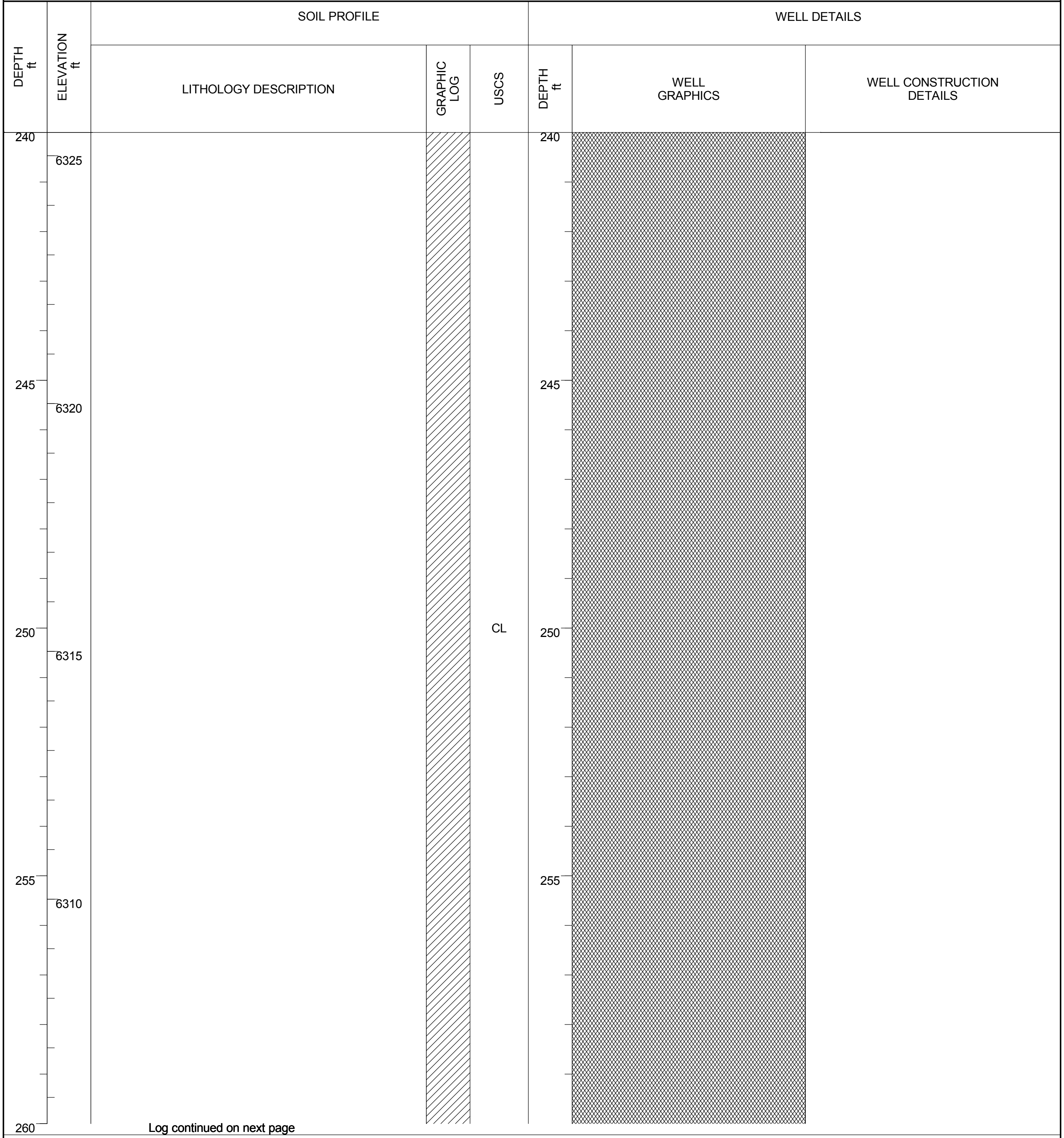
GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 13 of 16

PROJECT: Happy Jack Landfill	DRILL METHOD: Sonic	COORDS: N: 233,697.50 E: 700,456.95	DEPTH TO WATER (ft): 198.37
PROJECT NUMBER: 123-81971	DRILL RIG: Cascade Sonic	GS ELEVATION (ft): 6565.47	W.L. ELEVATION (ft): 6367.1
DRILLED DEPTH (ft): 310	DRILL DATE: 8/18/2013 12:15:17 PM	TOC ELEVATION (ft): 6567.99	



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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 5	Material: 10/20 washed silica sand, 50lb bags Quantity: 5	Material: Med Bentonite Chips, 50lb bags Quantity: 4	Material: 6", Stickup, Lockable Steel Quantity: 1

- ☰ USCS Low Plasticity Organic silt or clay (OL)
- ⁚ USCS Poorly-graded Sand (SP)
- ▨ USCS Low Plasticity Clay (CL)
- ▨ USCS Clayey Sand (SC)
- ○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

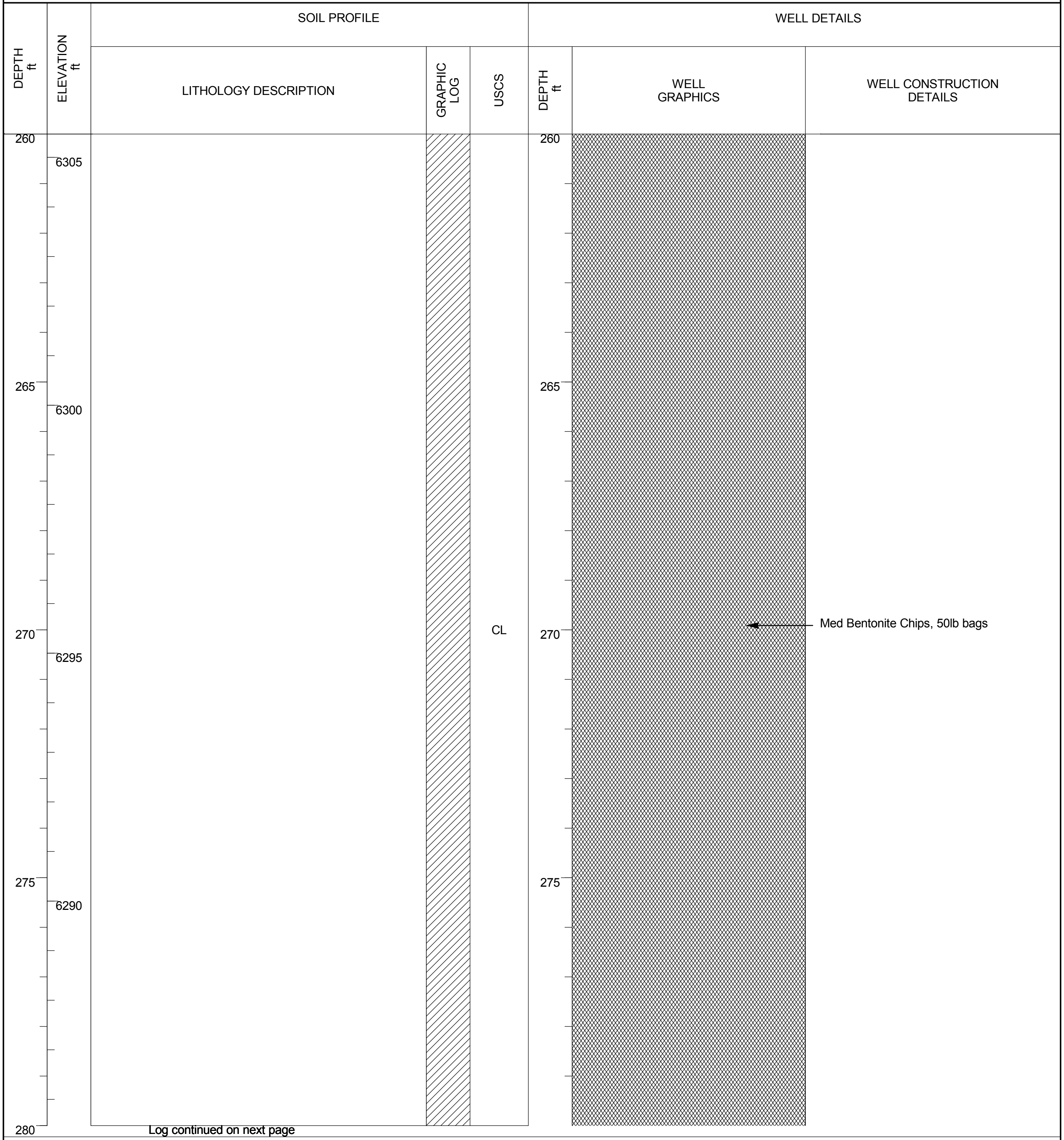
SHEET 14 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1



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WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted	Material: 10/20 washed silica sand, 50lb bags	Material: Med Bentonite Chips, 50lb bags	Material: 6", Stickup, Lockable Steel
Quantity: 19	Quantity: 5	Quantity: 5	Quantity: 4	Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
⁘	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 15 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

		SOIL PROFILE			WELL DETAILS		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
280	6285	280.0-310.0ft (CL) SILTY CLAY, some fine sand, orange tan	▨		280	▩	
285	6280		▨		285	▩	
290	6275		▨	CL	290	▩	
295	6270		▨		295	▩	
300							

Log continued on next page

WELL CASING	WELL SCREEN	FILTER PACK	FILTER PACK SEAL	PROTECTIVE CASING
Material: 10', 2" PVC, Threaded, Flush Joint Quantity: 19	Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted Quantity: 5	Material: 10/20 washed silica sand, 50lb bags Quantity: 5	Material: Med Bentonite Chips, 50lb bags Quantity: 4	Material: 6", Stickup, Lockable Steel Quantity: 1

☰ USCS Low Plasticity Organic silt or clay (OL)
⛆ USCS Poorly-graded Sand (SP)
▨ USCS Low Plasticity Clay (CL)
▨ USCS Clayey Sand (SC)
○ USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

RECORD OF WELL CONSTRUCTION GMW-2013-07

SHEET 16 of 16

PROJECT: Happy Jack Landfill
PROJECT NUMBER: 123-81971
DRILLED DEPTH (ft): 310

DRILL METHOD: Sonic
DRILL RIG: Cascade Sonic
DRILL DATE: 8/18/2013 12:15:17 PM

COORDS: N: 233,697.50 E: 700,456.95
GS ELEVATION (ft): 6565.47
TOC ELEVATION (ft): 6567.99

DEPTH TO WATER (ft): 198.37
W.L. ELEVATION (ft): 6367.1

		SOIL PROFILE			WELL DETAILS		
DEPTH ft	ELEVATION ft	LITHOLOGY DESCRIPTION	GRAPHIC LOG	USCS	DEPTH ft	WELL GRAPHICS	WELL CONSTRUCTION DETAILS
300			▨		300	▩	
	6265						
305				CL	305		
	6260						
310					310		
315							
320							

WELL CASING
Material: 10', 2" PVC, Threaded, Flush Joint
Quantity: 19

WELL SCREEN
Material: 10', 2" PVC, Threaded, Flush Joint, 0.01" Slotted
Quantity: 5

FILTER PACK
Material: 10/20 washed silica sand, 50lb bags
Quantity: 5

FILTER PACK SEAL
Material: Med Bentonite Chips, 50lb bags
Quantity: 4

PROTECTIVE CASING
Material: 6", Stickup, Lockable Steel
Quantity: 1

☰	USCS Low Plasticity Organic silt or clay (OL)
⁘	USCS Poorly-graded Sand (SP)
▨	USCS Low Plasticity Clay (CL)
▨	USCS Clayey Sand (SC)
○	USCS Poorly-graded Gravel (GP)

DRILLING COMPANY: Cascade Drilling L.P.
DRILLER: Adams

GA INSPECTOR: Steed
CHECKED BY:
DATE:

Golder Associates

DF WELL/LITH IMPORT.GPJ 2013 AMULSAR.GDT 10/25/13

APPENDIX C
CORE SAMPLE PHOTO LOG

<u>Photo Log Arrangement:</u> Core sample photos are presented in order of shallowest core sample sequence to the deepest. For each individual core sample sequence, the first photo shows the bottom, labeled depth of the sample with the corresponding depth range in the photo description. Subsequent photos show recovered core sample material above that bottom depth. For photos with multiple core samples, the noted depth ranges are presented top to bottom to corresponde to the sample cores in the photos, top to bottom.

PHOTO 1 MW-01 7 – 16 ft. 0 – 6 ft.	
PHOTO 2 MW-01 7 – 16 ft. cont'd 0 – 6 ft. cont'd	
PHOTO 3 MW-01 7 – 16 ft. cont'd 0 – 6 ft. cont'd	
PHOTO 4 MW-01 7 – 16 ft. cont'd	

PHOTO 5 MW-01 7 – 16 ft. cont'd	
PHOTO 6 MW-01 47 – 76 ft. 17 – 46 ft.	
PHOTO 7 MW-01 47 – 76 ft. cont'd 17 – 46 ft. cont'd	
PHOTO 8 MW-01 47 – 76 ft. cont'd 17 – 46 ft. cont'd	

PHOTO 9 MW-01 47 – 76 ft. cont'd 17 – 46 ft. cont'd	
PHOTO 10 MW-01 47 – 76 ft. cont'd	
PHOTO 11 MW-01 77 – 106 ft.	
PHOTO 12 MW-01 77 – 106 ft. cont'd	
PHOTO 13 MW-01 77 – 106 ft. cont'd	

PHOTO 14 MW-01 157 – 176 ft. 137 – 156 ft. 107 – 136 ft.	
PHOTO 15 MW-01 157 – 176 ft. cont'd 137 – 156 ft. cont'd 107 – 136 ft. cont'd	
PHOTO 16 MW-01 157 – 176 ft. cont'd 137 – 156 ft. cont'd 107 – 136 ft. cont'd	
PHOTO 17 MW-01 157 – 176 ft. cont'd 137 – 156 ft. cont'd 107 – 136 ft. cont'd	

PHOTO 18 MW-01 137 – 156 ft. cont'd	
PHOTO 19 MW-01 177 – 200 ft.	
PHOTO 20 MW-01 177 – 200 ft. cont'd	
PHOTO 21 MW-01 177 – 200 ft. cont'd	
PHOTO 22 MW-01 177 – 200 ft. cont'd	
PHOTO 23 MW-01 177 – 200 ft. cont'd	

PHOTO 24 MW-01 177 – 200 ft. cont'd	
PHOTO 25 MW-01 177 – 200 ft. cont'd	
PHOTO 26 MW-01 177 – 200 ft. cont'd	
PHOTO 27 MW-01 201 – 216 ft.	
PHOTO 28 MW-01 201 – 216 ft. cont'd	
PHOTO 29 MW-01 201 – 216 ft. cont'd	

PHOTO 30 MW-01 201 – 216 ft. cont'd	
PHOTO 31 MW-01 201 – 216 ft. cont'd	
PHOTO 32 MW-01 201 – 216 ft. cont'd	
PHOTO 33 MW-01 217 – 236 ft.	
PHOTO 34 MW-01 217 – 236 ft. cont'd	

PHOTO 35

MW-01
217 – 236 ft. cont'd

PHOTO 36

MW-01
217 – 236 ft. cont'd

PHOTO 37

MW-01
217 – 236 ft. cont'd

PHOTO 38

MW-01
217 – 236 ft. cont'd

PHOTO 39

MW-03
0 – 6 ft.

PHOTO 40 MW-03 0 – 6 ft. cont'd	
PHOTO 41 MW-03 0 – 6 ft. cont'd	
PHOTO 42 MW-03 7 – 16 ft.	
PHOTO 43 MW-03 7 – 16 ft. cont'd	
PHOTO 44 MW-03 7 – 16 ft. cont'd	

PHOTO 45 MW-03 7 – 16 ft. cont'd	
PHOTO 46 MW-03 7 – 16 ft. cont'd	
PHOTO 47 MW-03 7 – 16 ft. cont'd	
PHOTO 48 MW-03 17 – 46 ft.	
PHOTO 49 MW-03 17 – 46 ft. cont'd	
PHOTO 50 MW-03 17 – 46 ft. cont'd	

PHOTO 51 MW-03 17 – 46 ft. cont'd	
PHOTO 52 MW-03 47 – 76 ft.	
PHOTO 53 MW-03 47 – 76 ft. cont'd	
PHOTO 54 MW-03 47 – 76 ft. cont'd	
PHOTO 55 MW-03 47 – 76 ft. cont'd	

PHOTO 56 MW-03 77 – 96 ft.	
PHOTO 57 MW-03 77 – 96 ft. cont'd	
PHOTO 58 MW-03 77 – 96 ft. cont'd	
PHOTO 59 MW-03 77 – 96 ft. cont'd	
PHOTO 60 MW-03 77 – 96 ft. cont'd	
PHOTO 61 MW-03 97 – 146 ft.	

PHOTO 62 MW-03 97 – 146 ft. cont’d	
PHOTO 63 MW-03 97 – 146 ft. cont’d	
PHOTO 64 MW-03 97 – 146 ft. cont’d	
PHOTO 65 MW-03 97 – 146 ft. cont’d	
PHOTO 66 MW-03 147 – 156 ft.	

PHOTO 67 MW-03 147 – 156 ft. cont’d	
PHOTO 68 MW-03 147 – 156 ft. cont’d	
PHOTO 69 MW-03 147 – 156 ft. cont’d	
PHOTO 70 MW-03 147 – 156 ft. cont’d	
PHOTO 71 MW-03 157 – 176 ft.	
PHOTO 72 MW-03 157 – 176 ft. cont’d	

<table>
<tr><td>

PHOTO 73

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
<tr><td>

PHOTO 74

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
<tr><td>

PHOTO 75

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
<tr><td>

PHOTO 76

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
<tr><td>

PHOTO 77

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
<tr><td>

PHOTO 78

MW-03
157 – 176 ft. cont'd</td><td></td></tr>
</table>

PHOTO 79 MW-03 157 – 176 ft. cont’d	
PHOTO 80 MW-03 157 – 176 ft. cont’d	
PHOTO 81 MW-03 177 – 184 ft.	
PHOTO 82 MW-03 177 – 184 ft. cont’d	
PHOTO 83 MW-03 177 – 184 ft. cont’d	
PHOTO 84 MW-03 177 – 184 ft. cont’d	

PHOTO 85

MW-03
185 – 194 ft.

PHOTO 86

MW-03
185 – 194 ft. cont'd

PHOTO 87

MW-03
185 – 194 ft. cont'd

PHOTO 88

MW-03
185 – 194 ft. cont'd

PHOTO 89

MW-03
185 – 194 ft. cont'd

PHOTO 90

MW-03
194 – 196 ft.

PHOTO 91 MW-03 197 – ~202 ft.	
PHOTO 92 MW-03 197 – ~202 ft. cont’d	
PHOTO 93 MW-03 ~202 – 216 ft.	
PHOTO 94 MW-03 ~202 – 216 ft. cont’d	
PHOTO 95 MW-03 ~202 – 216 ft. cont’d	
PHOTO 96 MW-03 ~202 – 216 ft. cont’d	

PHOTO 97

MW-03
~202 – 216 ft. cont'd

PHOTO 98

MW-04
7 – 16 ft.
0 – 6 ft.

PHOTO 99

MW-04
7 – 16 ft. cont'd
0 – 6 ft. cont'd

PHOTO 100

MW-04
7 – 16 ft. cont'd
0 – 6 ft. cont'd

PHOTO 101

MW-04
7 – 16 ft. cont'd

PHOTO 102 MW-04 7 – 16 ft. cont'd	
PHOTO 103 MW-04 37 – 66 ft. 17 – 36 ft.	
PHOTO 104 MW-04 37 – 66 ft. cont'd 17 – 36 ft. cont'd	
PHOTO 105 MW-04 37 – 66 ft. cont'd 17 – 36 ft. cont'd	
PHOTO 106 MW-04 37 – 66 ft. cont'd 17 – 36 ft. cont'd	

PHOTO 107 MW-04 37 – 66 ft. cont’d 17 – 36 ft. cont’d	
PHOTO 108 MW-04 37 – 66 ft. cont’d 17 – 36 ft. cont’d	
PHOTO 109 MW-04 37 – 66 ft. cont’d 17 – 36 ft. cont’d	
PHOTO 110 MW-04 17 – 36 ft. cont’d	
PHOTO 111 MW-04 127 – 146 ft. 97 – 126 ft. 67 – 96 ft.	

PHOTO 112

MW-04
127 – 146 ft. cont'd
97 – 126 ft. cont'd
67 – 96 ft. cont'd

PHOTO 113

MW-04
127 – 146 ft. cont'd
97 – 126 ft. cont'd
67 – 96 ft. cont'd

PHOTO 114

MW-04
127 – 146 ft. cont'd
97 – 126 ft. cont'd
67 – 96 ft. cont'd

PHOTO 115

MW-04
127 – 146 ft. cont'd
97 – 126 ft. cont'd
67 – 96 ft. cont'd

PHOTO 116

MW-04
67 – 96 ft. cont'd

PHOTO 117

MW-04
67 – 96 ft. cont'd

PHOTO 118

MW-04
67 – 96 ft. cont'd

PHOTO 119

MW-04
Overview:
127 – 146 ft.
97 – 126 ft.
67 – 96 ft.

PHOTO 120 MW-04 147 – 166 ft.	
PHOTO 121 MW-04 147 – 166 ft. cont’d	
PHOTO 122 MW-04 147 – 166 ft. cont’d	
PHOTO 123 MW-04 147 – 166 ft. cont’d	

PHOTO 124 MW-04 147 – 166 ft. cont'd	
PHOTO 125 MW-04 167 – 196 ft.	
PHOTO 126 MW-04 167 – 196 ft. cont'd	
PHOTO 127 MW-04 167 – 196 ft. cont'd	
PHOTO 128 MW-04 167 – 196 ft. cont'd	
PHOTO 129 MW-04 167 – 196 ft. cont'd	

PHOTO 130 MW-04 167 – 196 ft. cont’d	
PHOTO 131 MW-04 197 – 226 ft.	
PHOTO 132 MW-04 197 – 226 ft. cont’d	
PHOTO 133 MW-04 197 – 226 ft. cont’d	
PHOTO 134 MW-04 197 – 226 ft. cont’d	

PHOTO 135

MW-04
197 – 226 ft. cont'd

PHOTO 136

MW-04
197 – 226 ft. cont'd

PHOTO 137

MW-04
197 – 226 ft. cont'd

PHOTO 138

MW-04
197 – 226 ft. cont'd

PHOTO 139

MW-04
197 – 226 ft. cont'd

PHOTO 140 MW-04 197 – 226 ft. cont’d	
PHOTO 141 MW-04 197 – 226 ft. cont’d	
PHOTO 142 MW-04 ~200 ft.	
PHOTO 143 MW-04 ~200 ft.	
PHOTO 144 MW-06 0 – 6 ft.	

PHOTO 145 MW-06 0 – 6 ft. cont'd	
PHOTO 146 MW-06 0 – 6 ft. cont'd	
PHOTO 147 MW-06 7 – 16 ft.	
PHOTO 148 MW-06 7 – 16 ft. cont'd	
PHOTO 149 MW-06 7 – 16 ft. cont'd	
PHOTO 150 MW-06 7 – 16 ft. cont'd	
PHOTO 151 MW-06 7 – 16 ft. cont'd	

PHOTO 152

MW-06
37 – 46 ft.
27 – 36 ft.
17 – 26 ft.

PHOTO 153

MW-06
37 – 46 ft. cont'd
27 – 36 ft. cont'd
17 – 26 ft. cont'd

PHOTO 154

MW-06
37 – 46 ft. cont'd
27 – 36 ft. cont'd
17 – 26 ft. cont'd

PHOTO 155

MW-06
37 – 46 ft. cont'd
27 – 36 ft. cont'd
17 – 26 ft. cont'd

PHOTO 156 MW-06 37 – 46 ft. cont'd 27 – 36 ft. cont'd 17 – 26 ft. cont'd	
PHOTO 157 MW-06 37 – 46 ft. cont'd 27 – 36 ft. cont'd 17 – 26 ft. cont'd	
PHOTO 158 MW-06 59 – 77 ft. 56 – 58 ft. 47 – 55 ft.	
PHOTO 159 MW-06 59 – 77 ft. cont'd 56 – 58 ft. cont'd 47 – 55 ft. cont'd	

PHOTO 160 MW-06 59 – 77 ft. cont’d 56 – 58 ft. cont’d 47 – 55 ft. cont’d	
PHOTO 161 MW-06 59 – 77 ft. cont’d 47 – 55 ft. cont’d	
PHOTO 162 MW-06 47 – 55 ft. cont’d	
PHOTO 163 MW-06 97 – 116 ft. 78 – 96 ft.	

<table>
<tr><td>

PHOTO 164

MW-06
97 – 116 ft. cont’d
78 – 96 ft. cont’d

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<tr><td>

PHOTO 165

MW-06
97 – 116 ft. cont’d
78 – 96 ft. cont’d

</td><td></td></tr>
<tr><td>

PHOTO 166

MW-06
97 – 116 ft. cont’d
78 – 96 ft. cont’d

</td><td></td></tr>
<tr><td>

PHOTO 167

MW-06
137 – 166 ft.
117 – 136 ft.

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<tr><td>

PHOTO 168

MW-06
137 – 166 ft. cont’d
117 – 136 ft. cont’d

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</table>

<table>
<tr><td>

PHOTO 169

MW-06
137 – 166 ft. cont'd
117 – 136 ft. cont'd

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<tr><td>

PHOTO 170

MW-06
137 – 166 ft. cont'd

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<tr><td>

PHOTO 171

MW-06
137 – 166 ft. cont'd

</td><td></td></tr>
<tr><td>

PHOTO 172

MW-06
137 – 166 ft. cont'd

</td><td></td></tr>
<tr><td>

PHOTO 173

MW-06
177 – 185 ft.
167 – 176 ft.

</td><td>
</td></tr>
</table>

PHOTO 174 MW-06 177 – 185 ft. cont'd 167 – 176 ft. cont'd	
PHOTO 175 MW-06 177 – 185 ft. cont'd 167 – 176 ft. cont'd	
PHOTO 176 MW-06 177 – 185 ft. cont'd 167 – 176 ft. cont'd	
PHOTO 177 MW-06 177 – 185 ft. cont'd 167 – 176 ft. cont'd	
PHOTO 178 MW-06 177 – 185 ft. cont'd 167 – 176 ft. cont'd	

PHOTO 179

MW-06
186 – 190 ft.

PHOTO 180

MW-06
186 – 190 ft. cont'd

PHOTO 181

MW-06
186 – 190 ft. cont'd

PHOTO 182

MW-07
7 – 16 ft.
0 – 6 ft.

PHOTO 183

MW-07
7 – 16 ft. cont'd
0 – 6 ft. cont'd

PHOTO 184

MW-07
7 – 16 ft. cont'd
0 – 6 ft. cont'd

PHOTO 185 MW-07 7 – 16 ft. cont'd	
PHOTO 186 MW-07 7 – 16 ft. cont'd	
PHOTO 187 MW-07 17 – 46 ft.	
PHOTO 188 MW-07 17 – 46 ft. cont'd	
PHOTO 189 MW-07 17 – 46 ft. cont'd	
PHOTO 190 MW-07 17 – 46 ft. cont'd	
PHOTO 191 MW-07 47 – 76 ft.	

PHOTO 192 MW-07 47 – 76 ft. cont'd	
PHOTO 193 MW-07 47 – 76 ft. cont'd	
PHOTO 194 MW-07 47 – 76 ft. cont'd	
PHOTO 195 MW-07 47 – 76 ft. cont'd	
PHOTO 196 MW-07 107 – 136 ft. 77 – 106 ft.	
PHOTO 197 MW-07 107 – 136 ft. cont'd 77 – 106 ft. cont'd	

PHOTO 198 MW-07 107 – 136 ft. cont'd 77 – 106 ft. cont'd	
PHOTO 199 MW-07 107 – 136 ft. cont'd 77 – 106 ft. cont'd	
PHOTO 200 MW-07 107 – 136 ft. cont'd 77 – 106 ft. cont'd	
PHOTO 201 MW-07 107 – 136 ft. cont'd 77 – 106 ft. cont'd	
PHOTO 202 MW-07 107 – 136 ft. cont'd	

PHOTO 203 MW-07 107 – 136 ft. cont'd	
PHOTO 204 MW-07 137 – 166 ft.	
PHOTO 205 MW-07 137 – 166 ft. cont'd	
PHOTO 206 MW-07 137 – 166 ft. cont'd	
PHOTO 207 MW-07 137 – 166 ft. cont'd	
PHOTO 208 MW-07 137 – 166 ft. cont'd	
PHOTO 209 MW-07 137 – 166 ft. cont'd	
PHOTO 210 MW-07 137 – 166 ft. cont'd	

PHOTO 211 MW-07 137 – 166 ft. cont'd	
PHOTO 212 MW-07 137 – 166 ft. cont'd	
PHOTO 213 MW-07 137 – 166 ft. cont'd	
PHOTO 214 MW-07 167 – 196 ft.	
PHOTO 215 MW-07 167 – 196 ft. cont'd	
PHOTO 216 MW-07 167 – 196 ft. cont'd	
PHOTO 217 MW-07 167 – 196 ft. cont'd	
PHOTO 218 MW-07 167 – 196 ft. cont'd	

PHOTO 219 MW-07 167 – 196 ft. cont'd	
PHOTO 220 MW-07 167 – 196 ft. cont'd	
PHOTO 221 MW-07 167 – 196 ft. cont'd	
PHOTO 222 MW-07 197 – 226 ft.	
PHOTO 223 MW-07 197 – 226 ft. cont'd	
PHOTO 224 MW-07 197 – 226 ft. cont'd	
PHOTO 225 MW-07 197 – 226 ft. cont'd	
PHOTO 226 MW-07 197 – 226 ft. cont'd	

PHOTO 227

MW-07
197 – 226 ft. cont’d

PHOTO 228

MW-07
197 – 226 ft. cont’d

PHOTO 229

MW-07
197 – 226 ft. cont’d

PHOTO 230

MW-07
197 – 226 ft. cont’d

PHOTO 231

MW-07
197 – 226 ft. cont’d

PHOTO 232

MW-07
227 – 246 ft.

PHOTO 233

MW-07
227 – 246 ft. cont’d

PHOTO 234

MW-07
227 – 246 ft. cont’d

PHOTO 235 MW-07 227 – 246 ft. cont’d	
PHOTO 236 MW-07 227 – 246 ft. cont’d	
PHOTO 237 MW-07 227 – 246 ft. cont’d	
PHOTO 238 MW-07 227 – 246 ft. cont’d	
PHOTO 239 MW-07 289 – 316 ft. 267 – 288 ft. 247 – 266 ft.	
PHOTO 240 MW-07 289 – 316 ft. cont’d 267 – 288 ft. cont’d 247 – 266 ft. cont’d	

PHOTO 241

MW-07
289 – 316 ft. cont'd
267 – 288 ft. cont'd
247 – 266 ft. cont'd

PHOTO 242

MW-07
289 – 316 ft. cont'd
267 – 288 ft. cont'd
247 – 266 ft. cont'd

PHOTO 243

MW-07
289 – 316 ft. cont'd
267 – 288 ft. cont'd
247 – 266 ft. cont'd

PHOTO 244

MW-07
289 – 316 ft. cont'd
267 – 288 ft. cont'd
247 – 266 ft. cont'd

PHOTO 245 MW-07 289 – 316 ft. cont'd 267 – 288 ft. cont'd 247 – 266 ft. cont'd	
PHOTO 246 MW-07 289 – 316 ft. cont'd 267 – 288 ft. cont'd 247 – 266 ft. cont'd	
PHOTO 247 MW-07 289 – 316 ft. cont'd 267 – 288 ft. cont'd 247 – 266 ft. cont'd	
PHOTO 248 MW-07 289 – 316 ft. cont'd 267 – 288 ft. cont'd	

APPENDIX D
LABORATORY TEST RESULTS

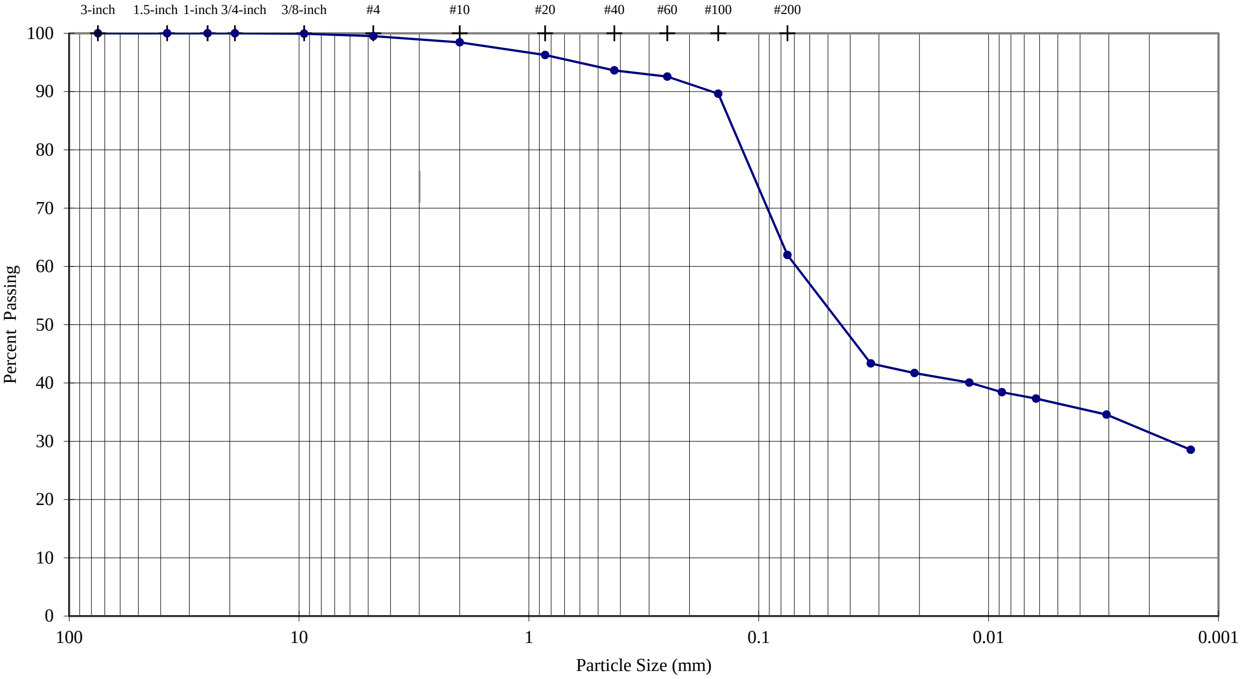
APPENDIX D-1
INDEX PROPERTY TEST RESULTS

July-13 **123-81971.0022**

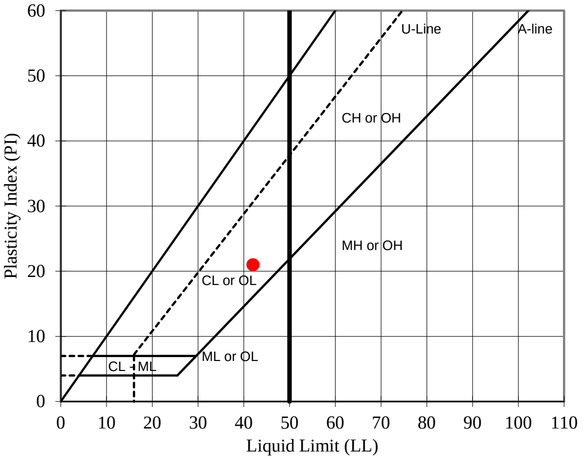
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME:	**SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID:	**GBH-2013-01, G-2**
DEPTH (ft):	**34-38**
TYPE:	**Pail**



	Sieve	Particle Size (mm)	% Passing	Description	Percentage
Sieve Analysis (Initial Separation on No. 4 Sieve)	3-inch	75.0	**100.0**		
	1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
	1-inch	25.0	**100.0**		
	3/4-inch	19.0	**100.0**		
	3/8-inch	9.5	**99.9**	Fine Gravel	**0.49**
	#4	4.75	**99.5**		
	#10	2.0	**98.4**	Coarse Sand	**1.07**
	#20	0.85	**96.3**	Medium Sand	**4.82**
	#40	0.425	**93.6**		
	#60	0.25	**92.6**	Fine Sand	**31.67**
	#100	0.15	**89.6**		
	#200	0.075	**62.0**		
Hydrometer Analysis		0.033	**43.3**	Silt or Clay Fines	**61.96**
		0.021	**41.7**		
		0.012	**40.1**		
		0.009	**38.4**		
		0.006	**37.3**		
		0.003	**34.6**		
		0.001	**28.5**		



USCS Description (ASTM D 2487):

Sandy lean clay, strong brown, moist

LL	PL	PI	SpG
42	**21**	**21**	**2.68**

As-Received Moisture Content (%): --

USCS Group Symbol: CL

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

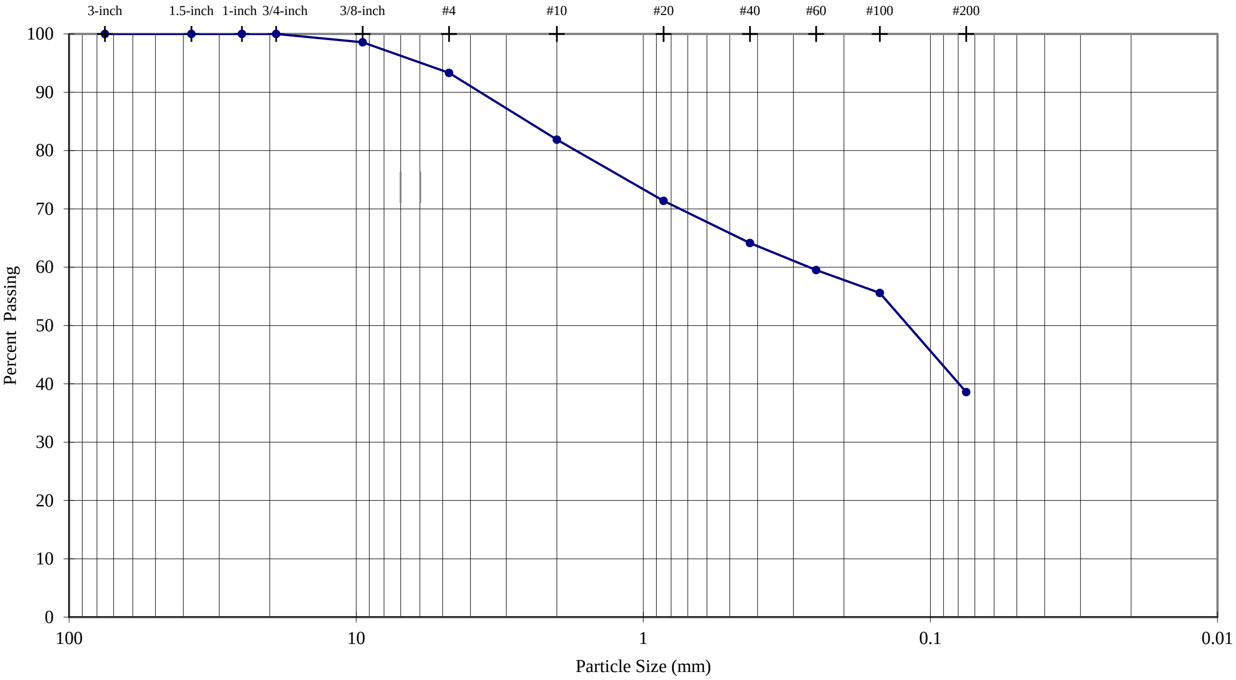
TECH	SB/SRS
DATE	7/22/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

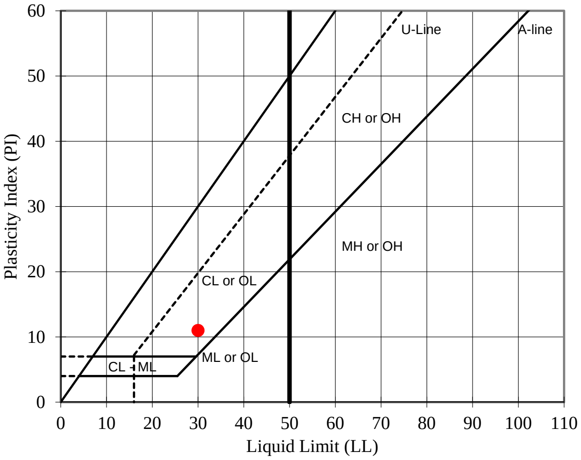
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-01, SS-10** DEPTH (ft): **49-51**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**98.6**
#4	4.8	**93.3**
#10	2.00	**81.9**
#20	0.85	**71.4**
#40	0.43	**64.1**
#60	0.25	**59.5**
#100	0.15	**55.6**
#200	0.075	**38.6**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**6.67**
Coarse Sand	**11.45**
Medium Sand	**17.73**
Fine Sand	**25.56**
Silt or Clay Fines	**38.59**



LL	PL	PI	SpG
30	**19**	**11**	**2.71**

USCS Description (ASTM D 2487):

Clayey sand, travel gravel, brown, moist

As-Received Moisture Content (%): **11.8**

USCS Group Symbol: SC

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

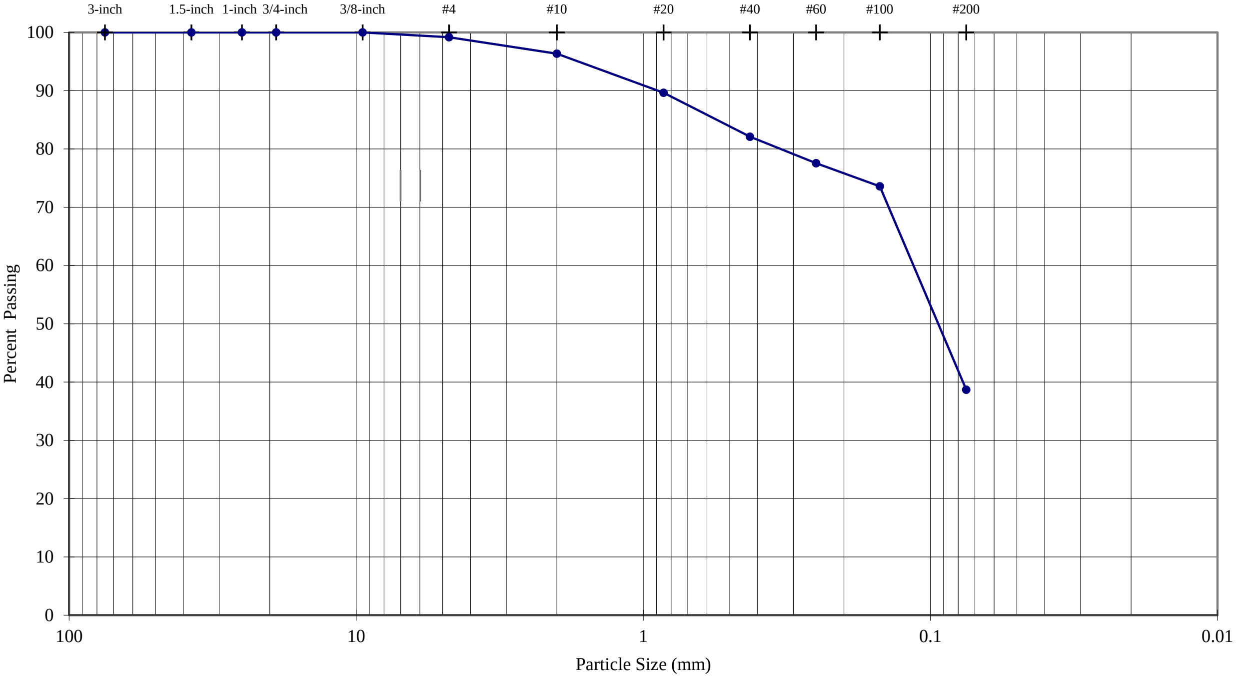
TECH	JP
DATE	7/22/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

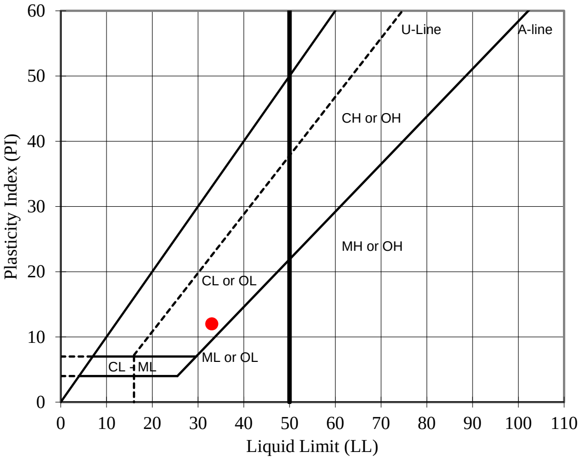
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-02, SS-6** DEPTH (ft): **29-31**
TYPE: **Bag**



Sieve Analysis
(Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.8	**99.2**
#10	2.00	**96.3**
#20	0.85	**89.6**
#40	0.43	**82.1**
#60	0.25	**77.6**
#100	0.15	**73.6**
#200	0.075	**38.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**0.83**
Coarse Sand	**2.83**
Medium Sand	**14.25**
Fine Sand	**43.40**
Silt or Clay Fines	**38.69**



USCS Description (ASTM D 2487):

Clayey sand, light brown, moist

LL	PL	PI	SpG
33	**21**	**12**	**2.68**

As-Received Moisture Content (%): **17.3**

USCS Group Symbol: SC

Notes: 0g of particles up to 9.5mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

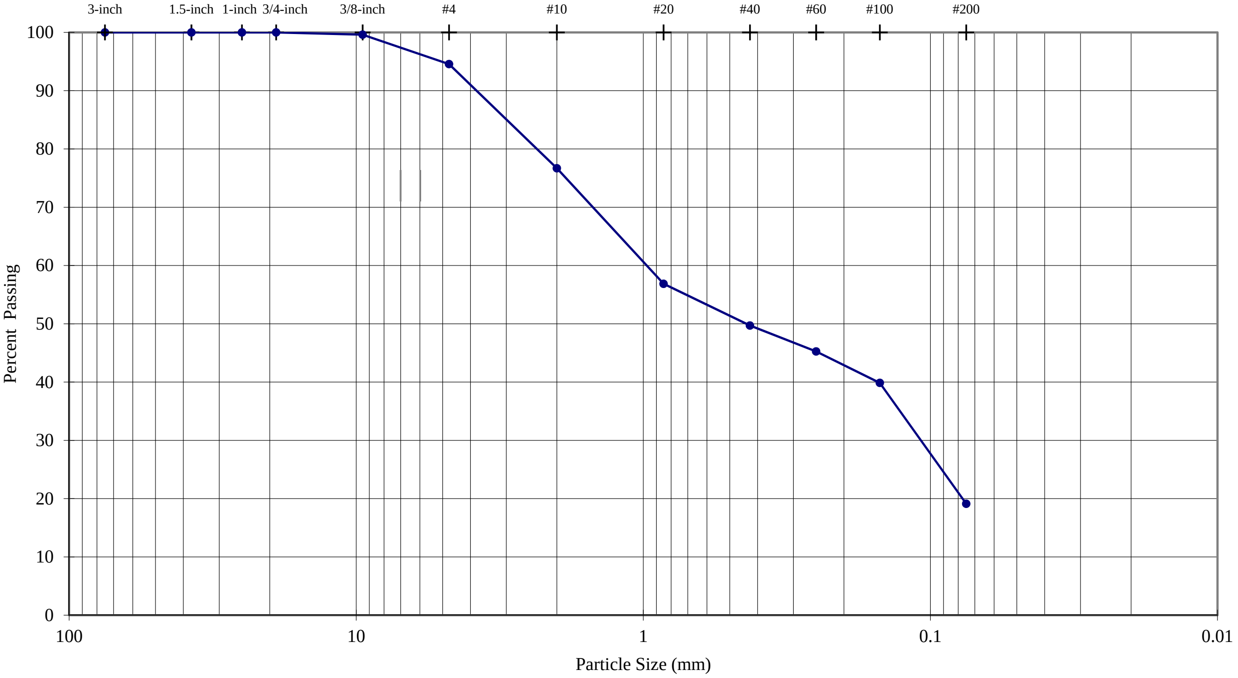
TECH	JP
DATE	7/22/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

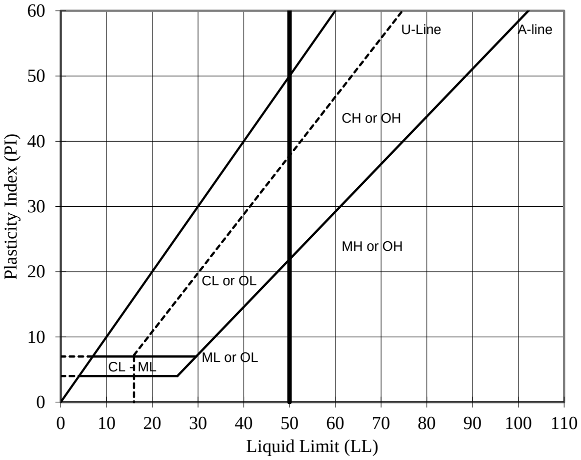
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-02, SS-13** DEPTH (ft): **74-75**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.6**
#4	4.8	**94.6**
#10	2.00	**76.7**
#20	0.85	**56.9**
#40	0.43	**49.7**
#60	0.25	**45.3**
#100	0.15	**39.9**
#200	0.075	**19.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**5.44**
Coarse Sand	**17.87**
Medium Sand	**26.99**
Fine Sand	**30.58**
Silt or Clay Fines	**19.12**



Visual Description (Golder Procedure):

Clayey sand, light brown, moist

LL	PL	PI
--	--	--

As-Received Moisture Content (%): 7.5

USCS Group Symbol: --

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed

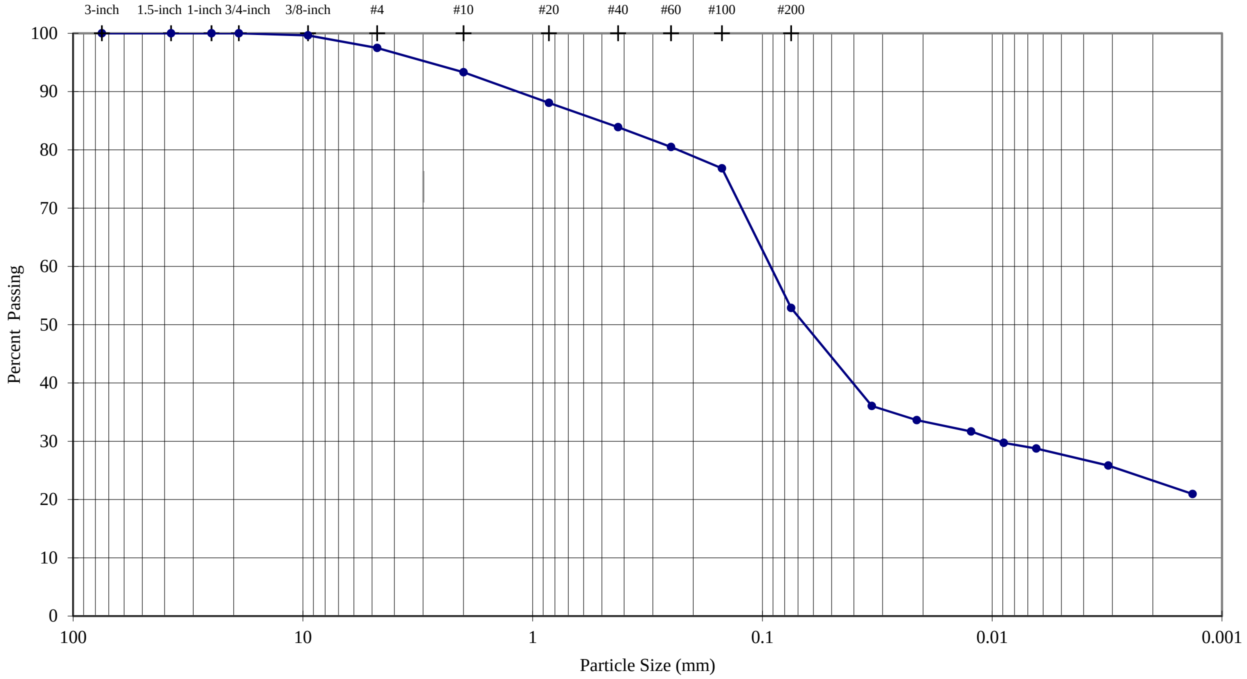
TECH	JAM
DATE	7/23/2013
REVIEW	MB

July-13 **123-81971.0022**

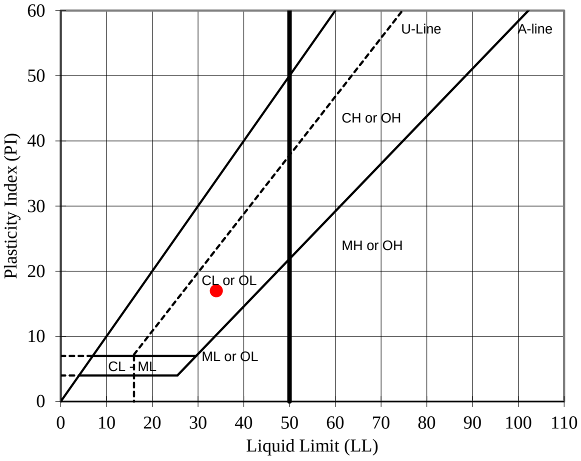
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-03, G-1** DEPTH (ft): **5-20**
TYPE: **Pail**



	Sieve	Particle Size (mm)	% Passing	Description	Percentage
Sieve Analysis (Initial Separation on No. 4 Sieve)	3-inch	75.0	**100.0**		
	1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
	1-inch	25.0	**100.0**		
	3/4-inch	19.0	**100.0**		
	3/8-inch	9.5	**99.6**	Fine Gravel	**2.51**
	#4	4.75	**97.5**		
	#10	2.0	**93.3**	Coarse Sand	**4.17**
	#20	0.85	**88.1**	Medium Sand	**9.41**
	#40	0.425	**83.9**		
	#60	0.25	**80.5**	Fine Sand	**31.03**
	#100	0.15	**76.8**		
	#200	0.075	**52.9**		
Hydrometer Analysis		0.033	**36.1**	Silt or Clay Fines	**52.87**
		0.021	**33.6**		
		0.012	**31.7**		
		0.009	**29.7**		
		0.006	**28.8**		
		0.003	**25.8**		
		0.001	**21.0**		



USCS Description (ASTM D 2487):

Sandy lean clay, trace gravel, dark yellowish brown, moist

LL	PL	PI	SpG
34	**17**	**17**	**2.68**

As-Received Moisture Content (%): --

USCS Group Symbol: CL

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

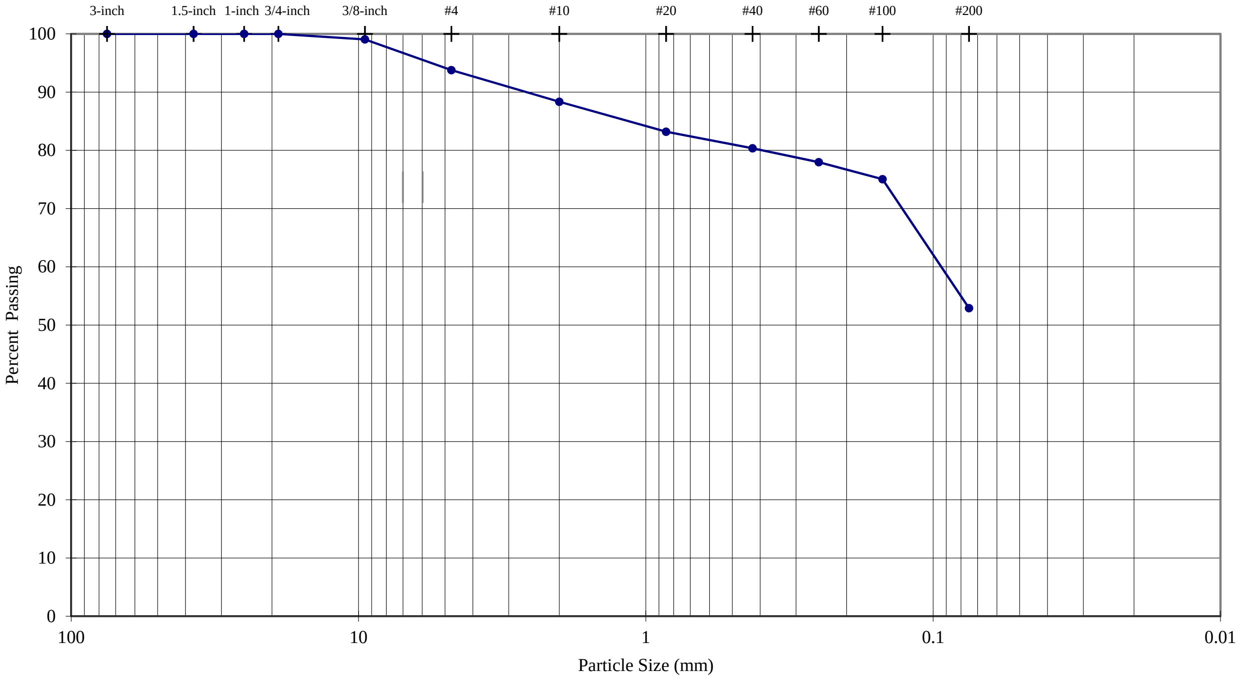
TECH	MGC/SRS
DATE	7/20/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

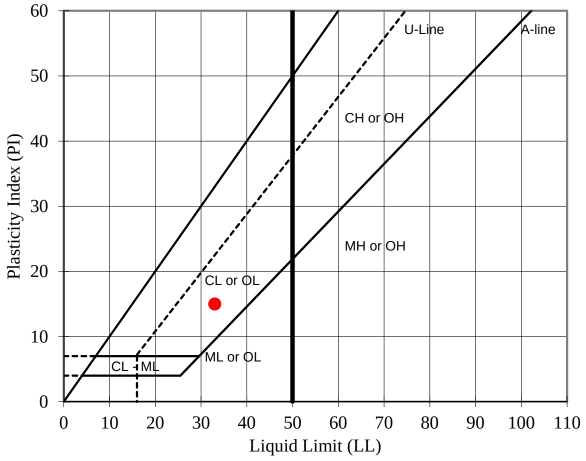
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-03, G-2** DEPTH (ft): **26-28**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.0**
#4	4.8	**93.8**
#10	2.00	**88.3**
#20	0.85	**83.2**
#40	0.43	**80.3**
#60	0.25	**78.0**
#100	0.15	**75.0**
#200	0.075	**52.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**6.22**
Coarse Sand	**5.44**
Medium Sand	**7.99**
Fine Sand	**27.44**
Silt or Clay Fines	**52.90**



USCS Description (ASTM D 2487):

Sandy lean clay, brown, moist

LL	PL	PI
33	**18**	**15**

As-Received Moisture Content (%): --

USCS Group Symbol: CL

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

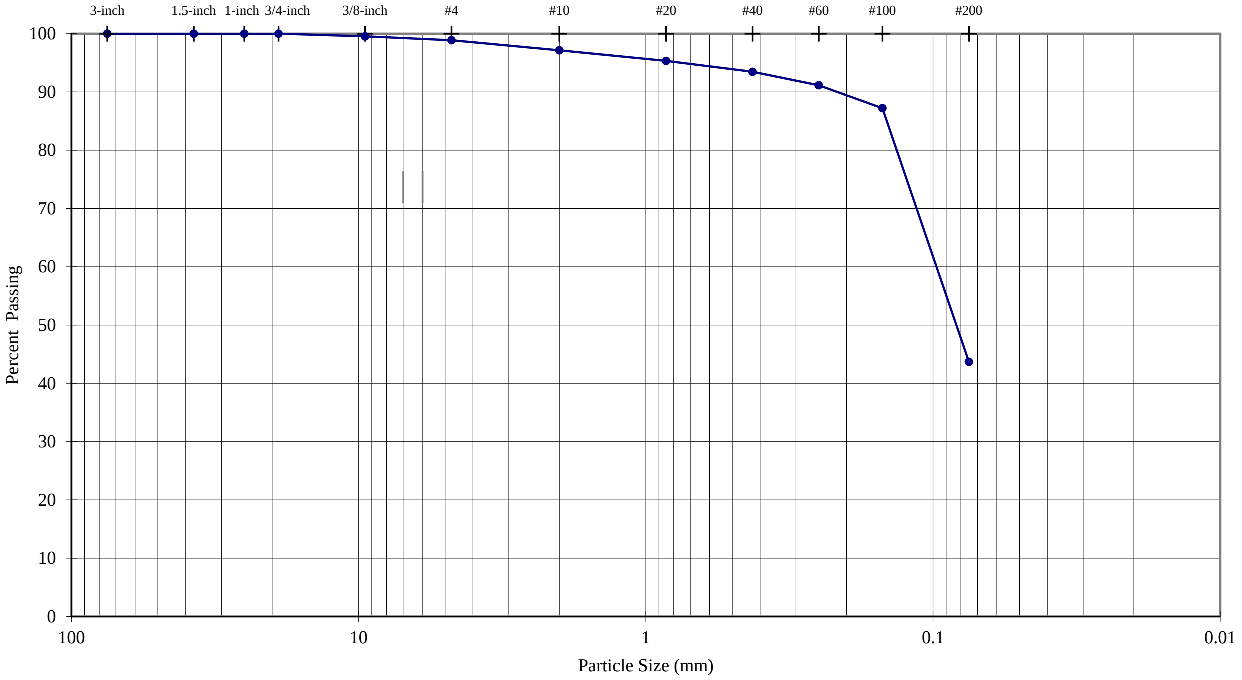
TECH	JAM
DATE	7/23/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

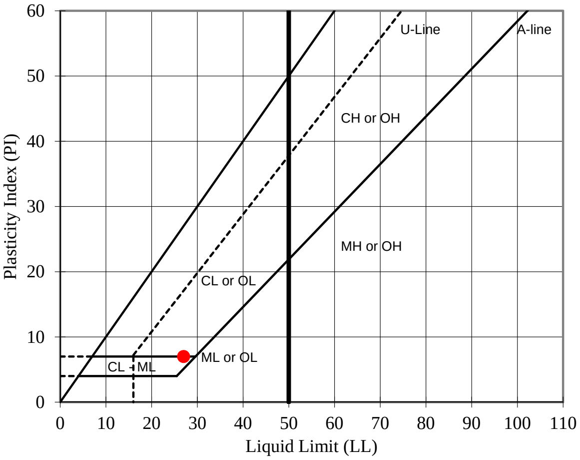
PROJECT NAME:	**SWPW/City of Cheyenne Landfill/CO**		
SAMPLE ID:	**GBH-2013-03, SS-5**	DEPTH (ft):	**19-21**
TYPE:	**Bag**		



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.5**
#4	4.8	**98.9**
#10	2.00	**97.1**
#20	0.85	**95.3**
#40	0.43	**93.5**
#60	0.25	**91.1**
#100	0.15	**87.2**
#200	0.075	**43.7**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**1.13**
Coarse Sand	**1.73**
Medium Sand	**3.68**
Fine Sand	**49.76**
Silt or Clay Fines	**43.70**



USCS Description (ASTM D 2487):

Silty, clayey sand, light yellowish brown, moist

LL	PL	PI	SpG
27	**20**	**7**	**2.68**

As-Received Moisture Content (%): **12.6**

USCS Group Symbol: SC-SM

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

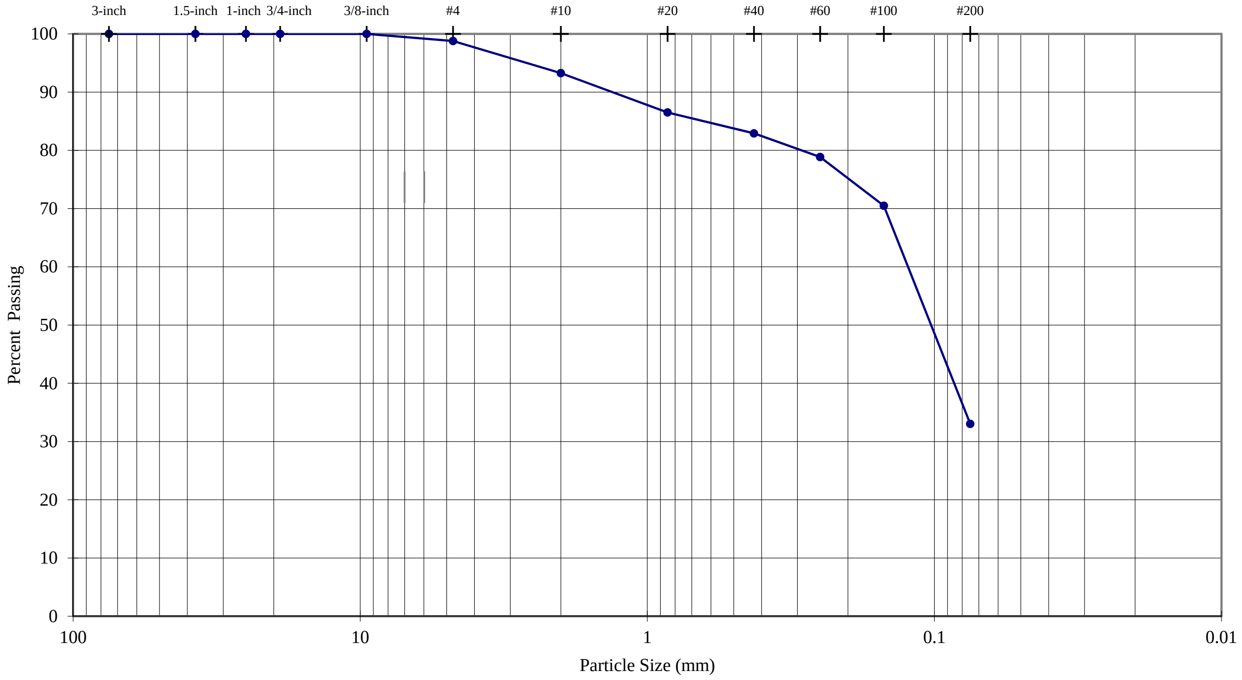
TECH	JAM
DATE	7/23/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

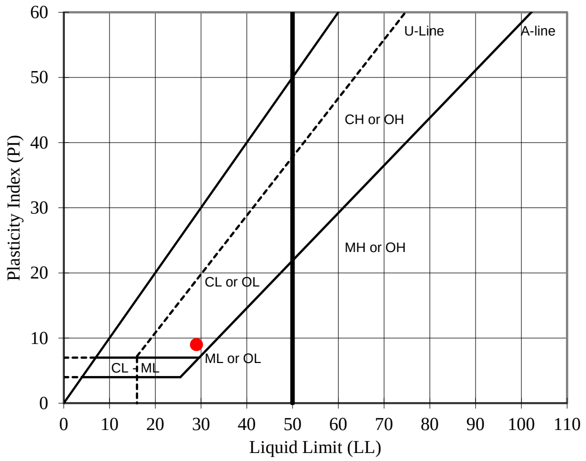
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-03, SS-9** DEPTH (ft): **59-61**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.8	**98.8**
#10	2.00	**93.3**
#20	0.85	**86.5**
#40	0.43	**82.9**
#60	0.25	**78.9**
#100	0.15	**70.5**
#200	0.075	**33.0**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**1.23**
Coarse Sand	**5.51**
Medium Sand	**10.34**
Fine Sand	**49.89**
Silt or Clay Fines	**33.03**



USCS Description (ASTM D 2487):

Clayey sand, light yellowish brown, moist

LL	PL	PI
29	**20**	**9**

As-Received Moisture Content (%): **10.6**

USCS Group Symbol: SC

Notes: 0g of particles up to 9.5mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

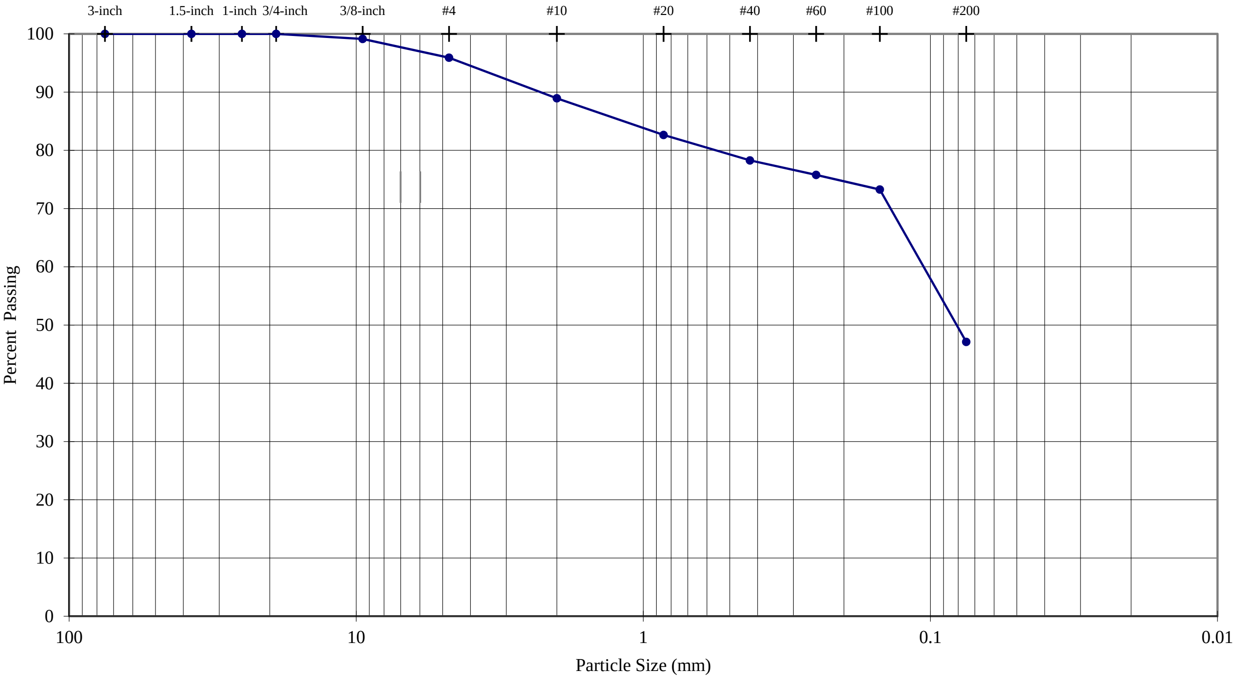
TECH	JAM
DATE	7/23/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

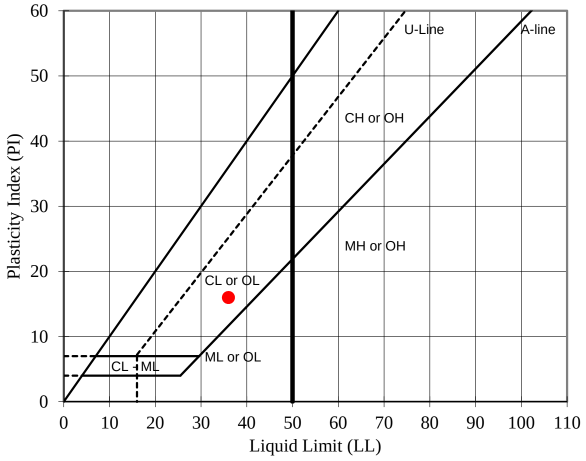
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-04, SS-8** DEPTH (ft): **35-37**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.1**
#4	4.8	**95.9**
#10	2.00	**88.9**
#20	0.85	**82.6**
#40	0.43	**78.3**
#60	0.25	**75.8**
#100	0.15	**73.3**
#200	0.075	**47.1**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**4.09**
Coarse Sand	**6.97**
Medium Sand	**10.66**
Fine Sand	**31.17**
Silt or Clay Fines	**47.10**



USCS Description (ASTM D 2487):

Clayey sand, light yellowish brown, moist

LL	PL	PI
36	**20**	**16**

As-Received Moisture Content (%): **16.1**

USCS Group Symbol: SC

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

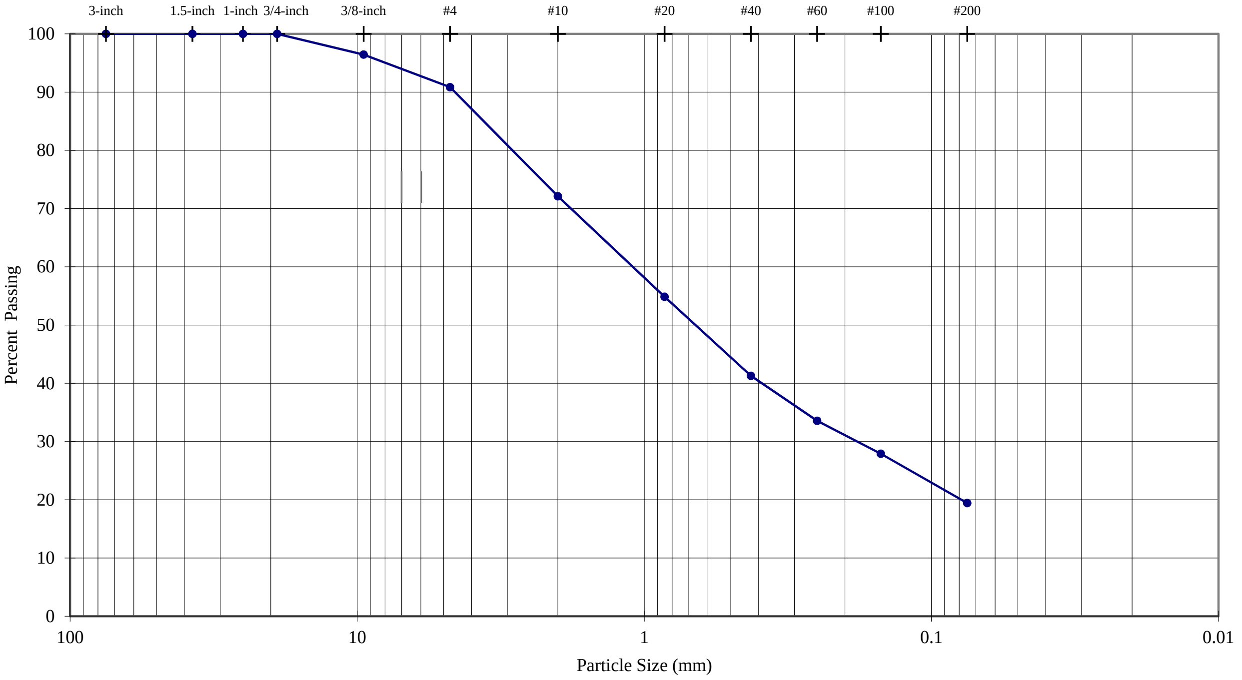
TECH	SB
DATE	7/24/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

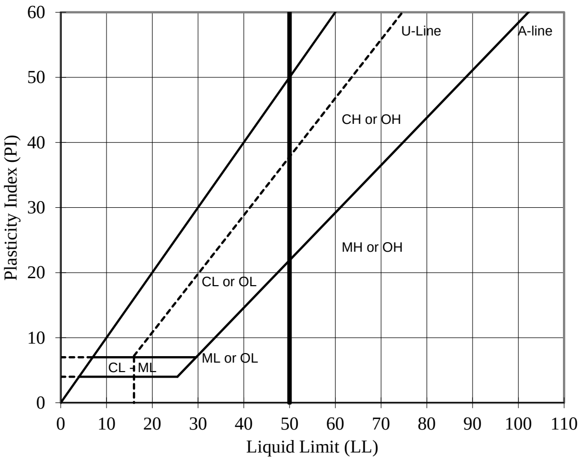
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-04, SS-13** DEPTH (ft): **60-62**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**96.4**
#4	4.8	**90.9**
#10	2.00	**72.1**
#20	0.85	**54.9**
#40	0.43	**41.3**
#60	0.25	**33.6**
#100	0.15	**27.9**
#200	0.075	**19.4**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**9.15**
Coarse Sand	**18.73**
Medium Sand	**30.85**
Fine Sand	**21.83**
Silt or Clay Fines	**19.44**



Visual Description (Golder Procedure):

CLAYEY SAND, some gravel, light reddish brown, moist

LL	PL	PI
#VALUE!	**#DIV/0!**	**#VALUE!**

As-Received Moisture Content (%): **5.5**

USCS Group Symbol: **--**

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed

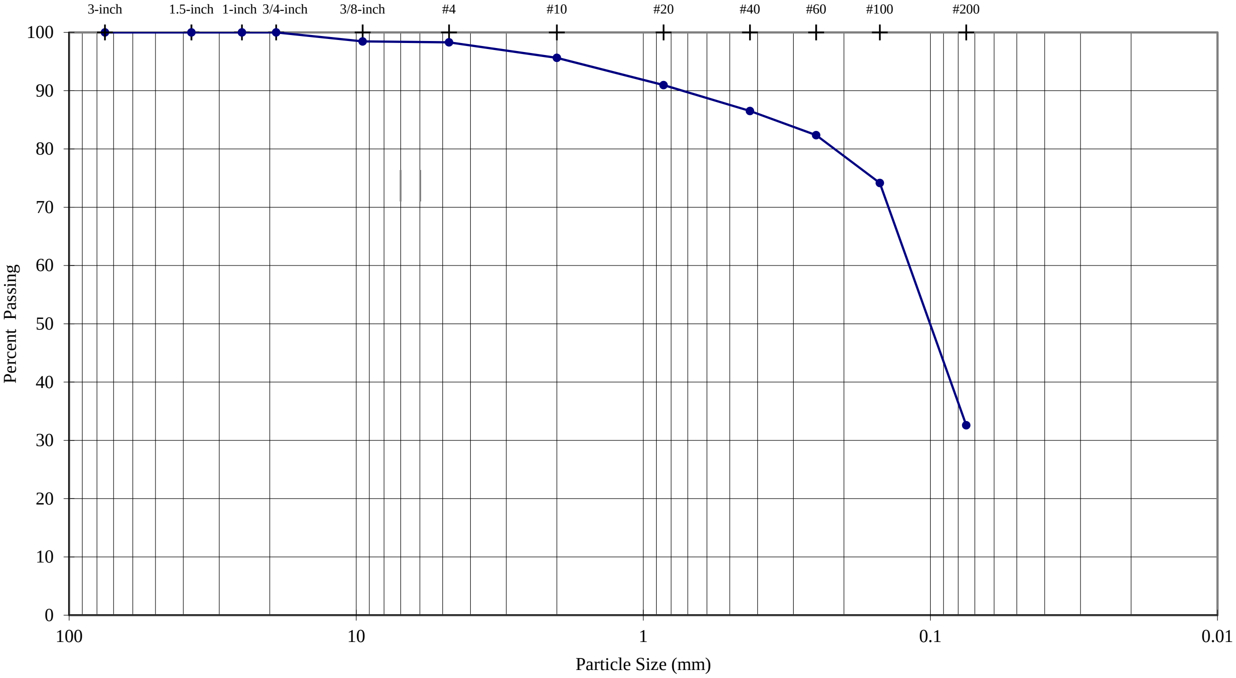
TECH	SB
DATE	7/24/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

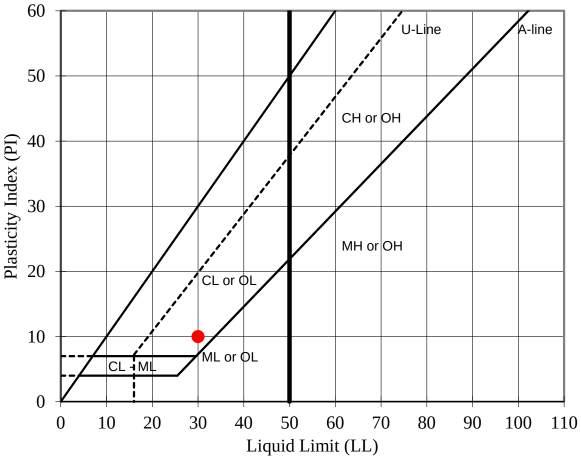
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-04, SS-15** DEPTH (ft): **70-72**
TYPE: **Bag**



Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**98.5**
#4	4.8	**98.3**
#10	2.00	**95.6**
#20	0.85	**91.0**
#40	0.43	**86.5**
#60	0.25	**82.4**
#100	0.15	**74.2**
#200	0.075	**32.6**

Sieve Analysis (Initial Separation on No. 4 Sieve)

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**1.70**
Coarse Sand	**2.66**
Medium Sand	**9.11**
Fine Sand	**53.92**
Silt or Clay Fines	**32.60**



USCS Description (ASTM D 2487):

Clayey sand, pale yellow, moist

LL	PL	PI	SpG
30	**20**	**10**	**P**

As-Received Moisture Content (%)	USCS Group Symbol
15.2	SC

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	SB
DATE	7/24/2013
REVIEW	MB

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME: SWPW/City of Cheyenne Landfill/CO
PROJECT NUMBER: 123-81971.0022
SAMPLE ID: GBH-2013-06 MC-1
SAMPLE DEPTH (ft): 24-25
SAMPLE TYPE: Bag

SAMPLE PREPARATION

Wet or Dry: Dry

Minus #40 Sieve: 100.0

PLASTIC LIMIT

Mass of Wet Soil & Tare (gm)	20.28	21.05
Mass of Dry Soil & Tare (gm)	19.23	19.94
Mass of Tare (gm)	13.74	13.97
Mass of Water (gm)	1.05	1.11
Mass of Dry Soil (gm)	5.49	5.97
Water Content %	19.13	18.59

LIQUID LIMIT

Number of Drops	35	28	21
Mass of Wet Soil & Tare (gm)	25.62	26.87	27.28
Mass of Dry Soil & Tare (gm)	23.41	24.27	24.91
Mass of Tare (gm)	14.00	13.91	15.65
Mass of Water (gm)	2.21	2.60	2.37
Mass of Dry Soil (gm)	9.41	10.36	9.26
Water Content %	23.49	25.10	25.59

PLASTIC LIMIT (PL)
19

LIQUID LIMIT (LL)
25

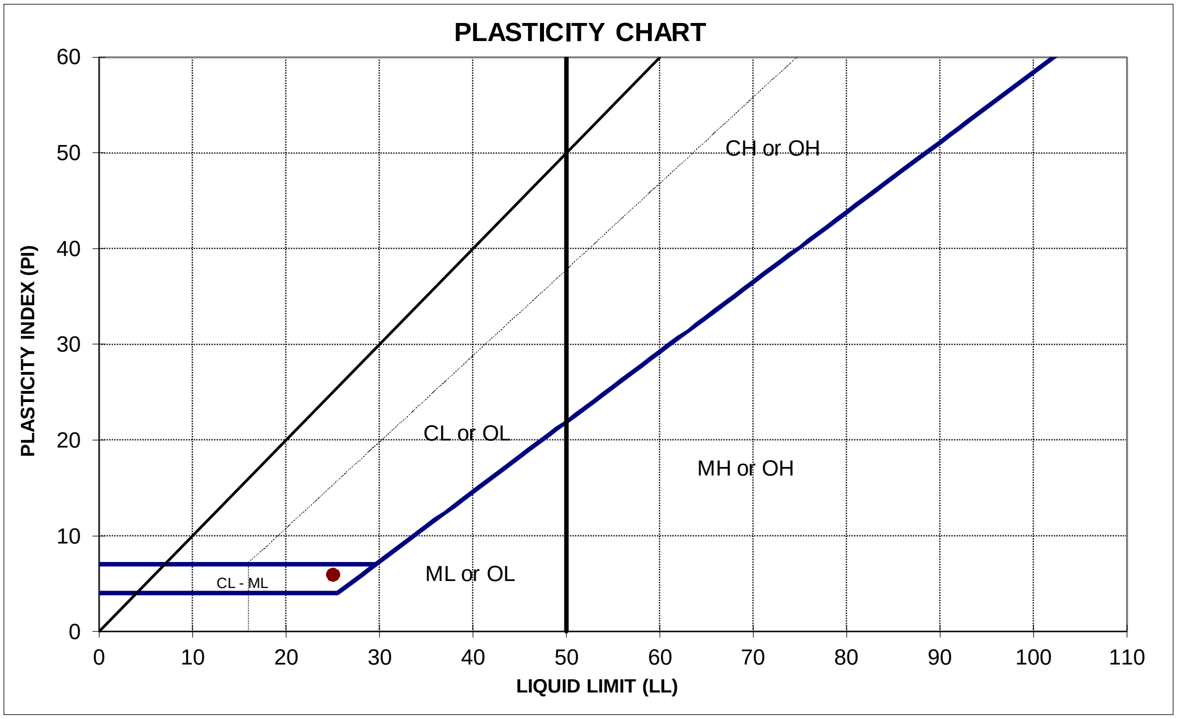
PLASTICITY INDEX (PI)
6

Visual Description (Golder Procedure)

CLAYEY SAND, very pale brown, moist

NOTES

Plastic Limit test performed by hand rolling.
Method A Liquid Limit test performed using mechanical device.



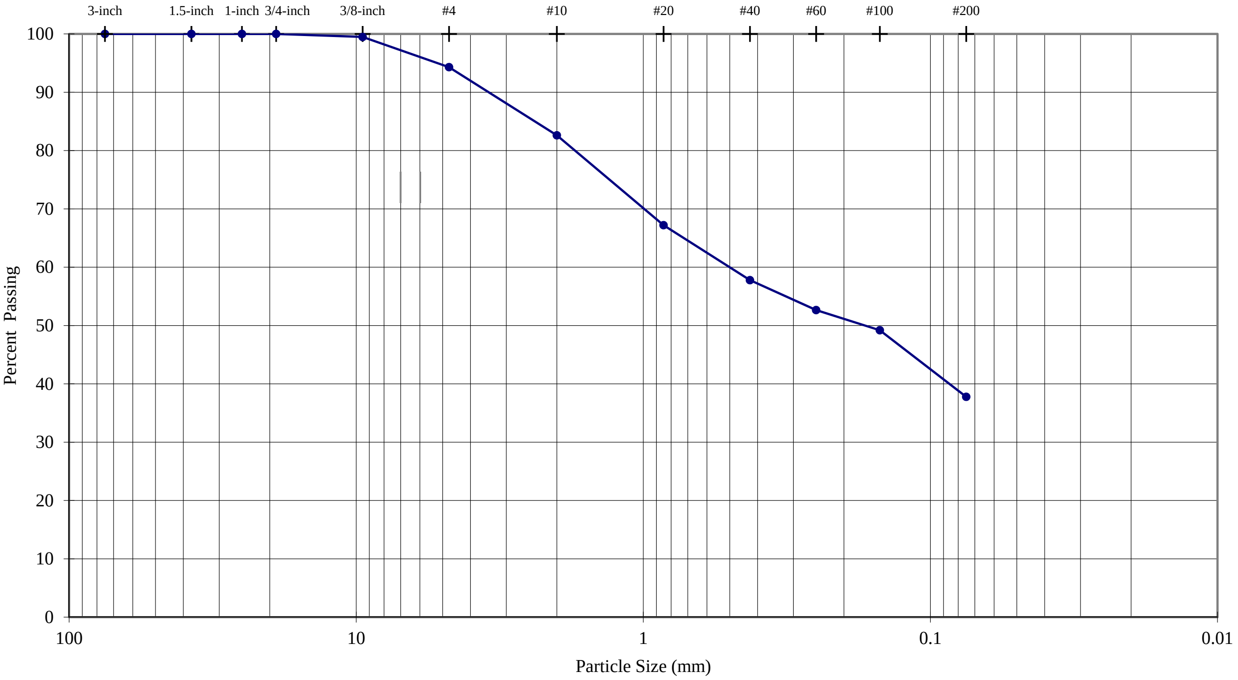
TECH	SB
DATE	8/5/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

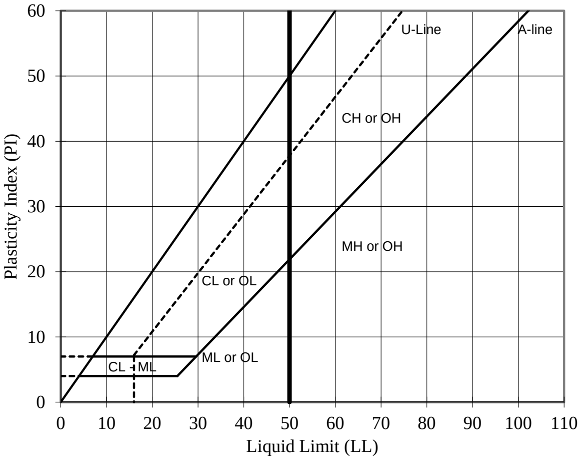
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-6, G-1** DEPTH (ft): **3-18**
TYPE: **Pail**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.5**
#4	4.8	**94.3**
#10	2.00	**82.6**
#20	0.85	**67.2**
#40	0.43	**57.8**
#60	0.25	**52.7**
#100	0.15	**49.2**
#200	0.075	**37.8**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**5.70**
Coarse Sand	**11.69**
Medium Sand	**24.83**
Fine Sand	**20.01**
Silt or Clay Fines	**37.78**



Visual Description (Golder Procedure):

CLAYEY SAND, brown, moist

LL	PL	PI	SpG
--	--	--	**2.69**

As-Received Moisture Content (%): **#DIV/0!**

USCS Group Symbol: **--**

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed

TECH	SB
DATE	7/22/2013
REVIEW	MB

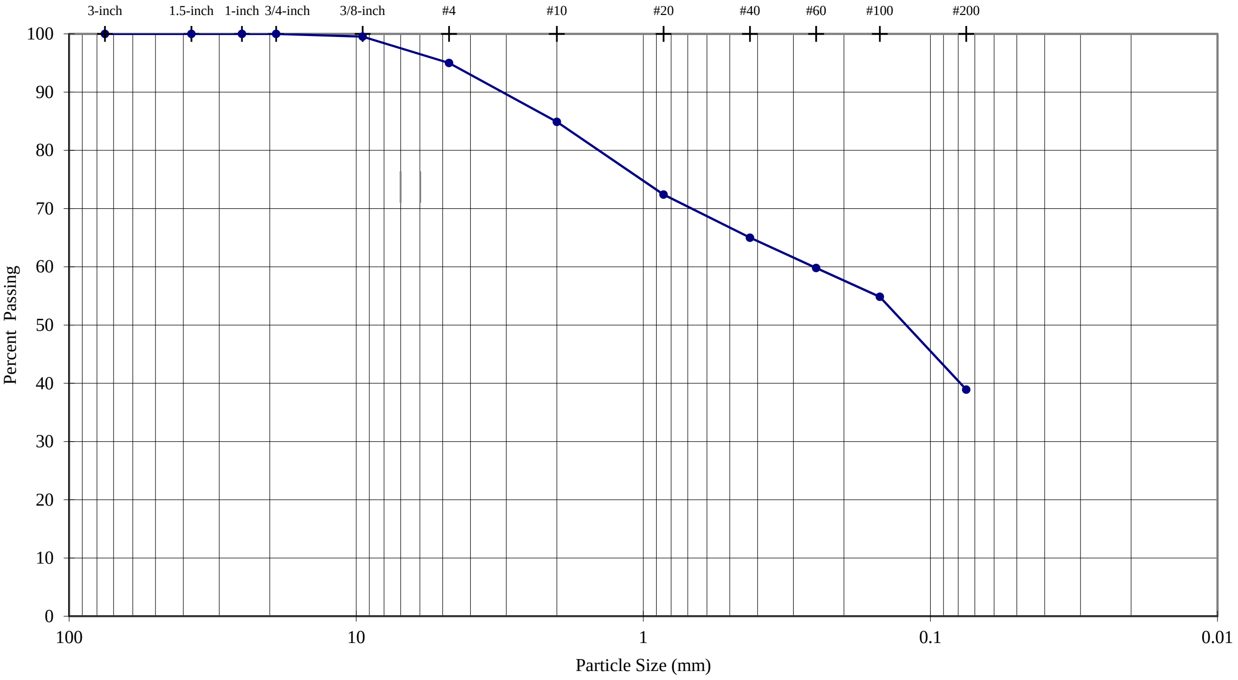
Golder Associates

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

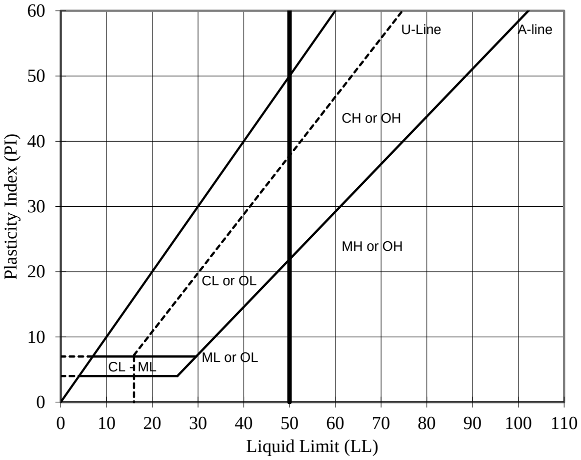
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-06 ,** DEPTH (ft): **22-38**
TYPE: **Pail**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**99.5**
#4	4.8	**95.0**
#10	2.00	**84.9**
#20	0.85	**72.4**
#40	0.43	**65.0**
#60	0.25	**59.8**
#100	0.15	**54.9**
#200	0.075	**38.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**4.99**
Coarse Sand	**10.11**
Medium Sand	**19.90**
Fine Sand	**26.08**
Silt or Clay Fines	**38.92**



Visual Description (Golder Procedure):

SILTY SAND, travel gravel, brown, moist

LL	PL	PI	SpG
--	**--**	**--**	**2.66**

As-Received Moisture Content (%): **#DIV/0!**

USCS Group Symbol: **--**

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed

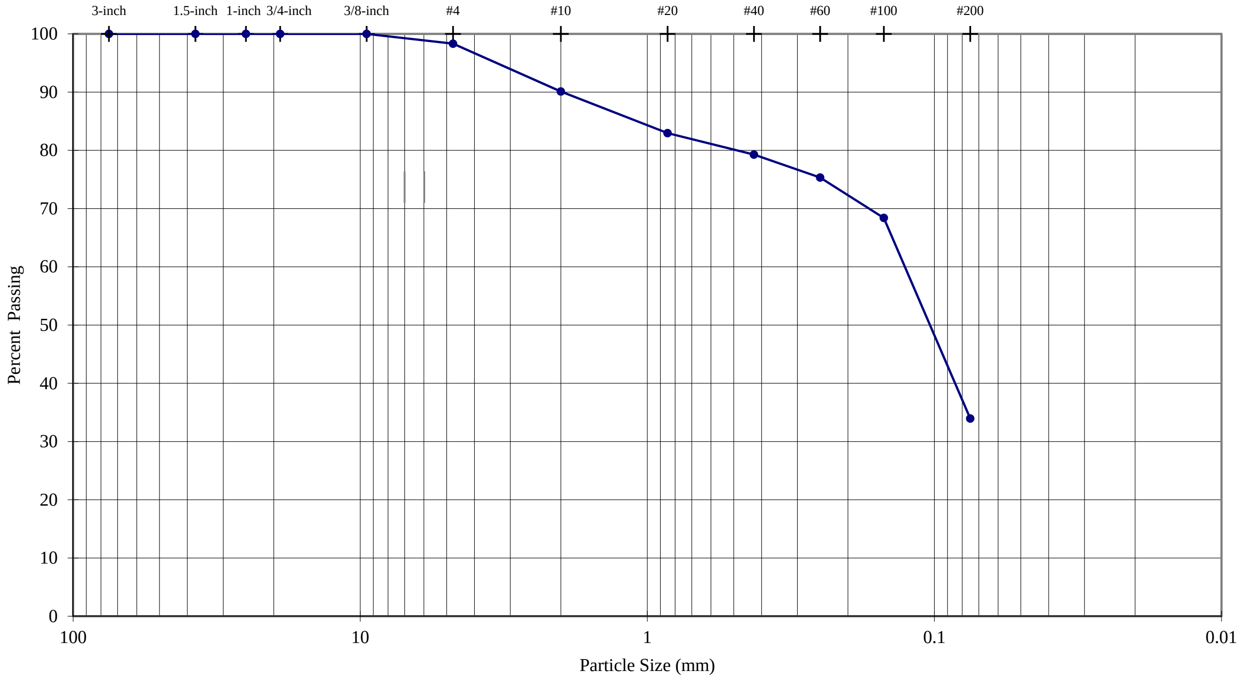
TECH	JP
DATE	7/22/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

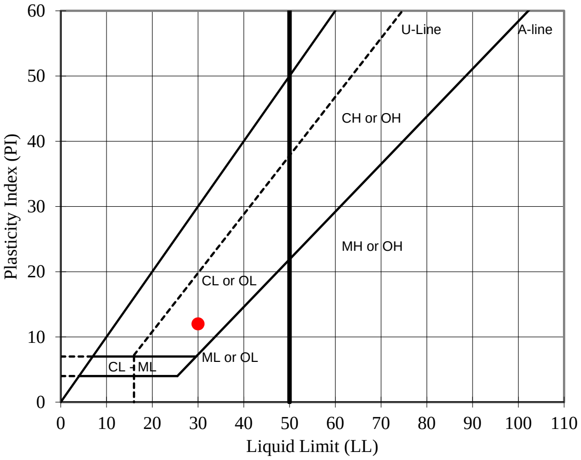
PROJECT NAME:	**SWPW/City of Cheyenne Landfill/CO**		
SAMPLE ID:	**GBH-2013-06, SS-7**	DEPTH (ft):	**34-36**
TYPE:	**Bag**		



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**100.0**
#4	4.8	**98.3**
#10	2.00	**90.1**
#20	0.85	**83.0**
#40	0.43	**79.3**
#60	0.25	**75.3**
#100	0.15	**68.4**
#200	0.075	**34.0**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**1.68**
Coarse Sand	**8.22**
Medium Sand	**10.83**
Fine Sand	**45.32**
Silt or Clay Fines	**33.95**



LL	PL	PI
30	**18**	**12**

USCS Description (ASTM D 2487):

Clayey sand, light yellowish brown, moist

As-Received Moisture Content (%)

11.0

USCS Group Symbol

SC

Notes: 0g of particles up to 9.5mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Attergerg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

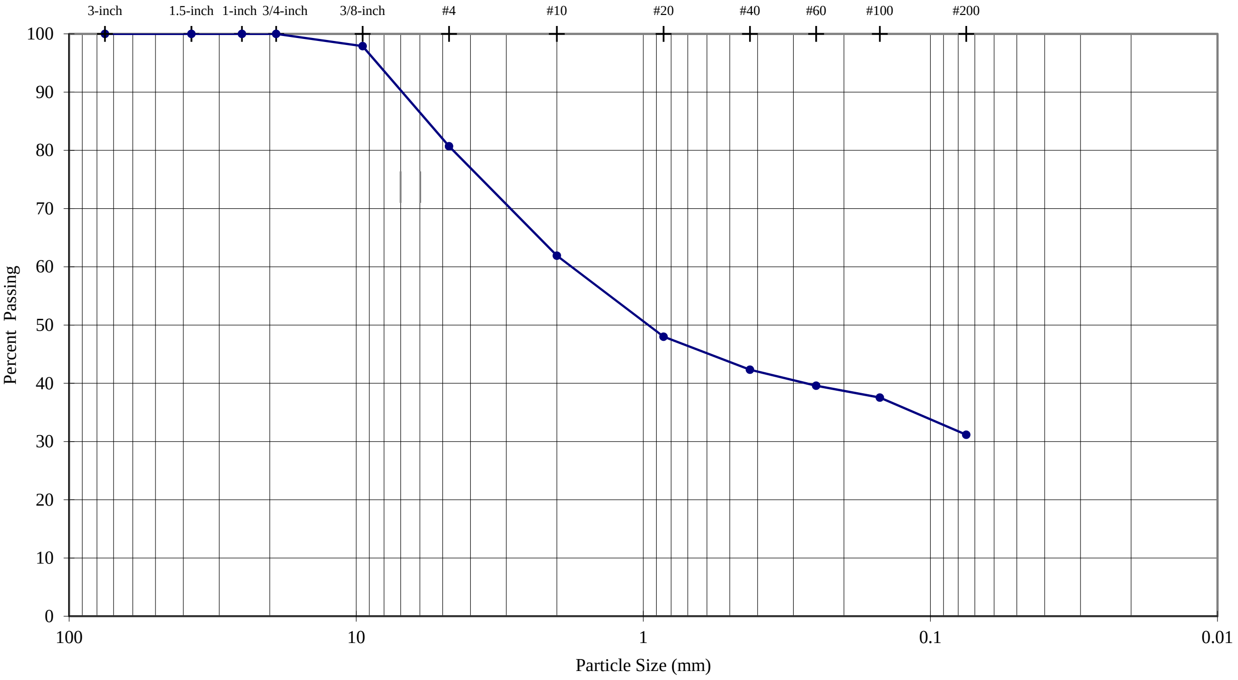
TECH	SB
DATE	7/24/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

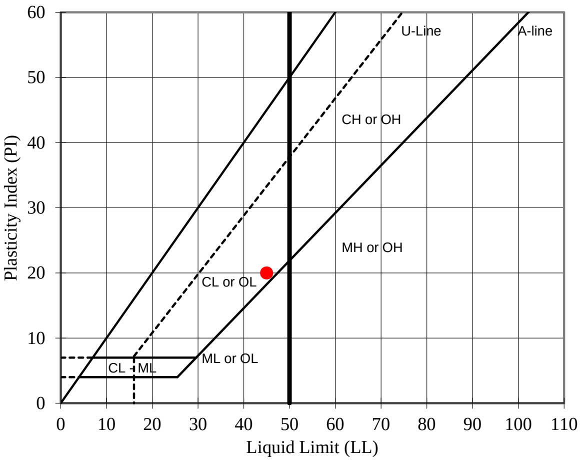
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-06, SS-13** DEPTH (ft): **69-70.5**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**97.9**
#4	4.8	**80.7**
#10	2.00	**61.9**
#20	0.85	**48.0**
#40	0.43	**42.3**
#60	0.25	**39.6**
#100	0.15	**37.6**
#200	0.075	**31.2**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**19.29**
Coarse Sand	**18.79**
Medium Sand	**19.59**
Fine Sand	**11.16**
Silt or Clay Fines	**31.17**



USCS Description (ASTM D 2487):

Clayey sand with gravel, light yellowish brown, moist

LL	PL	PI
45	**25**	**20**

As-Received Moisture Content (%): **9.7**

USCS Group Symbol: SC

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

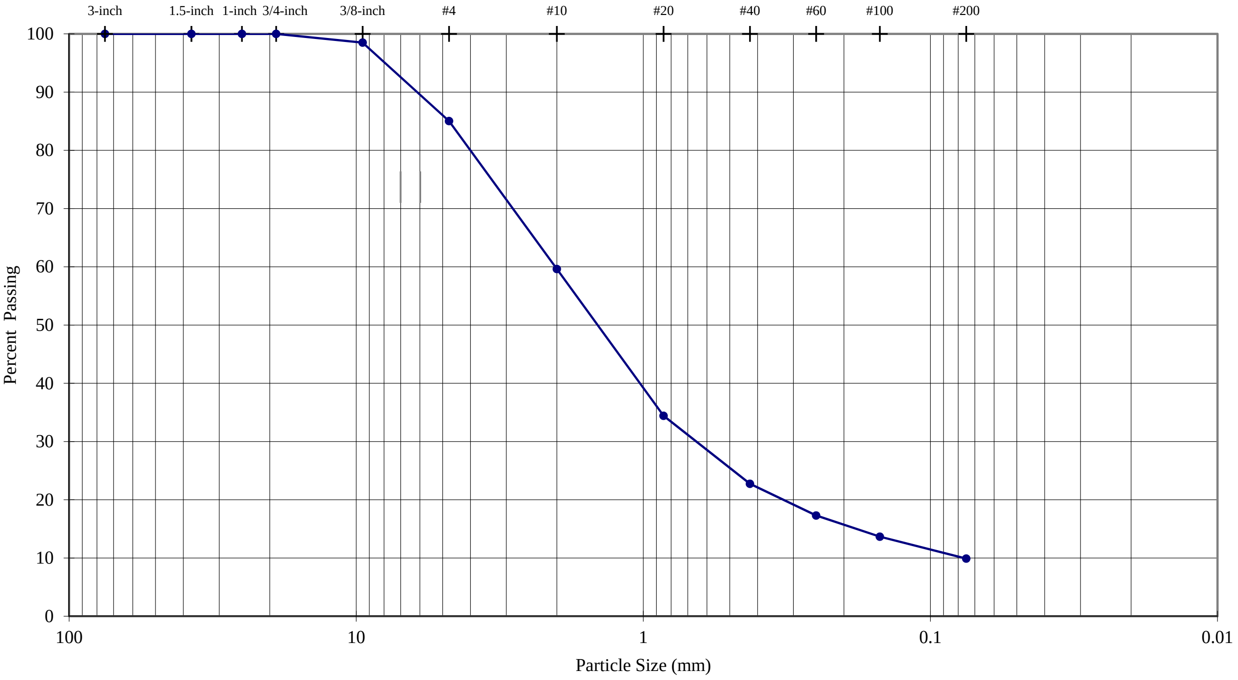
TECH	JP
DATE	7/24/2013
REVIEW	MB

July-13 **123-81971.0022**

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

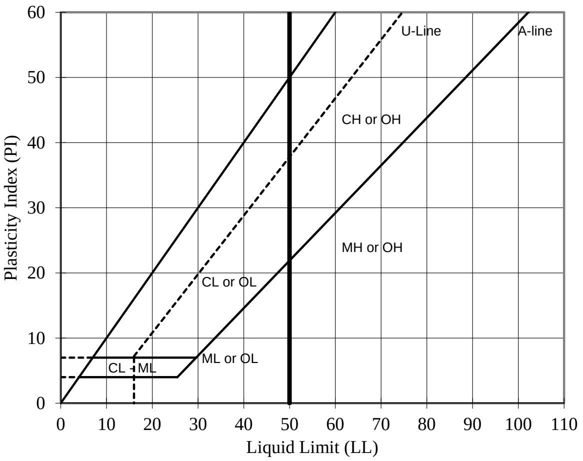
PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-06, SS-6** DEPTH (ft): **94-95**
TYPE: **Bag**



Sieve Analysis (Initial Separation on No. 4 Sieve)

Sieve	Particle Size (mm)	% Passing
3-inch	75.0	**100.0**
1.5-inch	37.5	**100.0**
1-inch	25.0	**100.0**
3/4-inch	19.0	**100.0**
3/8-inch	9.5	**98.5**
#4	4.8	**85.0**
#10	2.00	**59.6**
#20	0.85	**34.4**
#40	0.43	**22.7**
#60	0.25	**17.3**
#100	0.15	**13.7**
#200	0.075	**9.9**

Description	Percentage
Coarse Gravel	**0.00**
Fine Gravel	**14.97**
Coarse Sand	**25.41**
Medium Sand	**36.87**
Fine Sand	**12.85**
Silt or Clay Fines	**9.90**



Visual Description (Golder Procedure):

Gravelly, clayey sand, pale brown, moist

LL	PL	PI
--	--	--

As-Received Moisture Content (%)
1.7

USCS Group Symbol
--

Notes: 0g of particles up to 19.0mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample was not mechanically dispersed; hydrometer test was not performed

TECH	JP
DATE	7/24/2013
REVIEW	MB

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME: SWPW/City of CheyenneLandfill/CO
PROJECT NUMBER: 123-81971.0022
SAMPLE ID: GBH-2013-07, SS-8
SAMPLE DEPTH (ft): 39-41
SAMPLE TYPE: Bag

SAMPLE PREPARATION
Wet or Dry: Dry
Minus #40 Sieve: 100%

PLASTIC LIMIT

Mass of Wet Soil & Tare (gm)	31.92	32.54
Mass of Dry Soil & Tare (gm)	30.82	31.33
Mass of Tare (gm)	24.89	24.86
Mass of Water (gm)	1.10	1.21
Mass of Dry Soil (gm)	5.93	6.47
Water Content %	18.55	18.70

LIQUID LIMIT

Number of Drops	35	27	19
Mass of Wet Soil & Tare (gm)	45.10	36.32	37.37
Mass of Dry Soil & Tare (gm)	42.11	33.46	34.18
Mass of Tare (gm)	32.62	24.62	24.66
Mass of Water (gm)	2.99	2.86	3.19
Mass of Dry Soil (gm)	9.49	8.84	9.52
Water Content %	31.51	32.35	33.51

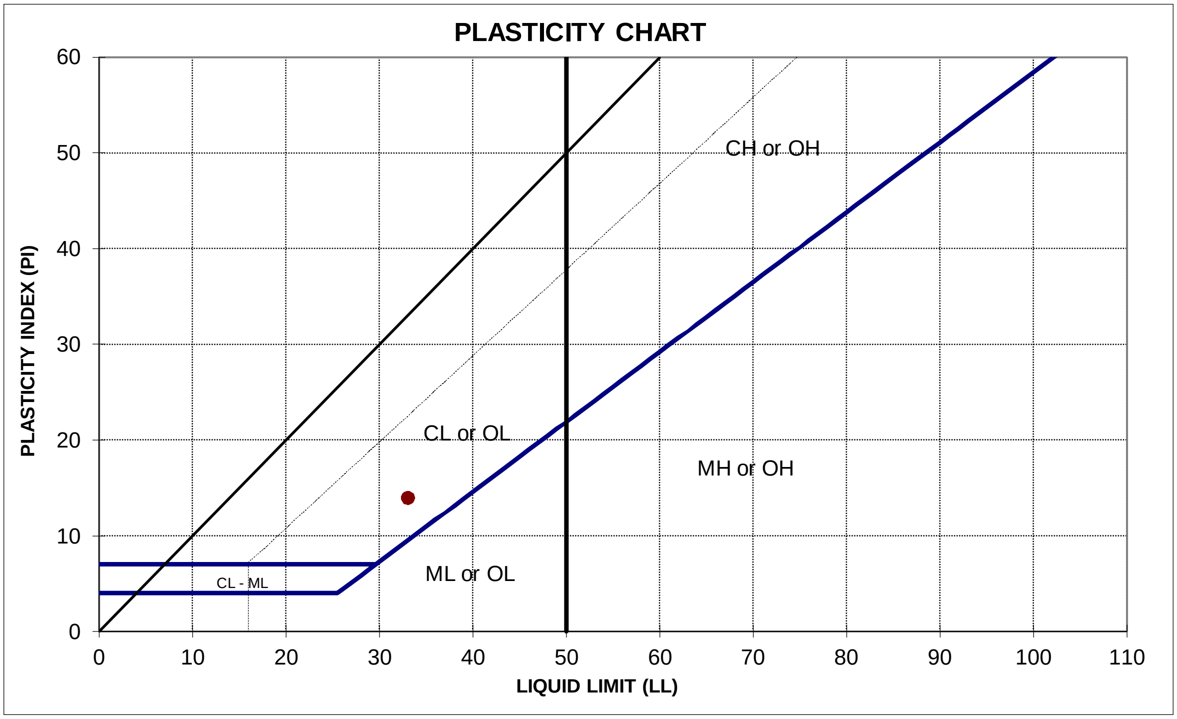
PLASTIC LIMIT (PL): 19

LIQUID LIMIT (LL): 33

PLASTICITY INDEX (PI): 14

Visual Description (Golder Procedure)
CLAYEY SAND, light yellowish brown, moist

NOTES
Plastic Limit test performed by hand rolling.
Method A Liquid Limit test performed using mechanical device.



TECH: JAM
DATE: 7/26/2013
REVIEW: MB

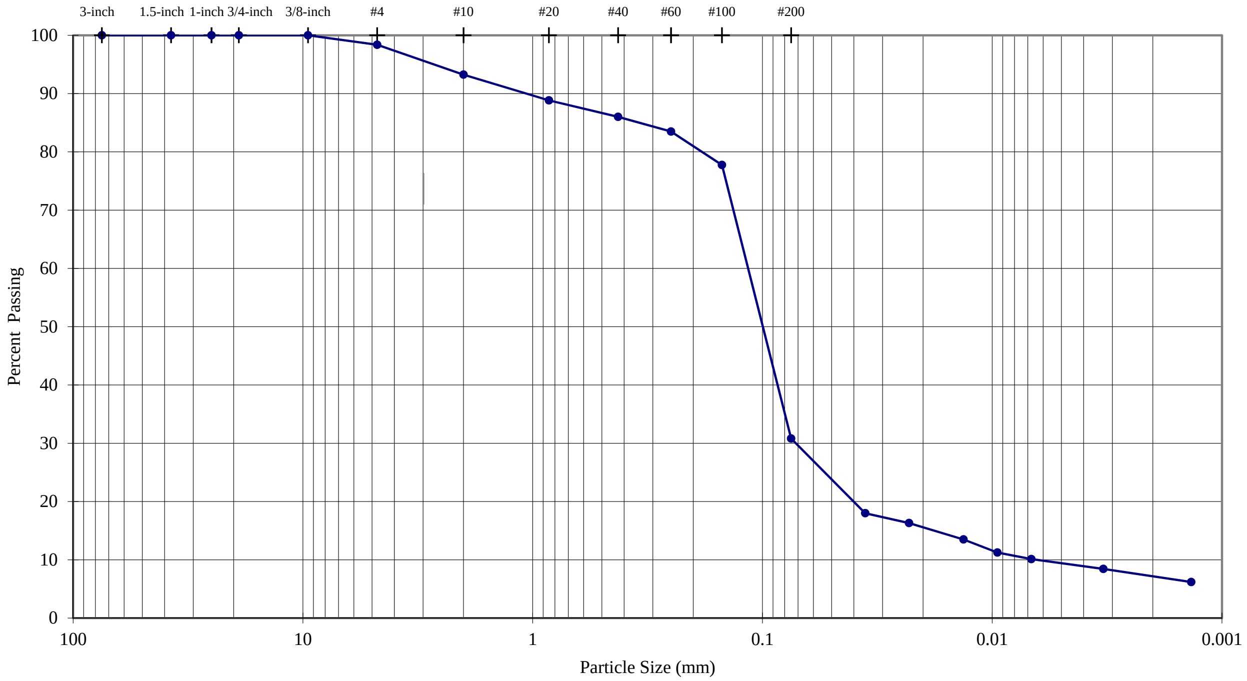
Golder Associates

July-13 **123-81971.0022**

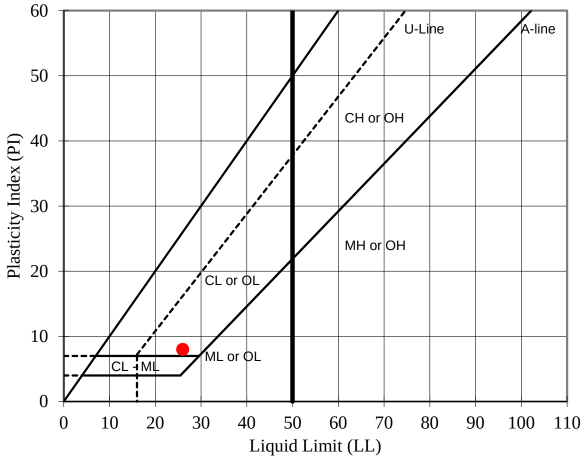
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-07, SS-14** DEPTH (ft): **79-81**
TYPE: **Bag**



	Sieve	Particle Size (mm)	% Passing	Description	Percentage
Sieve Analysis (Initial Separation on No. 4 Sieve)	3-inch	75.0	**100.0**		
	1.5-inch	37.5	**100.0**	Coarse Gravel	**0.00**
	1-inch	25.0	**100.0**		
	3/4-inch	19.0	**100.0**		
	3/8-inch	9.5	**100.0**	Fine Gravel	**1.63**
	#4	4.75	**98.4**		
	#10	2.0	**93.2**	Coarse Sand	**5.13**
	#20	0.85	**88.8**	Medium Sand	**7.24**
	#40	0.425	**86.0**		
	#60	0.25	**83.5**	Fine Sand	**55.19**
	#100	0.15	**77.7**		
	#200	0.075	**30.8**		
Hydrometer Analysis		0.036	**18.0**	Silt or Clay Fines	**30.81**
		0.023	**16.3**		
		0.013	**13.5**		
		0.009	**11.2**		
		0.007	**10.1**		
		0.003	**8.4**		
		0.001	**6.2**		



USCS Description (ASTM D 2487):

Clayey sand, light yellow brown, moist

LL	PL	PI
26	**18**	**8**

As-Received Moisture Content (%)
--

USCS Group Symbol
SC

Notes: 0g of particles up to 9.5mm maximum size were removed from particle size analysis sample prior to testing
Particle size analysis sample mechanically dispersed using Stirring Apparatus A for about 1 minute
Sample prepared for Atterberg Limits testing by the dry method
Material retained on No. 40 sieve removed from Atterberg Limits sample by sieving
Plastic Limit test performed by hand rolling. Method A Liquid Limit test performed using mechanical device

TECH	SB/PH
DATE	7/24/2013
REVIEW	MB

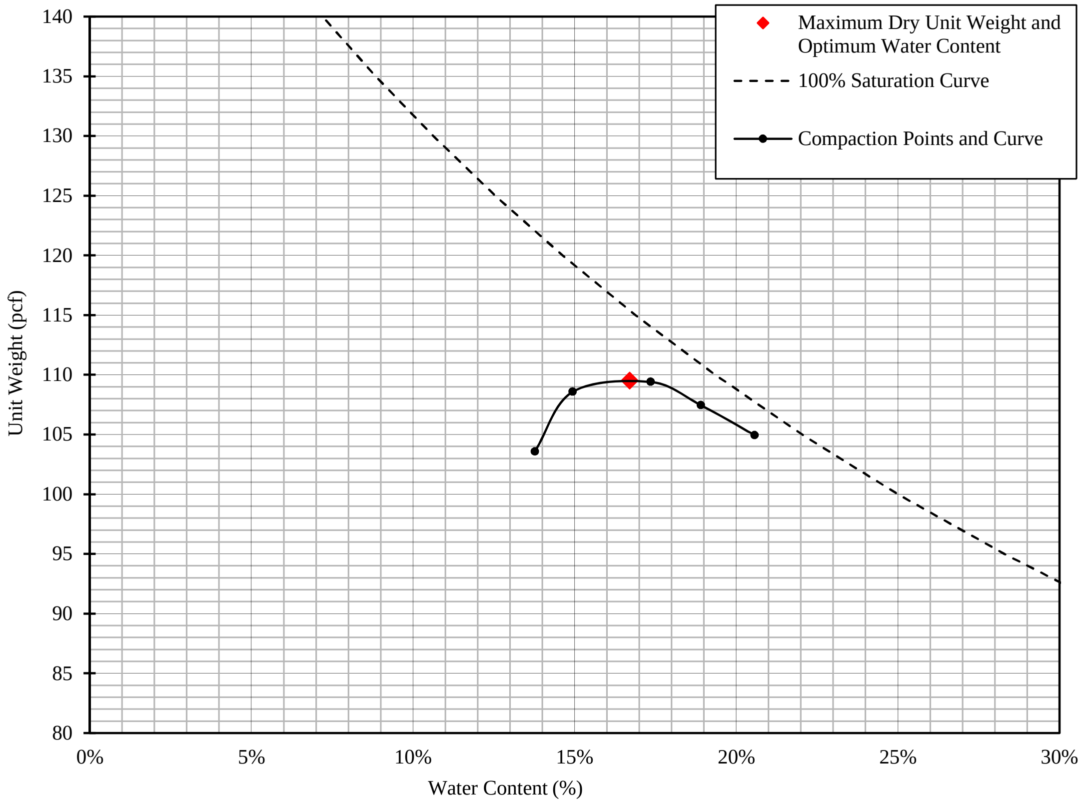
APPENDIX D-2
STANDARD PROCTOR TEST RESULTS

July-13 **123-81971.0022**

LABORATORY COMPACTION CHARACTERISTICS OF SOIL
ASTM D698 - Method A

Manual Rammer	**Moist Preparation**

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-01, G-2** DEPTH (ft): **34-38**
TYPE: **Pail**



% Test Fraction Passing #4 Sieve	**100%**
As-Received Moisture Content	--
Specific Gravity (ASTM D854)	**2.68**

Maximum Dry Unit Weight (pcf)	**109.5**
Optimum Water Content (%)	**16.7**

USCS Description (ASTM D 2487): Sandy lean clay, strong brown, moist

USCS CL

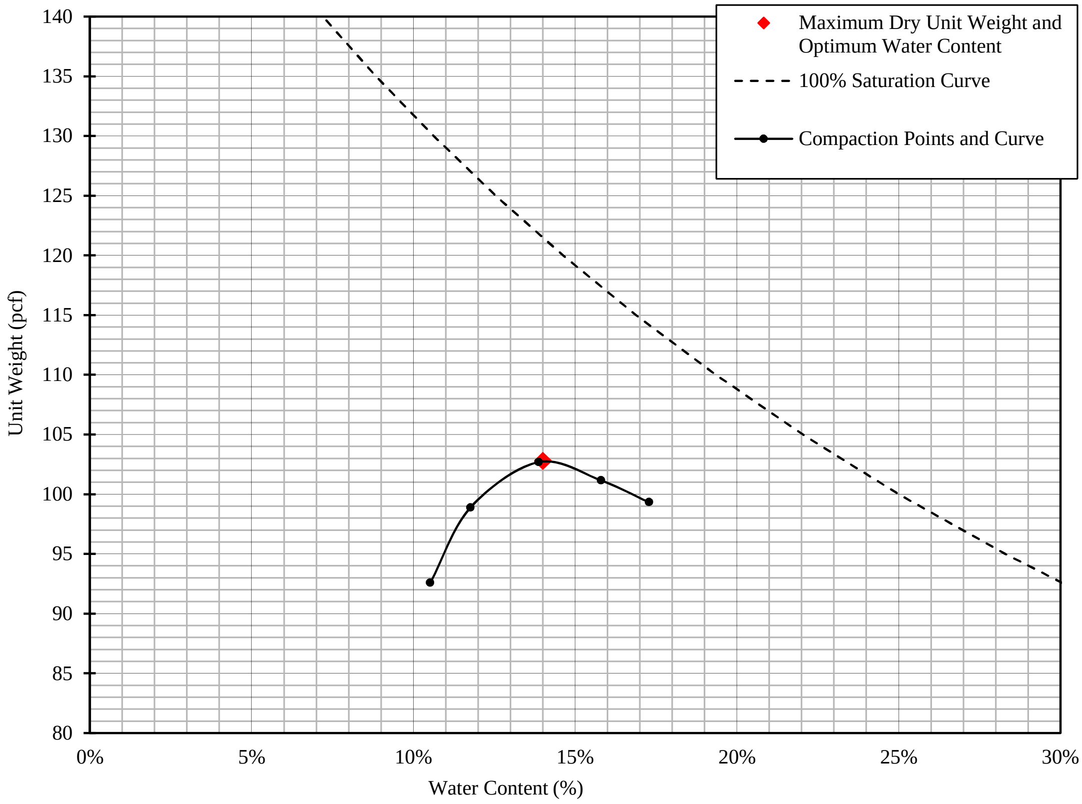
TECH	JP
DATE	7-24-2013
REVIEW	MB

July-13 **123-81971.0022**

LABORATORY COMPACTION CHARACTERISTICS OF SOIL
ASTM D698 - Method A

Manual Rammer	**Moist Preparation**

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-03, G-1** DEPTH (ft): **5-20**
TYPE: **Pail**



% Test Fraction Passing #4 Sieve	**98%**
As-Received Moisture Content	**NA**
Specific Gravity (ASTM D854)	**2.68**

Maximum Dry Unit Weight (pcf)	**102.8**
Optimum Water Content (%)	**14.0**

USCS Description (ASTM D 2487): Sandy lean clay, trace gravel, dark yellowish brown, moist

USCS CL

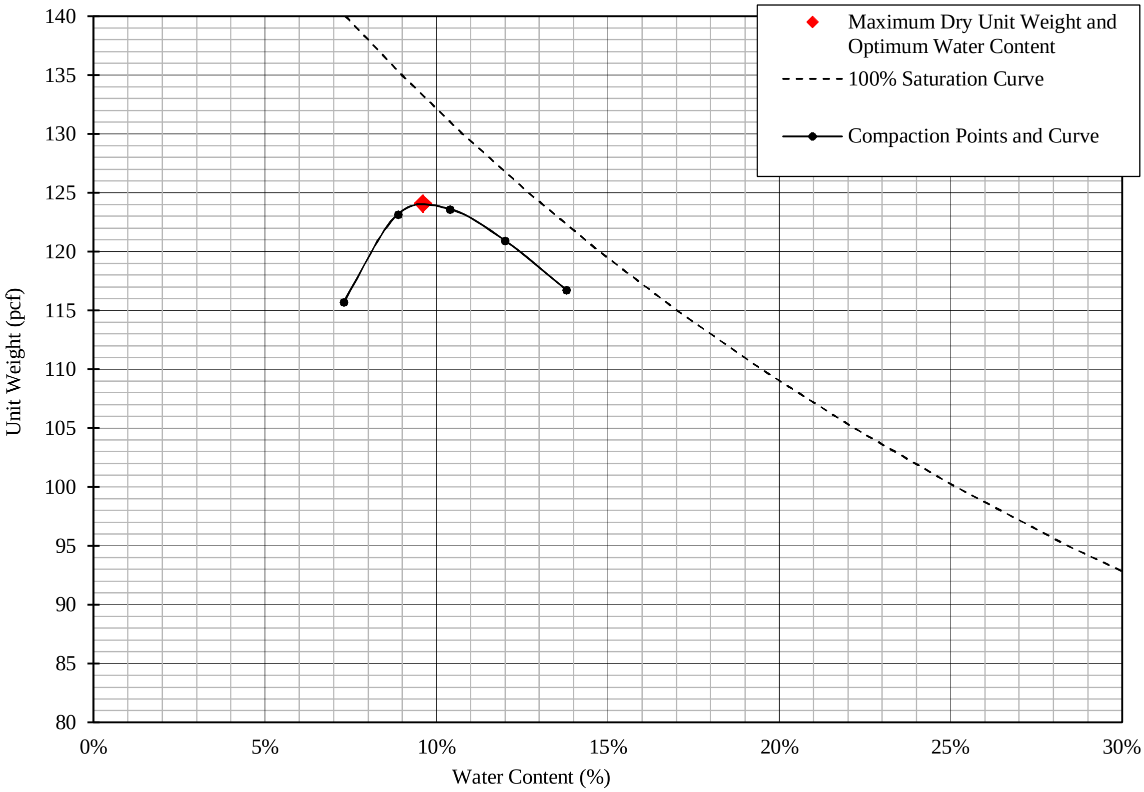
TECH	SB
DATE	7-23-2013
REVIEW	MB

July-13 **123-81971.0022**

LABORATORY COMPACTION CHARACTERISTICS OF SOIL
ASTM D698 - Method A

Manual Rammer	**Moist Preparation**

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-6, G-1** DEPTH (ft): **3-18**
TYPE: **Pail**



% Test Fraction Passing #4 Sieve	**94%**
As-Received Moisture Content	**--**
Specific Gravity (ASTM D854)	**2.69**

Maximum Dry Unit Weight (pcf)	**124.1**
Optimum Water Content (%)	**9.6**
Corrected Maximum Dry Unit Weight (pcf)	**125.7**
Corrected Optimum Water Content (%)	**9.1**

Visual Description (Golder Procedure): CLAYEY SAND, brown, moist

USCS --

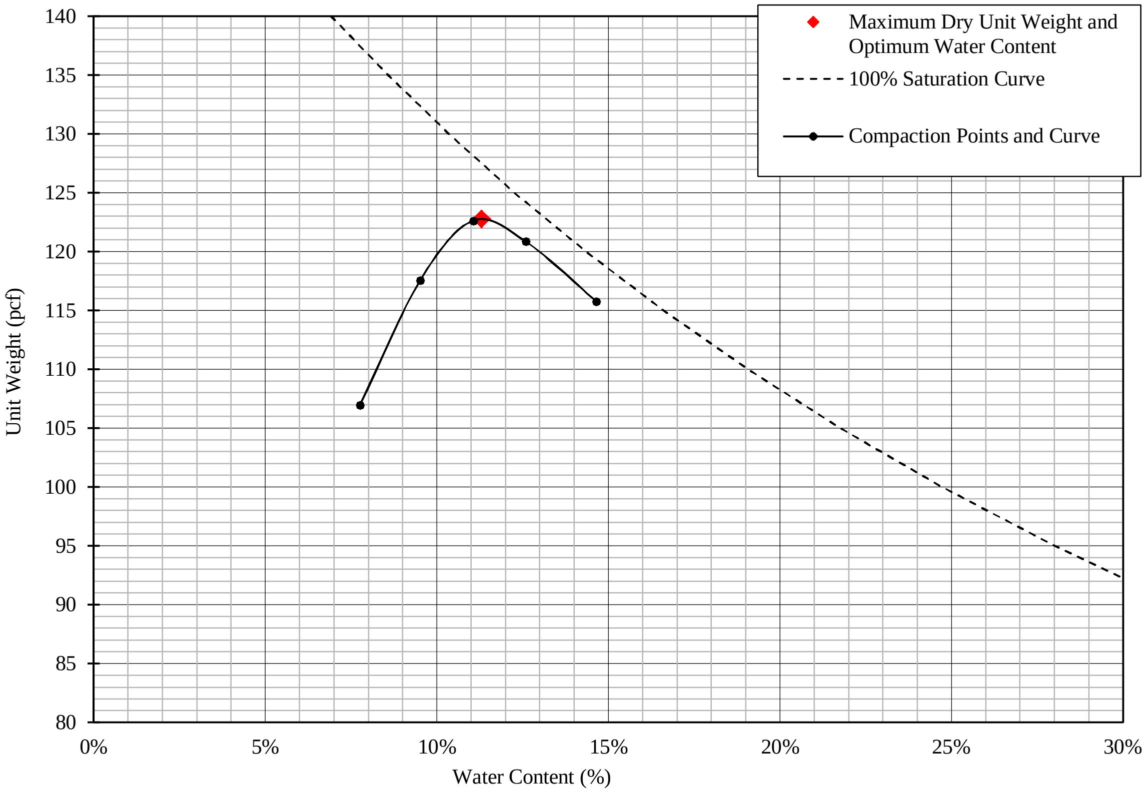
TECH	SB
DATE	7-23-2013
REVIEW	MB

July-13 **123-81971.0022**

LABORATORY COMPACTION CHARACTERISTICS OF SOIL
ASTM D698 - Method A

Manual Rammer	**Moist Preparation**

PROJECT NAME: **SWPW/City of Cheyenne Landfill/CO**
SAMPLE ID: **GBH-2013-06 ,** DEPTH (ft): **22-38**
TYPE: **Pail**



% Test Fraction Passing #4 Sieve	**95%**
As-Received Moisture Content	--
Specific Gravity (ASTM D854)	**2.66**

Maximum Dry Unit Weight (pcf)	**122.8**
Optimum Water Content (%)	**11.3**
Corrected Maximum Dry Unit Weight (pcf)	**124.3**
Corrected Optimum Water Content (%)	**10.8**

Visual Description (Golder Procedure): SILTY SAND, travel gravel, brown, moist

USCS --

TECH	SB
DATE	7-23-2013
REVIEW	MB

APPENDIX D-3
CONSOLIDATION TEST RESULTS

	Initial		Final	
Height =	1.330	in	1.246	in
Diameter =	1.928	in	1.928	in
Area =	2.919	in^2	2.919	in^2
Volume =	3.883	in^3	3.638	in^3
Water Content =	10.7%		3.0%	
Specific Gravity =	2.67	(ASTM D854)	2.67	(ASTM D854)
Height of Solids =	0.7674	in	0.7674	in
Void Ratio =	0.733		0.624	
Degree of Saturation =	39.0%		12.8%	
Wet Mass =	0.239	lb	0.222	lb
Dry Mass =	0.216	lb	0.216	lb
Wet Unit Weight =	106.3	pcf	105.5	pcf
Dry Unit Weight =	96.0	pcf	102.5	pcf

Notes

Visual description:	silty SAND trace gravel, light yellowish brown, dry		
Atterberg Limits (ASTM D4318):	LL = 25	PL = 19	PI = 6
Percent Finer (ASTM D422):	3/4 in. = --	No. 4 = --	No. 200 = --
Specimen Type:	☒ Intact	☐ Reconstituted	
Remold Targets:	Not applicable		
Water Content of Trimmings (ASTM D2216):	12.1%		
Trimming Procedure:	Specimen trimmed using consolidometer ring		
Inundation:	☒ Not inundated	☐ Inundated	
Test Method:	☐ A	☒ B	
Apparatus:	Frame No. 6	(ELE C-320A)	
Final Water Content Specimen:	☒ Entire	☐ Partial	
Final Differential Height:	-0.0151 in		
Estimated Preconsolidation Stress:	5.7 ksf		

-- indicates test was not performed

			At End of Primary Consolidation				At End of Load Duration							
	Axial Stress (ksf)	Load Duration (min)	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Deformation (in)	Specimen Height (in)	Axial Strain (%)	Void Ratio	Time Deformation Method	Average Void Ratio	Coefficient of Consolidation (ft^2/day)	Time to 50% Consolidation (min)
Seating	0.10	1260.00					0.0000	1.3247	0.00	0.726				
1	0.25	1440.12					0.0047	1.3199	0.36	0.720				
2	0.50	1470.00					0.0122	1.3124	0.92	0.710				
3	1.00	1440.15					0.0196	1.3051	1.47	0.701				
4	2.00	1500.00					0.0290	1.2956	2.18	0.688				
5	4.00	1380.13					0.0409	1.2838	3.07	0.673				
6	8.00	1440.12					0.0624	1.2623	4.69	0.645				
7	16.00	1380.10					0.0972	1.2275	7.30	0.600				
8	4.00	240.05					0.0964	1.2282	7.25	0.601				
9	1.00	60.02					0.0951	1.2296	7.15	0.602				
10	0.25	1140.07					0.0938	1.2309	7.05	0.604				

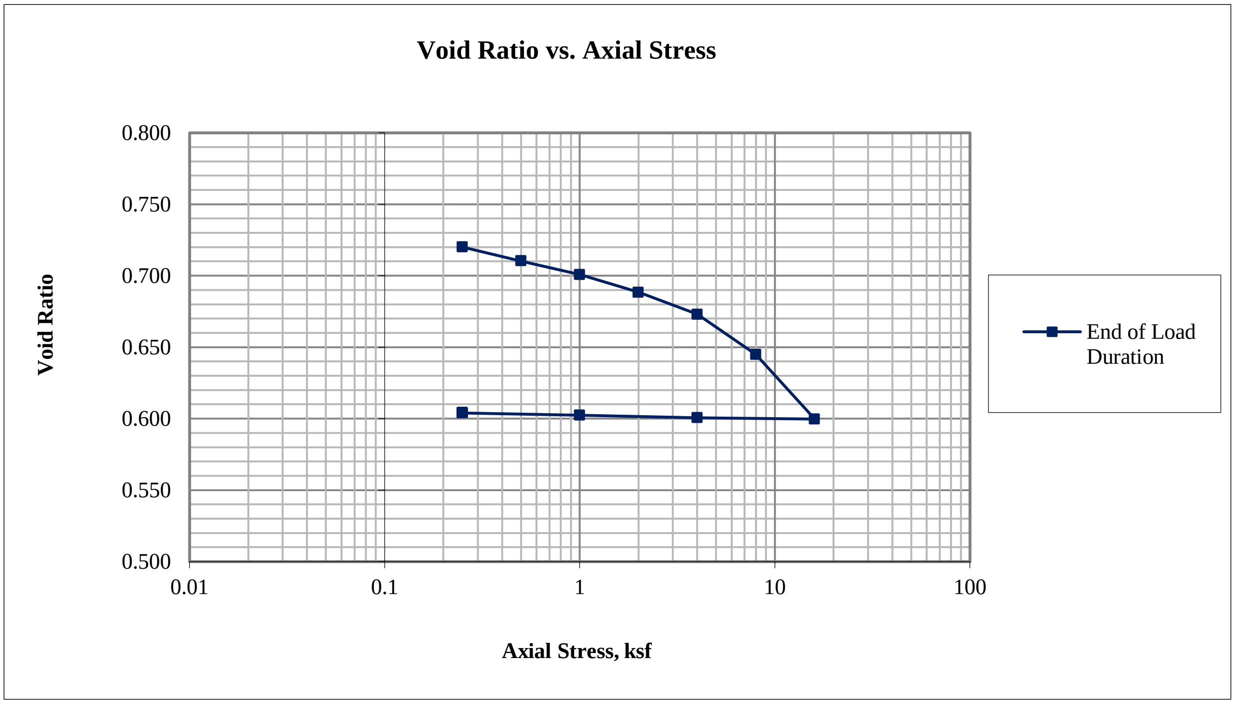
Golder Associates Inc.
Denver, Colorado

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:

ASTM D2435
ONE-DIMENSIONAL CONSOLIDATION TEST REPORT
SPECIMEN AND SUMMARY DATA

Sample:	Technician:	Reviewed:	Start Date:	Job Number:	Figure:
GBH-2013-06 / MC-1 @ 24-25 ft.	**RJM**	**CCS**	**7/24/2013**	**123-81971**	**1**

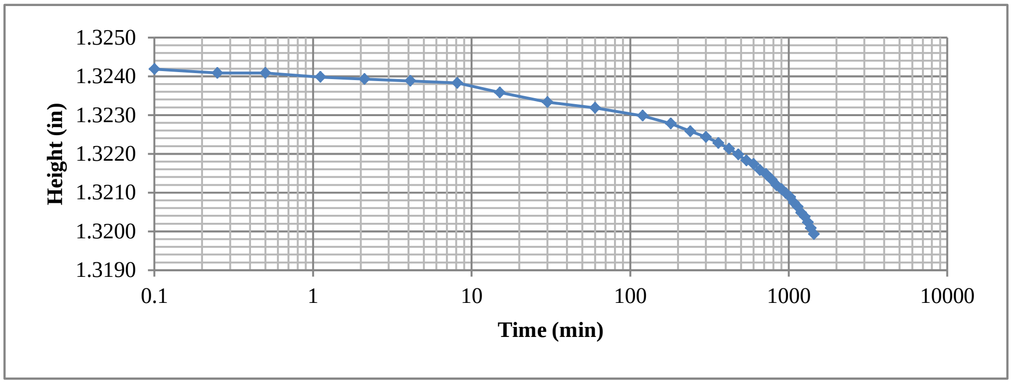


Golder Associates Inc.
Denver, Colorado

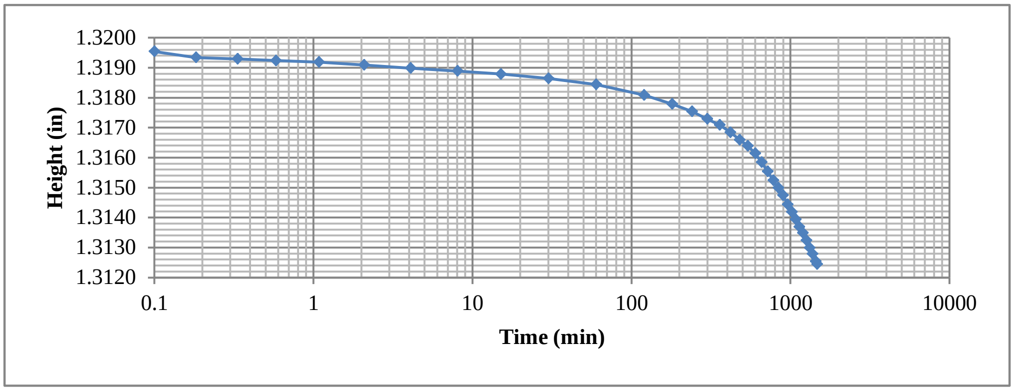
Title:	**ASTM D2435** **ONE-DIMENSIONAL CONSOLIDATION TEST REPORT** **CONSOLIDATION PLOTS**
Job Short Title:	**SWPW/City of Cheyenne Landfill/CO**

Sample:	**Technician:**	**Reviewed:**	**Start Date:**	**Job Number:**	**Figure:**
GBH-2013-06 / MC-1 @ 24-25 ft.	**RJM**	**CCS**	**7/24/2013**	**123-81971**	**2**

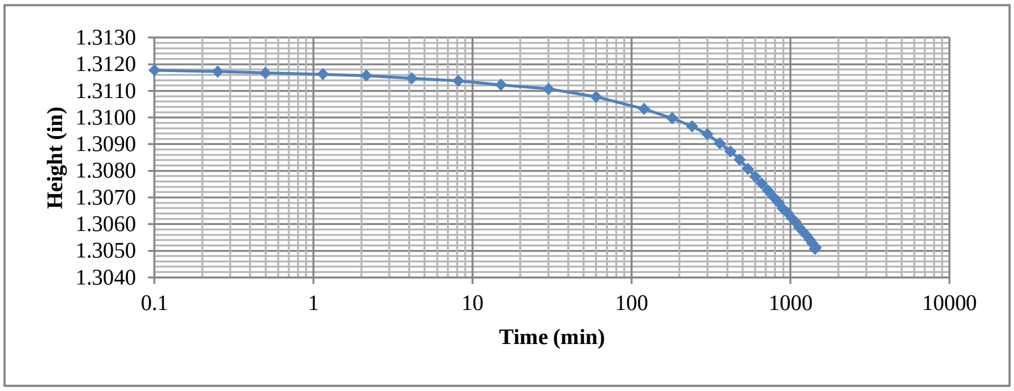
0.25 ksf



0.50 ksf



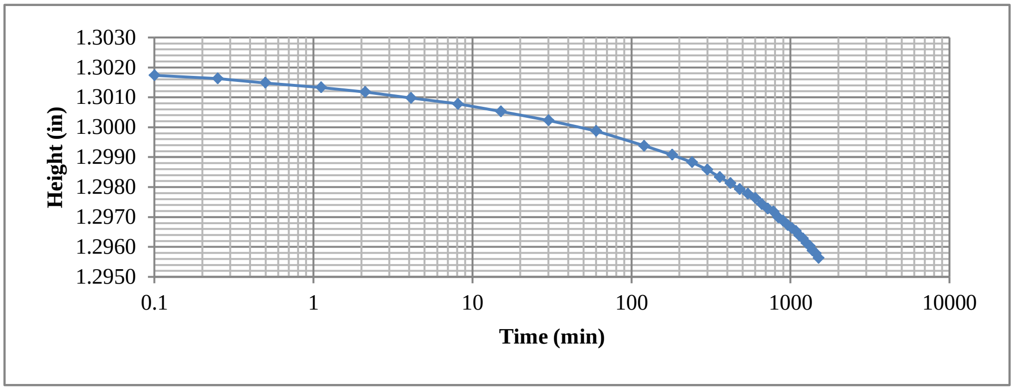
1.00 ksf



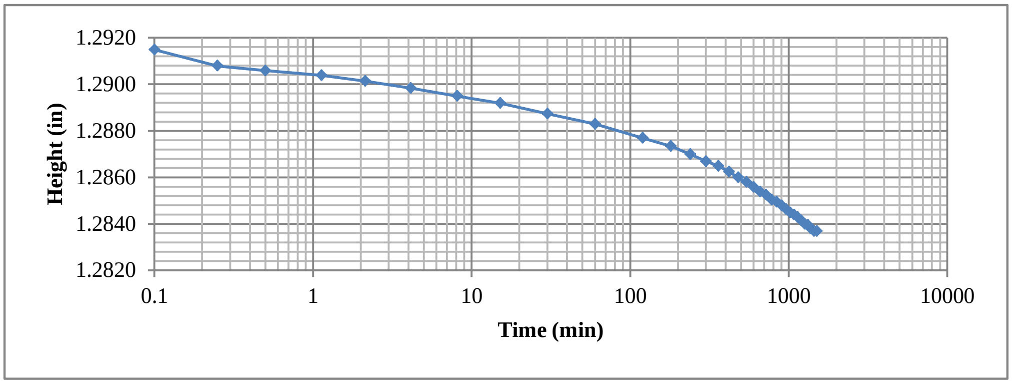
Golder Associates Inc. **Denver, Colorado**	**Title:** **ASTM D2435** **ONE-DIMENSIONAL CONSOLIDATION TEST REPORT** **TIME-DEFORMATION PLOTS (1)**
Job Short Title: **SWPW/City of Cheyenne Landfill/CO**	

Sample:	**Technician:**	**Reviewed:**	**Start Date:**	**Job Number:**	**Figure:**
GBH-2013-06 / MC-1 @ 24-25 ft.	**RJM**	**CCS**	**7/24/2013**	**123-81971**	**3**

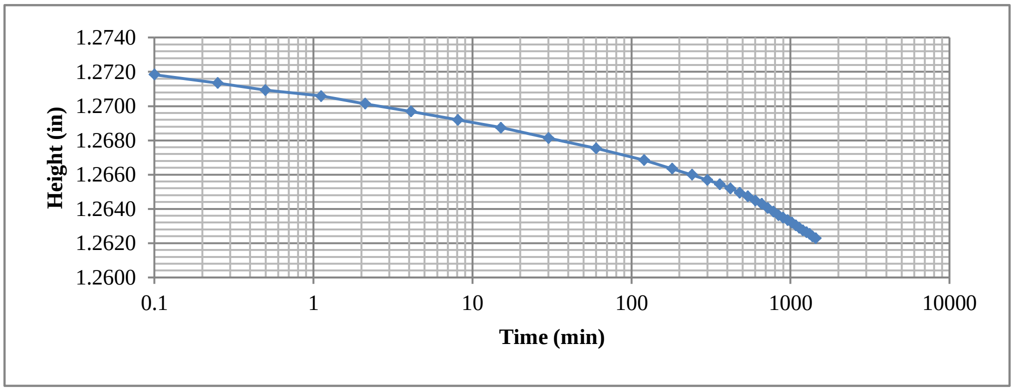
2.00 ksf



4.00 ksf



8.00 ksf

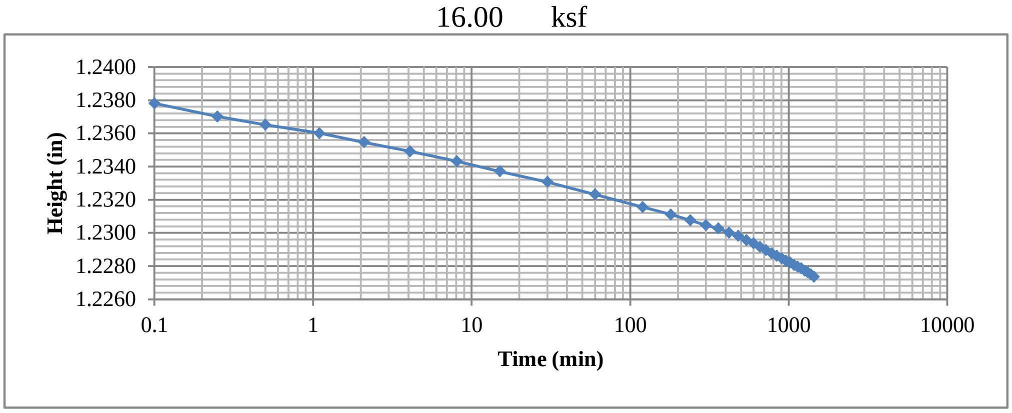


Golder Associates Inc.
Denver, Colorado

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D2435
ONE-DIMENSIONAL CONSOLIDATION TEST REPORT
TIME-DEFORMATION PLOTS (2)

Sample:	Technician:	Reviewed:	Start Date:	Job Number:	Figure:
GBH-2013-06 / MC-1 @ 24-25 ft.	RJM	CCS	7/24/2013	123-81971	4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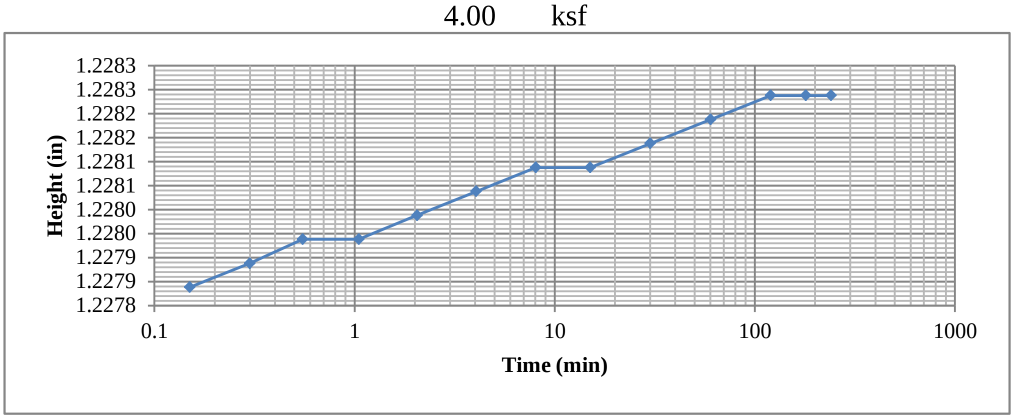
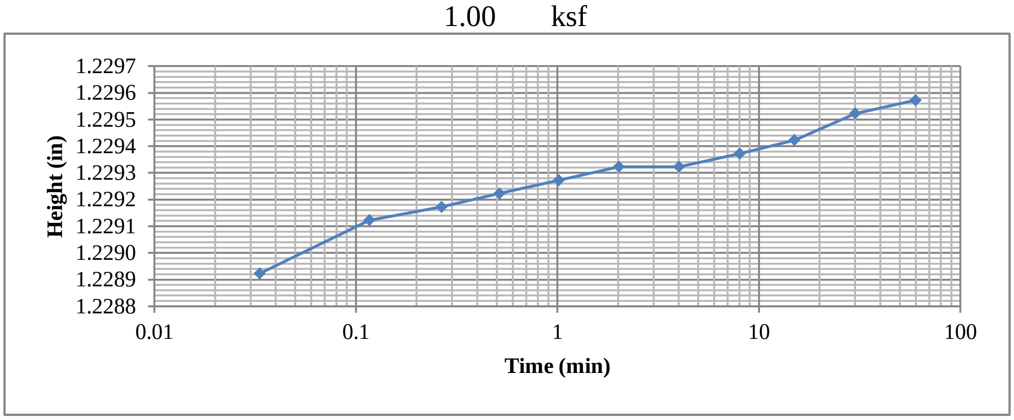

4.00 ksf

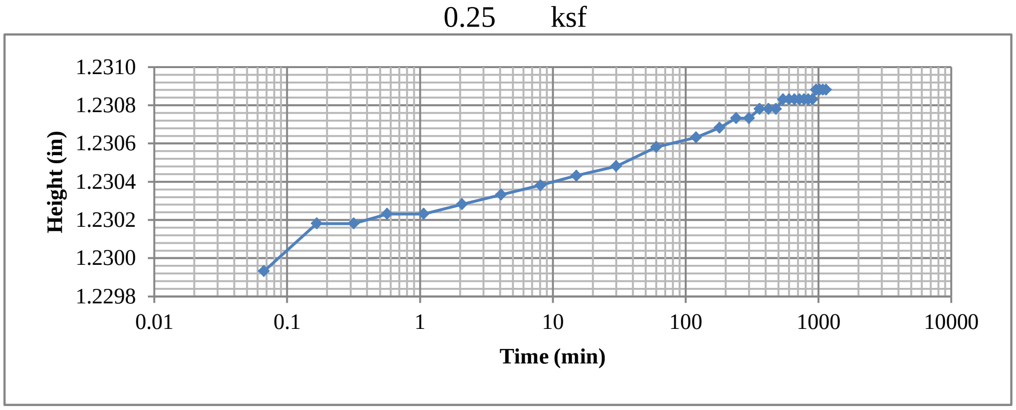

1.00 ksf

Golder Associates Inc.
Denver, Colorado

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D2435
ONE-DIMENSIONAL CONSOLIDATION TEST REPORT
TIME-DEFORMATION PLOTS (3)

Sample:	**Technician:**	**Reviewed:**	**Start Date:**	**Job Number:**	**Figure:**
GBH-2013-06 / MC-1 @ 24-25 ft.	**RJM**	**CCS**	**7/24/2013**	**123-81971**	**5**



Golder Associates Inc. **Denver, Colorado**	**Title:** **ASTM D2435** **ONE-DIMENSIONAL CONSOLIDATION TEST REPORT** **TIME-DEFORMATION PLOTS (4)**				
Job Short Title: **SWPW/City of Cheyenne Landfill/CO**					
Sample: **GBH-2013-06 / MC-1 @ 24-25 ft.**	**Technician:** **RJM**	**Reviewed:** **CCS**	**Start Date:** **7/24/2013**	**Job Number:** **123-81971**	**Figure:** **6**

APPENDIX D-4
TRIAXIAL SHEAR STRENGTH TEST RESULTS

Boring or Test Pit:	GBH-2013-07		GBH-2013-07		GBH-2013-07	
Sample:	MC-1 (Tube A)		MC-1 (Tube B)		MC-1 (Tube C)	
Depth:	19-21	ft	19-21	ft	19-21	ft
Point No.:	1		2		3	

	Initial		**Initial**		**Initial**	
Length =	4.017	in	4.020	in	4.956	in
Diameter =	1.996	in	1.994	in	2.436	in
Wet Mass =	0.903	lb	0.904	lb	1.664	lb
Area =	3.129	in^2	3.123	in^2	4.661	in^2
Volume =	12.569	in^3	12.554	in^3	23.098	in^3
Specific Gravity =	2.69	(ASTM D854)	2.69	(ASTM D854)	2.69	(ASTM D854)
Dry Mass of Solids =	0.752	lb	0.751	lb	1.379	lb
Moisture Content =	20.1%		20.4%		20.7%	
Wet Unit Weight =	124.2	pcf	124.4	pcf	124.5	pcf
Dry Unit Weight =	103.4	pcf	103.3	pcf	103.1	pcf
Void Ratio =	0.62		0.62		0.63	
Percent Saturation =	87%		88%		89%	

	After Consolidation		**After Consolidation**		**After Consolidation**	
Length =	3.972	in	3.982	in	4.881	in
Diameter =	1.993	in	1.996	in	2.382	in
Area =	3.118	in^2 (Method B)	3.129	in^2 (Method B)	4.454	in^2 (Method B)
Volume =	12.386	in^3	12.461	in^3	21.742	in^3
Moisture Content =	22.2%		22.7%		19.7%	
Wet Unit Weight =	128.3	pcf	127.7	pcf	131.2	pcf
Dry Unit Weight =	105.0	pcf	104.1	pcf	109.6	pcf
Void Ratio =	0.60		0.61		0.53	
Percent Saturation =	100%		100%		100%	

B Parameter =	0.96		0.96		0.97	
Shear Rate =	0.033%	/min.	0.033%	/min.	0.045%	/min.
t_{50} =	12.6	min.	--	(not computed)	8.9	min.
Strain at Failure =	16.9%		19.7%		18.7%	

Cell Pressure =	54	psi	68	psi	106	psi
Back Pressure =	40	psi	40	psi	50	psi
Confining Pressure =	14	psi	28	psi	56	psi

Notes:

Visual description: Silty clay, yellowish brown, moist

Atterberg limits: LL = -- PL = -- PI = -- (-- indicates test was not performed)

Percent finer: 3/4 in. = -- No. 4 = -- No. 200 = -- (-- indicates test was not performed)

Specimen type:	☐	Intact	☐	Reconstituted	☒	Tube C (point 3) was an intact specimen; Tube A and Tube B were remolded to the approximate dry unit weight of Tube C
Moisture from:	☐	Cuttings	☒	Entire specimen		
Saturation method:	☒	Wet	☐	Dry		
Failure criterion:	☐	$(\sigma'_1/\sigma'_3)_{max}$	☒	$(\sigma'_1-\sigma'_3)_{max}$	☐	% strain
Membrane effect:	☒	Corrected	☐	Not Corrected		

Golder Associates Inc.

Title:

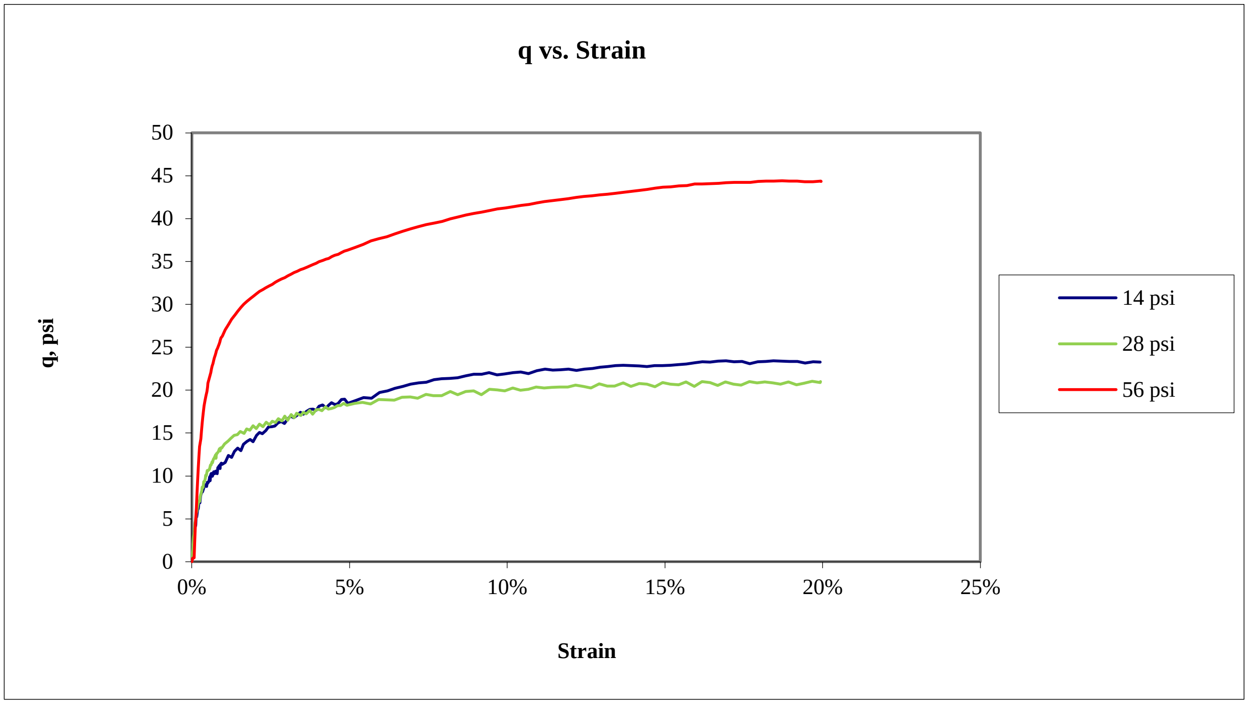
ASTM D4767

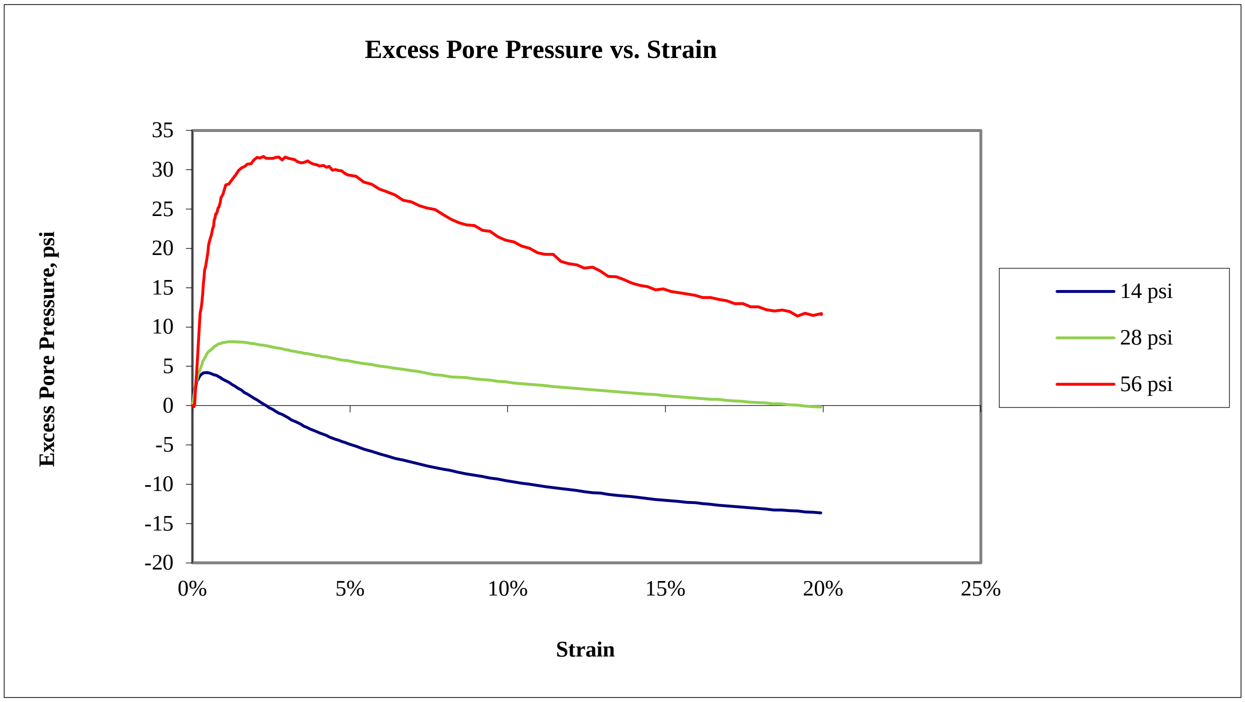
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT

SAMPLE AND TEST DATA

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

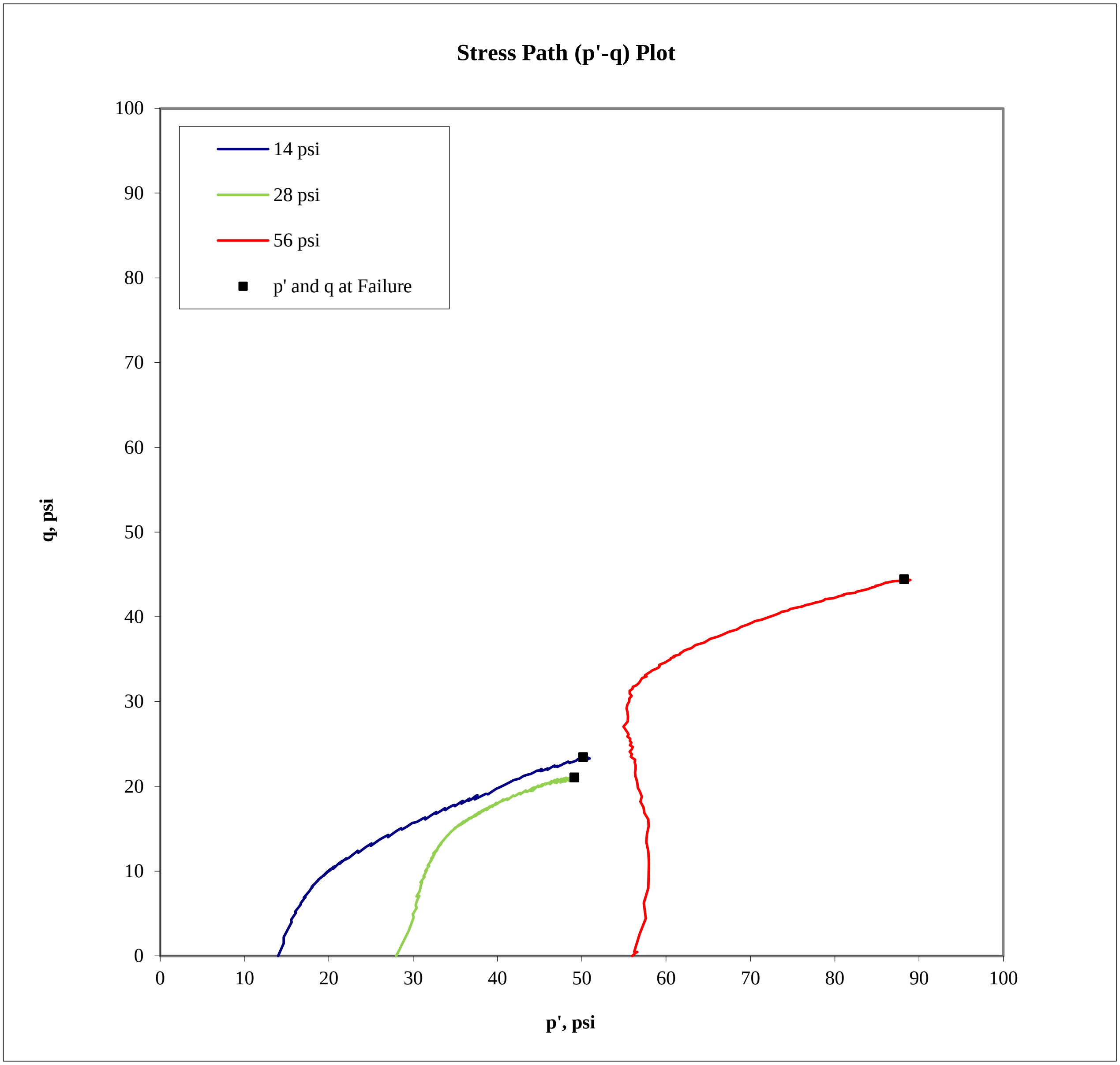
Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GBH-2013-07 / MC-1 @ 19 - 21 ft.	**RJM**	**CCS**	**8/7/2013**	**123-81971**	**1**





Golder Associates Inc. Golder Associates	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS			
Job Short Title: SWPW/City of Cheyenne Landfill/CO				
Sample: GBH-2013-07 / MC-1 @ 19 - 21 ft.	**Technician:** RJM	**Reviewed:** CCS	**Date:** 8/7/2013	**Job Number:** 123-81971

Figure: 2



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
14	37.4	50.2	23.4
28	49.0	49.1	21.0
56	100.4	88.3	44.4

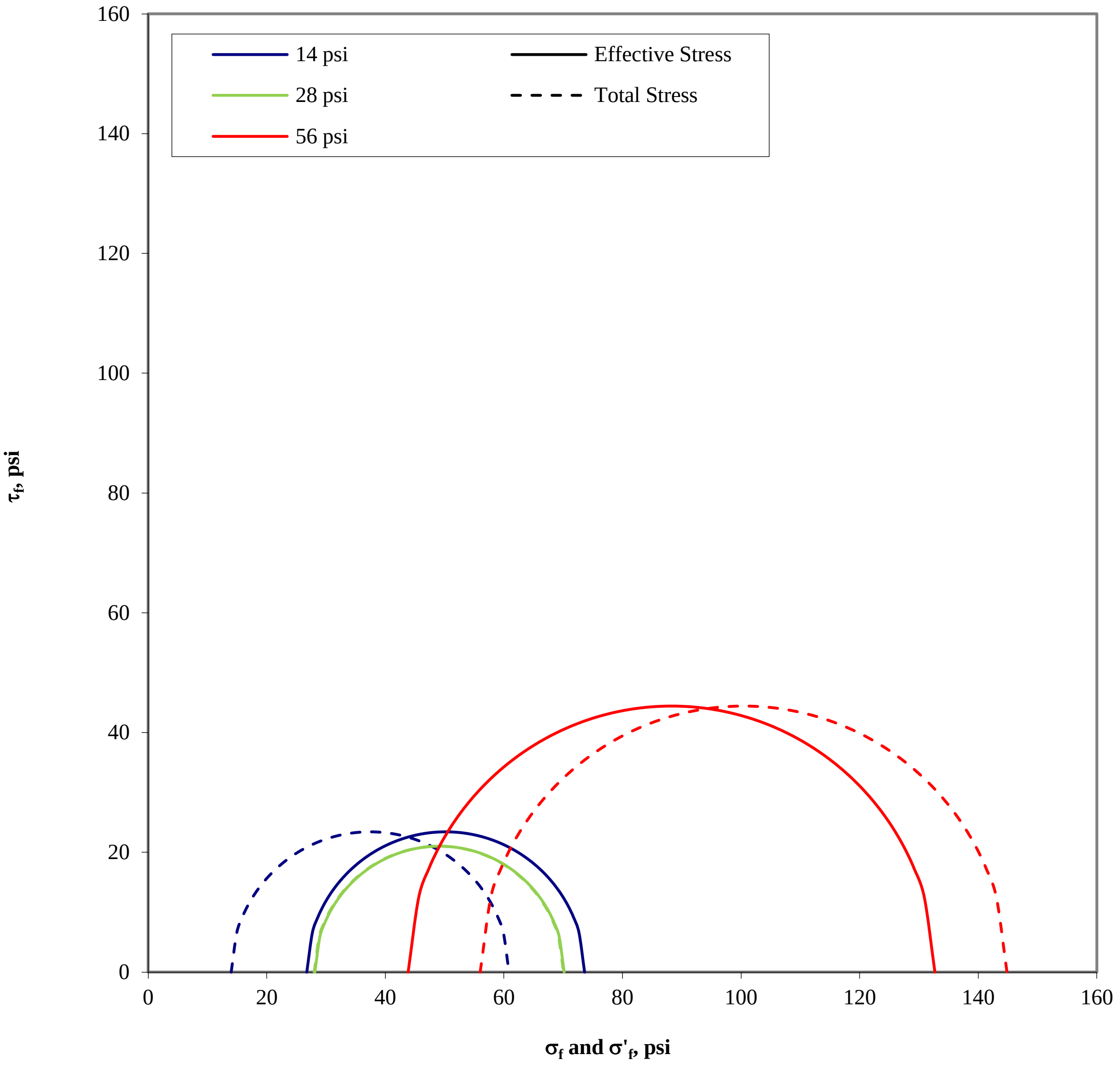
Golder Associates Inc. Golder Associates

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
STRESS PATH PLOT

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	3

Mohr's Circle Diagram



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
14	73.6	26.8	60.9	14.0
28	70.2	28.1	70.1	28.0
56	132.7	43.8	144.9	56.0

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
MOHR'S CIRCLE DIAGRAM

Sample: **GBH-2013-07 / MC-1 @ 19 - 21 ft.**	**Technician:** **RJM**	**Reviewed:** **CCS**	**Date:** **8/7/2013**	**Job Number:** **123-81971**	**Figure:** **4**

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Sample:
GBH-2013-07 / MC-1 @ 19 - 21 ft.

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SPECIMEN PHOTOGRAPH - 14 psi

Technician:	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
RJM	**CCS**	**8/7/2013**	**123-81971**	**5**

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SPECIMEN PHOTOGRAPH - 28 psi

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	6

Golder Associates Inc.

Title:

ASTM D4767

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT

SPECIMEN PHOTOGRAPH - 56 psi

Job Short Title: SWPW/City of Cheyenne Landfill/CO

Sample: GBH-2013-07 / MC-1 @ 19 - 21 ft.

Technician:	Reviewed:	Date:	Job Number:	Figure:
RJM	CCS	8/7/2013	123-81971	7

Boring or Test Pit:	GBH-2013-07		GBH-2013-07		GBH-2013-07	
Sample:	MC-1 (Tube A)		MC-1 (Tube B)		MC-1 (Tube C)	
Depth:	19-21	ft	19-21	ft	19-21	ft
Point No.:	1		2		3	
	Initial		**Initial**		**Initial**	
Length =	4.017	in	4.020	in	4.956	in
Diameter =	1.996	in	1.994	in	2.436	in
Wet Mass =	0.903	lb	0.904	lb	1.664	lb
Area =	3.129	in^2	3.123	in^2	4.661	in^2
Volume =	12.569	in^3	12.554	in^3	23.098	in^3
Specific Gravity =	2.69	(ASTM D854)	2.69	(ASTM D854)	2.69	(ASTM D854)
Dry Mass of Solids =	0.752	lb	0.751	lb	1.379	lb
Moisture Content =	20.1%		20.4%		20.7%	
Wet Unit Weight =	124.2	pcf	124.4	pcf	124.5	pcf
Dry Unit Weight =	103.4	pcf	103.3	pcf	103.1	pcf
Void Ratio =	0.62		0.62		0.63	
Percent Saturation =	87%		88%		89%	
	After Consolidation		**After Consolidation**		**After Consolidation**	
Length =	3.972	in	3.982	in	4.881	in
Diameter =	1.993	in	1.996	in	2.382	in
Area =	3.118	in^2 (Method B)	3.129	in^2 (Method B)	4.454	in^2 (Method B)
Volume =	12.386	in^3	12.461	in^3	21.742	in^3
Moisture Content =	22.2%		22.7%		19.7%	
Wet Unit Weight =	128.3	pcf	127.7	pcf	131.2	pcf
Dry Unit Weight =	105.0	pcf	104.1	pcf	109.6	pcf
Void Ratio =	0.60		0.61		0.53	
Percent Saturation =	100%		100%		100%	
B Parameter =	0.96		0.96		0.97	
Shear Rate =	0.033%	/min.	0.033%	/min.	0.045%	/min.
t_{50} =	12.6	min.	--	(not computed)	8.9	min.
Strain at Failure =	1.5%		4.8%		4.3%	
Cell Pressure =	54	psi	68	psi	106	psi
Back Pressure =	40	psi	40	psi	50	psi
Confining Pressure =	14	psi	28	psi	56	psi

Notes:
Visual description: Silty clay, yellowish brown, moist
Atterberg limits: LL = -- PL = -- PI = -- (-- indicates test was not performed)
Percent finer: 3/4 in. = -- No. 4 = -- No. 200 = -- (-- indicates test was not performed)
Specimen type: ☐ Intact ☐ Reconstituted ☒ Tube C (point 3) was an intact specimen; Tube A and Tube B were remolded to the approximate dry unit weight of Tube C
Moisture from: ☐ Cuttings ☒ Entire specimen
Saturation method: ☒ Wet ☐ Dry
Failure criterion: ☒ $(\sigma'_1/\sigma'_3)_{max}$ ☐ $(\sigma'_1-\sigma'_3)_{max}$ ☐ % strain
Membrane effect: ☒ Corrected ☐ Not Corrected

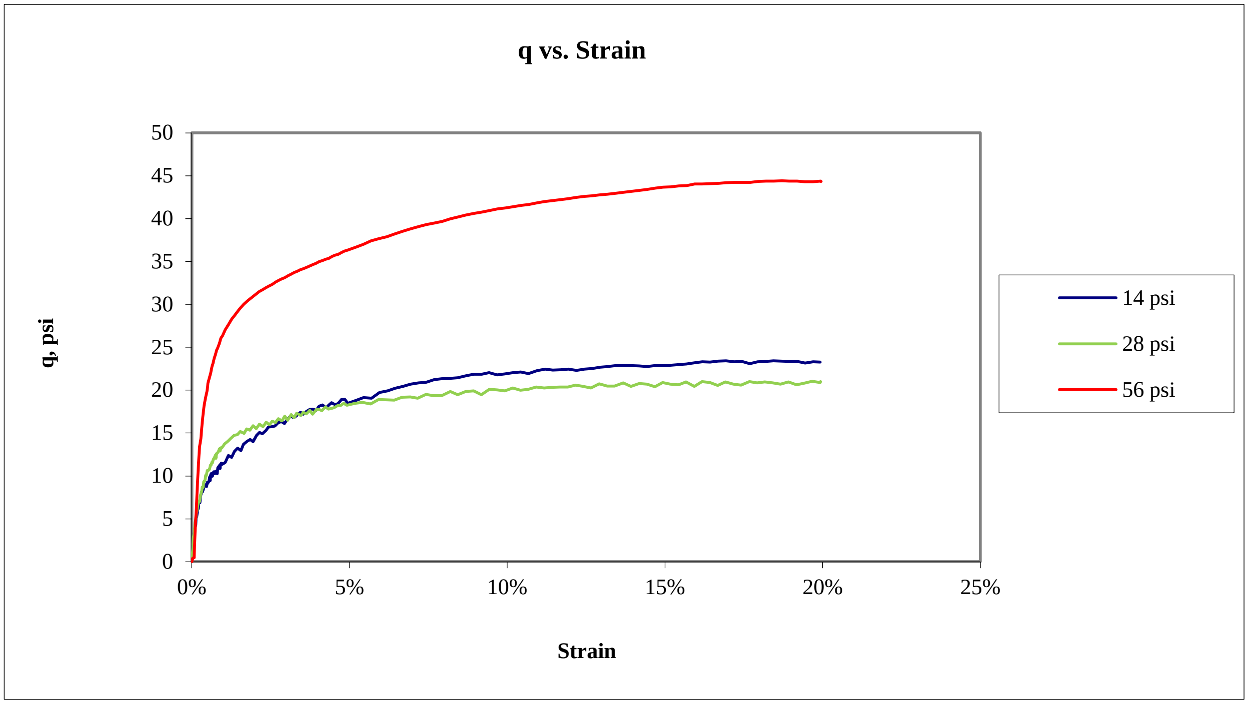
Golder Associates Inc.

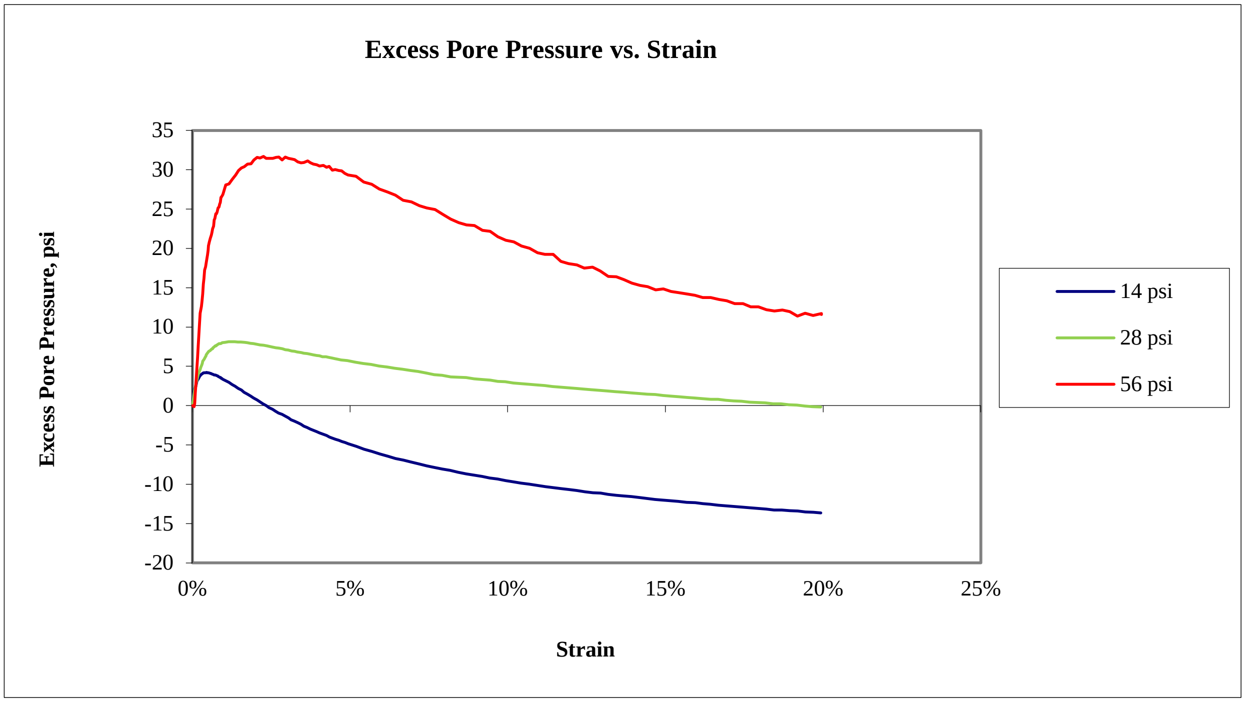
Title:

ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SAMPLE AND TEST DATA

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

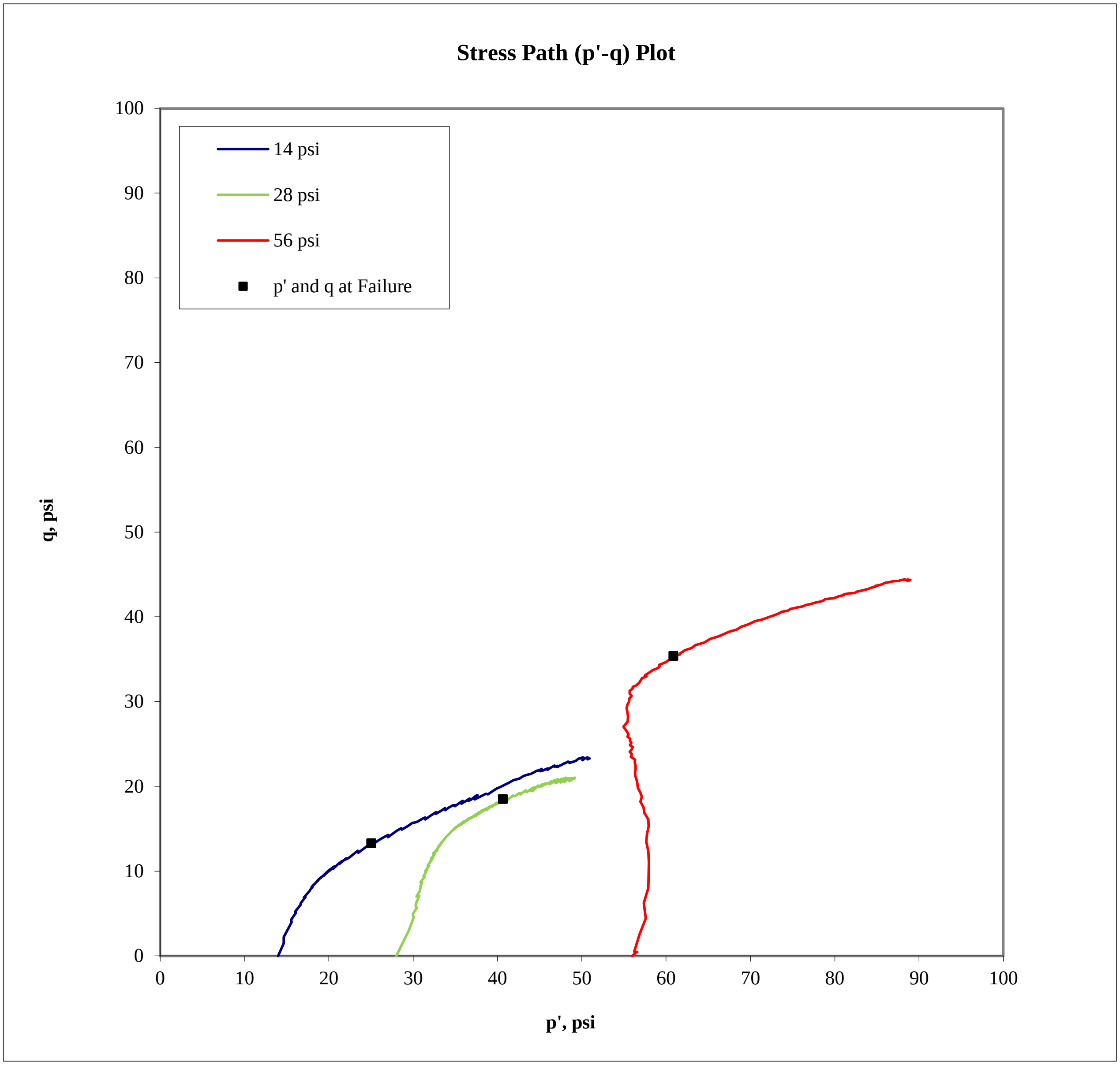
Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GBH-2013-07 / MC-1 @ 19 - 21 ft.	**RJM**	**CCS**	**8/7/2013**	**123-81971**	**1**





Golder Associates Inc.	**Title:** ASTM D4767 CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT q AND EXCESS PORE PRESSURE PLOTS
Job Short Title: SWPW/City of Cheyenne Landfill/CO	

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	2



Confining Pressure (psi)	p at failure (psi)	p' at failure (psi)	q at failure (psi)
14	27.3	25.1	13.3
28	46.5	40.7	18.5
56	91.4	60.9	35.4

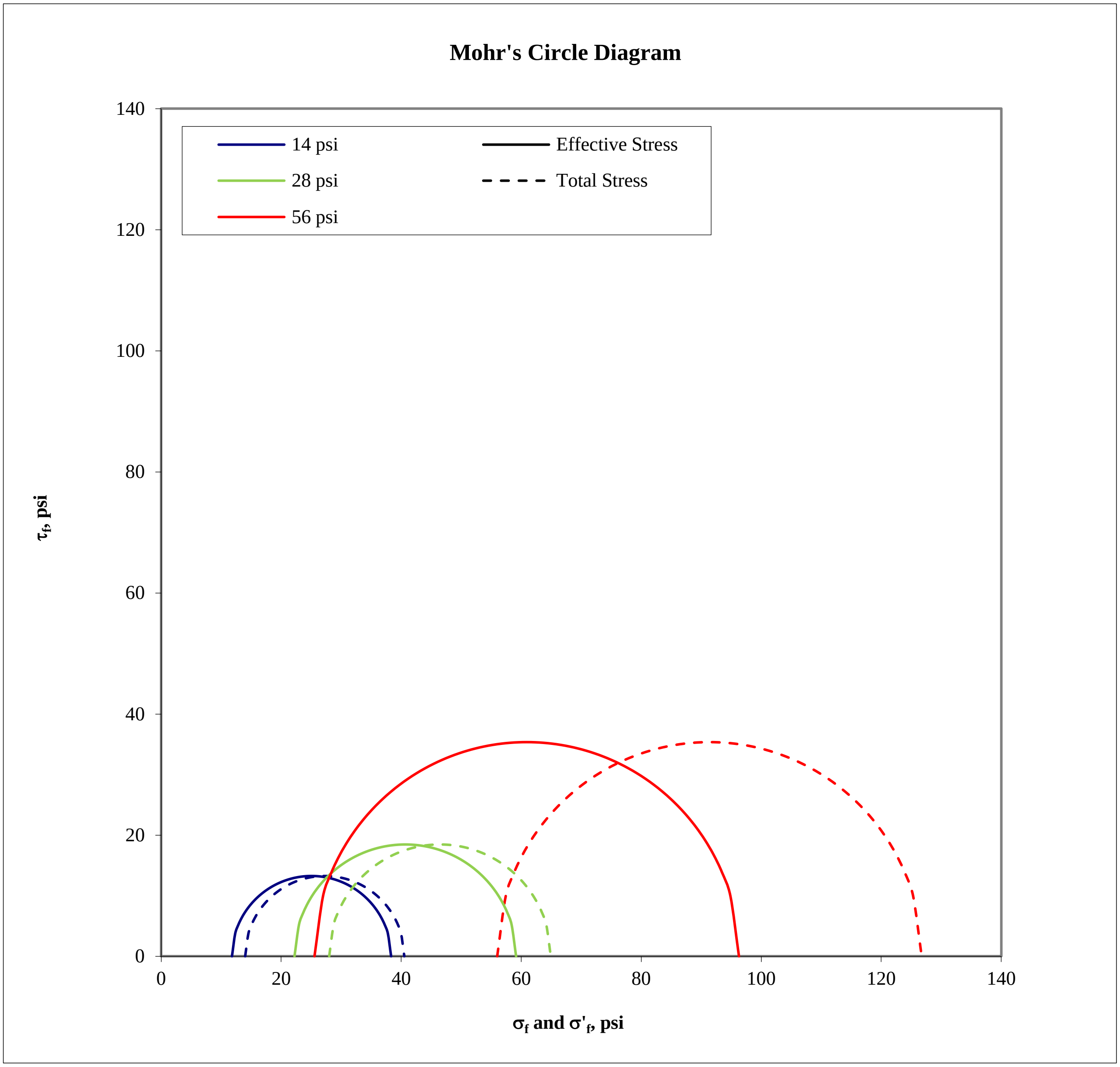
Golder Associates Inc.

Title:

ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
STRESS PATH PLOT

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Sample:	**Technician:**	**Reviewed:**	**Date:**	**Job Number:**	**Figure:**
GBH-2013-07 / MC-1 @ 19 - 21 ft.	**RJM**	**CCS**	**8/7/2013**	**123-81971**	**3**



Confining Pressure (psi)	σ'_1 at failure (psi)	σ'_3 at failure (psi)	σ_1 at failure (psi)	σ_3 at failure (psi)
14	38.3	11.8	40.5	14.0
28	59.1	22.2	64.9	28.0
56	96.3	25.6	126.7	56.0

Golder Associates Inc. Golder Associates

Title:

ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
MOHR'S CIRCLE DIAGRAM

Job Short Title: SWPW/City of Cheyenne Landfill/CO

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	4

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SPECIMEN PHOTOGRAPH - 14 psi

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	5

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:
ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SPECIMEN PHOTOGRAPH - 28 psi

Sample: **GBH-2013-07 / MC-1 @ 19 - 21 ft.**

Technician:	Reviewed:	Date:	Job Number:	Figure:
RJM	CCS	8/7/2013	123-81971	6

Golder Associates Inc.

Job Short Title:
SWPW/City of Cheyenne Landfill/CO

Title:

ASTM D4767
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST REPORT
SPECIMEN PHOTOGRAPH - 56 psi

Sample:	Technician:	Reviewed:	Date:	Job Number:	Figure:
GBH-2013-07 / MC-1 @ 19 - 21 ft.	RJM	CCS	8/7/2013	123-81971	7

APPENDIX D-5
PERMEABILITY TEST RESULTS

FLOW PUMP #1

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER
ASTM D5084
METHOD D, CONSTANT RATE OF FLOW

PROJECT TITLE	SWPW/City of Cheyenne Landfill/CO	**BOARD #**	7	
PROJECT NUMBER	123-81971.0022	**CELL #**	#7	
SAMPLE ID	GBH-2013-01, G-2 @ 34-38 ft	**Flow Pump Speed**	12	
SAMPLE TYPE	Remold	**Technician**	RJM	

COMMENTS
1. Specific gravity tested per ASTM D854.
2. Specimen was remolded to 97.3% of the Maximum Dry Density and +2.6% of optimum moisture content (per ASTM D698)

Sample Data

	Initial	Final
Specific Gravity	2.68	
Height, cm	9.395	9.474
Diameter, cm	7.317	7.363
Area, m²	0.004205	0.004258
Volume, m^3	0.0003951	0.0004034
Mass, g	803.72	817.28
Moisture Content	19.3%	20.2%
Dry Unit Weight, kN/m^3	16.73	16.54
Dry Unit Weight, lbf/ft^3	106.5	105.3
Saturation, %	90.4%	91.7%

Permeant	Water
Back Pressure, kPa	340
Effective Consolidation Stress, kPa	69
Length During Permeation, cm	9.474
Area During Permeation, m²	0.004258

USCS Description (ASTM D 2487):
Sandy lean clay, yellowish brown, moist

DATE/TIME		TEMP (°C)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
8/2/13	10:15:00	20.7	189	--	--	--
8/2/13	10:30:00	20.7	185	5.0E-09	19.74	6.54E-09
8/2/13	10:45:00	20.7	189	5.0E-09	19.74	6.54E-09
8/2/13	11:00:00	20.7	190	4.9E-09	20.00	6.46E-09
8/2/13	11:15:00	20.7	188	5.0E-09	19.95	6.47E-09

Average Corrected Hydraulic Conductivity (cm/s) 6.4E-09

DATE 8/13/2013
REVIEW MB

FLOW PUMP #2

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER
ASTM D5084
METHOD D, CONSTANT RATE OF FLOW

PROJECT TITLE	SWPW/City of Cheyenne Landfill/CO
PROJECT NUMBER	123-81971
SAMPLE ID	GBH-2013-03, G-1 @ 5-20 ft (A)
SAMPLE TYPE	Remold

BOARD #	1
CELL #	AA
Flow Pump Speed	6
Technician	RJM

COMMENTS
1. Specific gravity tested per ASTM D854.
2. Specimen was remolded to 97.5% of the Maximum Dry Density and +2.6% of optimum moisture content (per ASTM D698)

Sample Data

	Initial	Final
Specific Gravity	2.68	
Height, cm	9.333	9.227
Diameter, cm	7.318	7.310
Area, m^2	0.004206	0.004197
Volume, m^3	0.0003926	0.0003872
Mass, g	734.73	760.93
Moisture Content	16.6%	20.7%
Dry Unit Weight, kN/m^3	15.75	15.98
Dry Unit Weight, lbf/ft^3	100.2	101.7
Saturation, %	66.5%	85.7%

Permeant	Water
Back Pressure, kPa	480
Effective Consolidation Stress, kPa	69
Length During Permeation, cm	9.227
Area During Permeation, m^2	0.004197

USCS Description (ASTM D 2487)

Sandy lean clay, dark yellowish brown, moist

DATE/TIME		TEMP (^oC)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
8/16/13	10:00:00	20.7	106	--	--	--
8/16/13	10:10:00	20.7	107	3.3E-07	11.54	1.14E-06
8/16/13	10:20:00	20.7	107	3.3E-07	11.60	1.13E-06
8/16/13	10:30:00	20.7	108	3.3E-07	11.65	1.12E-06
8/16/13	10:40:00	20.7	107	3.3E-07	11.65	1.12E-06

Average Corrected Hydraulic Conductivity (cm/s) 1.1E-06

DATE	8/20/2013
REVIEW	MB

Golder Associates Inc.

FLOW PUMP #1

HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MEDIA USING A FLEXIBLE WALL PERMEAMETER
ASTM D5084
METHOD D, CONSTANT RATE OF FLOW

PROJECT TITLE	SWPW/City of Cheyenne Landfill/CO	**BOARD #**	8
PROJECT NUMBER	123-81971	**CELL #**	AA
SAMPLE ID	GBH-2013-03, G-1 @ 5-20 ft	**Flow Pump Speed**	5
SAMPLE TYPE	Remold	**Technician**	RJM

COMMENTS
1. Specific gravity tested per ASTM D854.
2. Specimen was remolded to 97.3% of the Maximum Dry Density and +2.1% of optimum moisture content (per ASTM D698)

Sample Data

	Initial	Final
Specific Gravity	2.68	
Height, cm	9.458	9.126
Diameter, cm	7.301	7.305
Area, m^2	0.004187	0.004191
Volume, m^3	0.0003960	0.0003825
Mass, g	735.69	760.04
Moisture Content	16.1%	19.8%
Dry Unit Weight, kN/m^3	15.70	16.28
Dry Unit Weight, lbf/ft^3	100.0	103.6
Saturation, %	63.9%	86.1%

Permeant	Water
Back Pressure, kPa	340
Effective Consolidation Stress, kPa	69
Length During Permeation, cm	9.126
Area During Permeation, m^2	0.004191

USCS Description (ASTM D 2487):
Sandy lean clay, yellowish brown, moist

DATE/TIME		TEMP (^oC)	Δh (cm)	Flow (m^3)	Gradient	Uncorrected Hydraulic Conductivity (cm/s)
8/11/13	10:10:00	20.7	133	--	--	--
8/11/13	10:15:00	20.7	132	4.2E-07	14.52	2.30E-06
8/11/13	10:20:00	20.7	132	4.2E-07	14.46	2.31E-06
8/11/13	10:25:00	20.7	132	4.2E-07	14.46	2.31E-06
8/11/13	10:30:00	20.7	132	4.2E-07	14.46	2.31E-06

Average Corrected Hydraulic Conductivity (cm/s) 2.3E-06

DATE 8/13/2013
REVIEW MB

TABLE 1
SWPW/CITY OF CHEYENNE LANDFILL/CO
SUMMARY OF FLEXIBLE-WALL PERMEABILITY TEST RESULTS

Sample Number	**Boring Number**	**Sample Depth (ft)**	**Sample Length(1) (cm)**	**Sample Diameter(1) (cm)**	**Initial Dry Density (lbf/ft^3)**	**Maximum Dry Density (lbf/ft^3)**	**Compaction (%)**	**Initial Moisture (%)**	**Optimum Moisture (%)**	**Effective Stress (kPa)**	**Back Pressure (kPa)**	**Gradient**	**Average Permeability (cm/sec)**
G-2	GBH-2013-01	34-38	9.474	7.363	106.5	109.5	97.3	19.3	16.7	69	340	20	6.4E-09
G-1	GBH-2013-03	5-20	9.126	7.305	100.0	102.8	97.3	16.1	14.0	69	340	14	2.3E-06
G-1	GBH-2013-03 (A)	5-20	9.227	7.310	100.2	102.8	97.5	16.6	14.0	69	480	12	1.1E-06

NOTE: (1) Dimensions are from final measurements
P = indicates pending test results

APPENDIX E

TRAVEL TIME CALCULATION FROM PROPOSED LANDFILL EXPANSION AREA TO HYPOTHETICAL RECEPTOR

TECHNICAL MEMORANDUM

Date:	October 29, 2013	**Made by:**	RT
Project No.:	123-81971	**Checked by:**	JM
Project:	Happy Jack Landfill Expansion	**Reviewed by:**	RM

Subject: **TRAVEL TIME CALCULATION FROM PROPOSED LANDFILL EXPANSION AREA TO HYPOTHETICAL RECEPTOR**

Golder Associates Inc. (Golder) prepared this technical memorandum to document the hypothetical leakage scenario that was simulated to estimate subsurface travel time of leachate from the base of the proposed Happy Jack landfill expansion area to a hypothetical receptor located along Happy Jack Road. The simulated scenario assumes the following:

- Vertical leakage through the landfill liner system (i.e., 12-inch operations layer, geomembrane, and geosynthetic clay liner) has already occurred;
- One foot of leachate accumulates on the 2.5-foot-thick compacted clay liner and subgrade (design and regulatory maximum permissible hydraulic head);
- Vertical transport of leachate leaking through the clay liner, subgrade, and through the unsaturated zone; and
- Horizontal transport of leachate in groundwater downgradient to a hypothetical receptor (i.e., a potential well located adjacent to Happy Jack Road, north of the landfill expansion area).

To evaluate this hypothetical leakage scenario, a site conceptual model was developed based on the 2013 site characterization field program. As summarized in the *Site Characterization Report*, the unsaturated zone consists primarily of alternating layers of sand, clayey sand, and silty clay. The vertical soil profile from monitoring well GMW-2013-07, installed in the proposed expansion area, was considered typical of the area geology and data from this well were used for the transport calculations.

From water level measurements in the groundwater monitoring wells, the water table occurs at a depth of approximately 200 feet below the ground surface. The minimum vertical separation or clearance between the landfill liner and the water table is proposed to be no less than 122 feet (i.e., maximum excavation cut for the landfill is proposed to be 78 feet). The hypothetical leakage scenario was based on conservative assumptions of minimum travel distance and time of travel. That is, the unsaturated zone was assumed to be 122 feet thick, consisting of 0.5 feet of liner subgrade and 121.5 feet of the GMW-2013-07 soil profile, including sand, clayey sand, and silty clay layers. In addition, 2 feet of compacted clay liner, above the subgrade and unsaturated zone, was included in the analysis so that total depth range of vertical flow through the unsaturated zone considered is 76 to 200 feet below ground surface.

The saturated zone consists primarily of alternating layers of poorly-graded sand and silty clay. In order to conservatively estimate the shortest travel time, it was assumed that groundwater preferentially travels in the most transmissive material (i.e., sand) and the sand layers are laterally continuous within the saturated zone.

The site conceptual model for transport from the proposed landfill expansion area to a receptor is presented in Figure 1.

1.1 Advective Travel Time Calculation

The advective travel time in the unsaturated zone depends on vertical recharge (rate of flow through the landfill liner into the unsaturated zone, see Section 1.1.1) and the hydraulic properties of the unsaturated soil. The advective travel time in the saturated zone depends on hydrologic conditions (e.g., hydraulic gradient) and the hydraulic properties of the saturated soil.

As described in the following sections, the travel time of leaking leachate was evaluated in three stages:

1. Flow through the compacted clay liner and subgrade to the unsaturated soil zone;
2. Flow through the unsaturated zone to the water table; and
3. Flow through the saturated zone, from the northwest corner of the proposed landfill expansion area to the nearest hypothetical downgradient receptor.

1.1.1 Flow through Compacted Clay Liner and Subgrade to the Unsaturated Zone

To estimate the travel time of flow through the compacted clay liner and subgrade, an unsaturated hydraulic conductivity of this soil was conservatively used since unsaturated material has a lower hydraulic conductivity than saturated material. Soil moisture in the unsaturated zone travels through only the wetted cross-section of pore space. Thus, the ability of an unsaturated material to transmit water is a function of its water content or degree of saturation.

Richards equation is a non-linear partial differential equation that defines moisture flow in unsaturated material and is used to estimate the rate of water movement in the unsaturated materials. To approximate a solution to Richards equation, the van Genuchten-Mualem equation (van Genuchten 1980) and modified Bouma equation (Radcliffe and West 2009) were used. The van Genuchten-Mualem equation is an analytical model that relates unsaturated hydraulic conductivity to both water content and pressure head using model fitting parameters corresponding to soil texture. The Bouma equation can be applied to a two-layer system with a specified overlying liquid depth, in this case leachate in the landfill overlying the clay liner and unsaturated soil profile.

The Rosetta soil catalog (Schaap et al. 2001) was used to provide unsaturated hydraulic properties for the compacted clay liner, subgrade, and underlying unsaturated material. Clay loam (USDA soil texture) was considered to be similar to the compacted clay liner and subgrade material due to the relatively low hydraulic conductivity of this material. Sandy clay (USDA soil texture) was assumed as an average soil texture of the unsaturated zone beneath the liner subgrade. The vertical recharge to the unsaturated zone was then estimated by assuming a maximum of one foot of hydraulic head on the two foot compacted clay liner and subgrade soils, and iteratively solving the van Genuchten-Mualem equation (van Genuchten 1980) and modified Bouma equation (Radcliffe and West 2009). Recharge was estimated to be approximately $1.6\text{x}10^{-4}$ feet per day.

1.1.2 Flow through the Unsaturated Zone to the Water Table

The total travel time of flow through the unsaturated zone to the water table (t_{unsat}) was estimated by taking the summation of the travel time (equal to the depth of the layer divided by the average vertical groundwater velocity (v) for each layer in the unsaturated zone (Sousa et al. 2013). The vertical velocity at a certain height above the water table $(v(z))$ can be estimated by dividing the Darcy flux (i.e., recharge) by the effective porosity and saturation of the layer at that height. This relationship yields the following equation used to estimate advective travel time in the unsaturated zone:

$$t_{unsat} = \int_{0}^{L} \frac{1}{v(z)} dz = \int_{76}^{200} \frac{n_{eff}(z) * S(z)}{R} dz$$

Where:

- $n_{eff}(z)$ = Effective porosity (unitless), the portion of porosity that is available for fluid flow, as a function of height above the water table, estimated from average literature values (McWorter and Sunada 1977)
- $S(z)$ = Degree of saturation (unitless), a function of residual saturation, pressure head or height above the water table and unsaturated hydraulic properties of soil, estimated from saturation profile using a simplified van Genuchten technique (Sousa et al. 2013)
- R = Recharge (feet/day), estimated as described in Section 1.1.1 using the van Genuchten-Mualem equation and modified Bouma equation (van Genuchten 1980; Radcliffe and West 2009)
- dz = Thickness (feet) of each material type in the unsaturated zone
- Limits of the integral, 76 to 200 feet, is the depth of the compacted clay liner, subgrade, and unsaturated zone below ground surface used in the analysis

The soil hydraulic properties, model parameters, and calculated values for the compacted clay liner, subgrade, and underlying unsaturated zone layers are summarized in Table 1.

1.1.3 Flow through the Saturated Zone to the Receptor

The travel time of flow through the saturated zone to the hypothetical receptor, a potential well located adjacent to Happy Jack Road, north of the landfill expansion area, (t_{sat}) was estimated by using a straight-line travel path approximation of Darcy's law (Sousa et al. 2013). Darcy's law is the analytical equation which defines groundwater flow as a function of saturated hydraulic conductivity and hydraulic gradient (i.e., the change in hydraulic head divided by change in distance). As shown in the following equation, the advective travel time in the saturated zone can be estimated from Darcy's law by converting flow into particle velocity and accounting for horizontal travel distance to the receptor:

$$t_{sat} = \frac{D * n_{eff}}{K_{sat} * i}$$

Where:

- D = Horizontal distance (feet) from northwest corner of the proposed landfill expansion area to the hypothetical receptor north of Happy Jack Road, as shown in Figure 1
- n_{eff} = Effective porosity (unitless), the portion of porosity that is available for fluid flow, estimated from average literature values (McWorter and Sunada 1977).
- K_{sat} = Saturated hydraulic conductivity (feet/day), from hydraulic test results of BOPU Koppes No. 6 well.
- i = Average hydraulic gradient (feet/feet) in the proposed landfill expansion area, calculated from groundwater levels measured on October 14, 2013, and presented in Figure 1.

These saturated zone values are summarized in Table 2.

1.1.4 Assumptions of Travel Time Calculations

The simplifying assumptions associated with these travel times were conservatively considered to allow for the worst case leakage scenario to be simulated. Travel distance has been minimized and travel time has been underestimated, based on the following assumptions:

- Complete failure of (hole[s] through) the geosynthetic liner material in the landfill
- Vertical leakage through multiple, very low hydraulic conductivity liner materials
- Constant recharge based on maintaining a maximum of 1 foot of hydraulic head on the compacted clay liner
- Non-reactive leachate with only advective unsaturated and saturated flow (no dispersion), no sorption, no retardation, and no biodegradation of leachate, all of which would increase travel times in reality
- Shortest vertical unsaturated flow distance of 122 feet below the liner subgrade
- In the unsaturated zone, the simplified, analytical van Genuchten technique underestimates saturation and, thus, travel time, relative to a numerical model (Sousa et al. 2013)
- Shortest horizontal saturated flow distance from the northwest corner of the proposed landfill expansion area to the hypothetical receptor well
- Groundwater transported in most transmissive material (i.e., sand) and the sand layers are laterally continuous in the saturated zone.

1.2 Advective Travel Time Results

Based on the site conceptual model (Figure 1) and tables summarizing advective travel time calculations (Tables 1 and 2), the estimate of travel time from the northwest corner of the landfill expansion area to a hypothetical receptor (i.e., a well located adjacent to Happy Jack Road, north of the landfill expansion area) are as follows:

- $t_{unsat} \sim 230\ years$
- $t_{sat} \sim 10\ years$
- $t_{TOTAL} = t_{unsat} + t_{sat} = 240\ years$

1.3 Sensitivity and Uncertainty

The most sensitive parameter used to estimate travel time between the landfill and the hypothetical receptor is the rate of recharge through the liner into the unsaturated zone. By using the modified Bouma equation (described in Radcliffe and West [2009]), the recharge rate is sensitive to the hydraulic properties of the unsaturated soil layer immediately underlying the compacted clay liner and subgrade soil. Sandy clay was assumed as an average soil texture for the unsaturated zone. If there are more silty or sandy layers within the unsaturated zone, the recharge rate could increase by a factor of two. This would reduce the travel time in the unsaturated zone from approximately 230 years to 115 years.

The estimated travel time calculations presented in this memorandum are based on the best data available at the time of writing. Although additional data could be used to refine these estimates, conservative assumptions have been used to offset uncertainties in site-specific conditions. Since the estimated travel times in both the unsaturated and saturated zones are large, there will be ample time for responding to monitored impacts at the landfill if any are observed. For example, if annual monitoring at the closest portion of the landfill to Happy Jack Road detected groundwater impacts, then there would be at least 10 years available to implement corrective action in advance of the impacts reaching the hypothetical receptor adjacent to Happy Jack Road.

Table 1: Unsaturated Zone Advective Travel Time Summary Table

Layer Depth Below Ground Surface		**GMW-2013-07 Boring Log(1)**				**Residual Water Content(2)**	**Saturated Water Content(2)**	**van Genuchten (1980) Model Parameter (2)**			**Saturated Hydraulic Conductivity(2)**	**Effective Porosity(3)**	**Residual Saturation(4)**	**Pressure Head(5)**		**Saturation(4)**	**Recharge(6)**	**Advective Travel Time in Unsaturated Zone(4)**	
Top Depth (ft)	Bottom Depth (ft)	Layer	Layer thickness (ft)	USDA Soil Texture	USCS	θ_r (-)	θ_s (-)	alpha (cm^{-1})	n (-)	m (-)	K_{sat} (cm/day)	n_{eff} (-)	S_r (-)	ψ (ft)	ψ (cm)	S (-)	R (ft/day)	t_{unsat} (days)	t_{unsat} (years)
76	78.5	Compacted Clay Liner and Subgrade	2.5	Clay Loam	CL	0.079	0.442	0.0158	1.4145	0.293	8.18	0.16	0.50	-122.75	-3741	0.588	1.6E-04	1,434	4
78.5	88	1	9.5	Sand	SP	0.053	0.375	0.0353	3.1798	0.686	642.98	0.33	0.16	-116.75	-3559	0.161		3,070	8
88	97	2	9	Sandy Clay	CL	0.117	0.385	0.0334	1.2067	0.171	11.35	0.16	0.73	-107.5	-3277	0.833		7,310	20
97	106	3	9	Sandy Clay Loam	SC	0.063	0.384	0.0211	1.3298	0.248	13.19	0.20	0.32	-98.5	-3002	0.490		5,381	15
106	120	4	14	Silty Clay	CL	0.111	0.481	0.0162	1.3207	0.243	9.61	0.16	0.69	-87	-2652	0.784		10,713	29
120	124	5	4	Sand	SP	0.053	0.375	0.0353	3.1798	0.686	642.98	0.33	0.16	-78	-2377	0.161		1,293	4
124	151	6	27	Silty Clay	CL	0.111	0.481	0.0162	1.3207	0.243	9.61	0.16	0.69	-62.5	-1905	0.795		20,929	57
151	156	7	5	Sand	SP	0.053	0.375	0.0353	3.1798	0.686	642.98	0.33	0.16	-46.5	-1417	0.161		1,617	4
156	182	8	26	Silty Clay	CL	0.111	0.481	0.0162	1.3207	0.243	9.61	0.16	0.69	-31	-945	0.820		20,794	57
182	187	9	5	Sand	SP	0.053	0.375	0.0353	3.1798	0.686	642.98	0.33	0.16	-15.5	-472	0.162		1,634	4
187	200	10	13	Silty Clay	CL	0.111	0.481	0.0162	1.3207	0.243	9.61	0.16	0.69	-6.5	-198	0.894		11,341	31
																	TOTAL:	**85,516**	**234**

Notes:

1) Unified Soil Classification System (USCS) soil description from GMW-2013-07 boring log, 78–200 feet below ground surface
2) Value from Rosetta soil catalog (Schaap et al. 2001)
3) Effective porosity estimated from McWorter and Sunada (1977)
4) Value calculated from Sousa et al. (2013)
5) Pressure head calculated from average layer height above the water table
6) Recharge calculated from Radcliffe and West (2009)

Table 2: Unsaturated Zone Advective Travel Time Summary Table

From Northwest Corner of Proposed Landfill Expansion Area				
Groundwater Travel Distance to Receptor Adjacent to Happy Jack Road(1)	**Effective Porosity(2)**	**Saturated Hydraulic Conductivity(3)**	**Average Gradient (4)**	**Advective Travel Time in Saturated Zone(5)**
D (ft)	n_{eff} (-)	K (ft/day)	i (ft/ft)	t_{sat} (years)
2410	0.33	7.8	0.03	10

Notes:
1) Groundwater horizontal travel distance measured along shortest flow pathway (Figure 5)
2) Effective porosity estimated from McWorter and Sunada (1977)
3) Saturated hydraulic conductivity value from hydraulic testing results of Koppes No. 6 well
4) Average groundwater gradient calculated from potentiometric surface (Groundwater levels measured October 14, 2013; see Figure 3)
5) Value calculated from Sousa et al. (2013)

QUALIFICATIONS STATEMENT
LANDFILL CONSTRUCTION

THE INFORMATION SUPPLIED IN THIS DOCUMENT IS CONFIDENTIAL TO THE EXTENT PERMITTED BY LAWS AND REGULATIONS

1. SUBMITTED BY:

Official Name of Firm: ______________________

Address: ______________________

____

____

2. SUBMITTED TO: ______________________

3. SUBMITTED FOR: ______________________

Owner: ______________________

Project Name: ______________________

____

____

____

TYPE OF WORK: ______________________

____

____

4. CONTRACTOR'S CONTACT INFORMATION

Contact Person: ______________________

Title: ______________________

Phone: ______________________

Email: ______________________

5. AFFILIATED COMPANIES:

Name: ______________________________

Address: ______________________________

____

____

6. TYPE OF ORGANIZATION:

☐ SOLE PROPRIETORSHIP

Name of Owner: ______________________________

Doing Business As: ______________________________

Date of Organization: ______________________________

☐ PARTNERSHIP

Date of Organization: ______________________________

Type of Partnership: ______________________________

Name of General Partner(s): ______________________________

____

____

☐ CORPORATION

State of Organization: ______________________________

Date of Organization: ______________________________

Executive Officers:

- President: ______________________________
- Vice President(s): ______________________________

____

____

- Treasurer: ______________________________
- Secretary: ______________________________

☐ LIMITED LIABILITY COMPANY

State of Organization: ______________________________

Date of Organization: ______________________________

Members: ______________________________

____

____

____

☐ JOINT VENTURE

Sate of Organization: ______________________________

Date of Organization: ______________________________

Form of Organization: ______________________________

Joint Venture Managing Partner

- Name: ______________________________
- Address: ______________________________

____

____

Joint Venture Managing Partner

- Name: ______________________________
- Address: ______________________________

____

Joint Venture Managing Partner

- Name: ______________________________
- Address: ______________________________

____

7. LICENSING

Jurisdiction: ____________________

Type of License: ____________________

License Number: ____________________

Jurisdiction: ____________________

Type of License: ____________________

License Number: ____________________

8. CERTIFICATIONS

CERTIFIED BY:

Disadvantage Business Enterprise: ____________________

Minority Business Enterprise: ____________________

Woman Owned Enterprise: ____________________

Small Business Enterprise: ____________________

Other (____________________): ____________________

9. BONDING INFORMATION

Bonding Company: ____________________

Address: ____________________

____

Bonding Agent: ____________________

Address: ____________________

____

____

Contact Name: ____________________

Phone: ____________________

Aggregate Bonding Capacity: ____________________

Available Bonding Capacity as of date of this submittal:____________________

10. FINANCIAL INFORMATION

Financial Institution: ______________________

Address: ______________________

____

Account Manager: ______________________

Phone: ______________________

INCLUDE AS AN ATTACHMENT AN AUDITED BALANCE SHEET FOR EACH OF THE LAST 3 YEARS

11. CONSTRUCTION EXPERIENCE:

Current Experience:

List on **Schedule A** all uncompleted projects currently under contract (If Joint Venture list each participant's projects separately).

Previous Experience:

List on **Schedule B** all projects completed within the last 5 Years (If Joint Venture list each participant's projects separately).

Has firm listed in Section 1 ever failed to complete a construction contract awarded to it?

☐YES ☐ NO

If YES, attach as an Attachment details including Project Owner's contact information.

Has any Corporate Officer, Partner, Joint Venture participant or Proprietor ever failed to complete a construction contract awarded to them in their name or when acting as a principal of another entity?

☐ YES ☐ NO

If YES, attach as an Attachment details including Project Owner's contact information.

Are there any judgments, claims, disputes or litigation pending or outstanding involving the firm listed in Section 1 or any of its officers (or any of its partners if a partnership or any of the individual entities if a joint venture)?

☐YES ☐ NO

If YES, attach as an Attachment details including Project Owner's contact information.

12. SAFETY PROGRAM:

Name of Contractor's Safety Officer:____

Include the following as attachments:

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) OSHA No. 500- Log & Summary of Occupational Injuries & Illnesses for the past 5 years.

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) list of all OSHA Citations & Notifications of Penalty (monetary or other) received within the last 5 years (indicate disposition as applicable) - IF NONE SO STATE.

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) list of all safety citations or violations under any state all received within the last 5 years (indicate disposition as applicable) - IF NONE SO STATE.

Provide the following for the firm listed in Section V (and for each proposed Subcontractor furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) the following (attach additional sheets as necessary):

Workers' compensation Experience Modification Rate (EMR) for the last 5 years:

YEAR ______ EMR ______
YEAR ______ EMR ______
YEAR ______ EMR ______
YEAR ______ EMR ______
YEAR ______ EMR ______

Total Recordable Frequency Rate (TRFR) for the last 5 years:

YEAR ______ TRFR ______
YEAR ______ TRFR ______
YEAR ______ TRFR ______
YEAR ______ TRFR ______
YEAR ______ TRFR ______

Total number of man-hours worked for the last 5 Years:

YEAR ______ TOTAL NUMBER OF MAN-HOURS ______
YEAR ______ TOTAL NUMBER OF MAN-HOURS ______
YEAR ______ TOTAL NUMBER OF MAN-HOURS ______
YEAR ______ TOTAL NUMBER OF MAN-HOURS ______
YEAR ______ TOTAL NUMBER OF MAN-HOURS ______

Provide Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) Days Away From Work, Days of Restricted Work Activity or Job Transfer (DART) incidence rate for the particular industry or type of Work to be performed by Contractor and each of Contractor's proposed Subcontractors and Suppliers) for the last 5 years:

YEAR ________ DART ______
YEAR ________ DART ______
YEAR ________ DART ______
YEAR ________ DART ______
YEAR ________ DART ______

13. EQUIPMENT:

MAJOR EQUIPMENT:

List on **Schedule C** all pieces of major equipment available for use on Owner's Project.

I HEREBY CERTIFY THAT THE INFORMATION SUBMITTED HEREWITH, INCLUDING ANY ATTACHMENTS, IS TRUE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

NAME OF ORGANIZATION: ______________________________

BY: ______________________________

TITLE: ______________________________

DATED: ______________________________

NOTARY ATTEST:

SUBSCRIBED AND SWORN TO BEFORE ME
THIS ___________ DAY OF ___________, 20___

NOTARY PUBLIC - STATE OF ______________________
MY COMMISSION EXPIRES:______________________

<u>REQUIRED ATTACHMENTS</u>

1. Schedule A (Current Experience).
2. Schedule B (Previous Experience).
3. Schedule C (Major Equipment).

<u>ATTACHMENTS BY REQUEST</u>

1. Audited balance sheet for each of the last 3 years for firm named in Section 1.
2. Evidence of authority for individuals listed in Section 6 to bind organization to an agreement.
3. Resumes of officers and key individuals (including Safety Officer) of firm named in Section 1.
4. Required safety program submittals listed in Section 12.
5. Additional items as pertinent.

SCHEDULE A

CURRENT EXPERIENCE

Project Name	Owner's Contact Person	Design Engineer	Contract Date	Type of Work	Status	Cost of Work
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				

SCHEDULE B

PREVIOUS EXPERIENCE (Include ALL Projects Completed within last 5 years)

Project Name	Owner's Contact Person	Design Engineer	Contract Date	Type of Work	Status	Cost of Work
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				

SCHEDULE B

PREVIOUS EXPERIENCE (Include ALL Projects Completed within last 5 years)

Project Name	Owner's Contact Person	Design Engineer	Contract Date	Type of Work	Status	Cost of Work
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				
	Name: Address: Telephone:	Name: Company: Telephone:				

SCHEDULE C - LIST OF MAJOR EQUIPMENT AVAILABLE

ITEM	PURCHASE DATE	CONDITION	ACQUIRED VALUE

APPENDIX F-1

CONSTRUCTION QUALITY ASSURANCE PLAN

Happy Jack Landfill
Cheyenne, Wyoming

Submitted To: The City of Cheyenne, Wyoming
Sanitation/Trash Division
220 N. College Drive
Cheyenne, Wyoming 82001 USA

Submitted By: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228 USA

Solid Waste Professionals of Wyoming
316 West Birch Street
Glenrock, Wyoming 82637

April 14, 2017
September 15, 2017 – Revision 1

Project No. 123-81971

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capabilities
delivered locally

Table of Contents

List of Tables

1.0 INTRODUCTION

1.1 Purpose

The purpose of this construction quality assurance (CQA) plan (Plan) is to describe CQA procedures that will be used during construction of the containment components in the base liner and final cover systems for the Cheyenne Sanitary Landfill, also known as the Happy Jack Landfill (Landfill), in Cheyenne, Wyoming. CQA personnel shall use this Plan as their guidance document to implement the CQA program.

This CQA Plan is organized to address the individual components of liner and final cover systems (e.g., earthen components, geomembranes, etc.). For example, the section on geomembrane liner could apply to both the bottom liner system and the final cover used in either Phase 1 or Phase 2 of the Landfill, with specific requirements for each discussed within this section. Currently, a conceptual final cover design for Phase 1 and conceptual liner and final cover design for Phase 2 of the Landfill have been proposed. When the liner and final cover designs are approved and finalized for both phases, this CQA Plan will be modified as necessary to include and/or revise the CQA procedures and requirements for the specific liner and final cover system components.

This CQA Plan is also applied to elements of the liner or cover system placed by the City of Cheyenne (City or owner) during operations, if necessary.

Detailed manufacturer’s quality control (MQC) and construction quality control (CQC) requirements, which are the responsibility of organizations that manufacture materials and contractors that install these materials, respectively, are also provided in this Plan.

The company performing CQA services (i.e., the CQA consultant) will prepare a construction report for each discrete liner or final cover construction project at the Landfill to document that construction was performed in accordance with the design intent, construction drawings, technical specifications, and the CQA Plan. CQA, MQC, and CQC data generated during the project will be used to support conclusions presented in the construction report.

1.2 Document Format

This CQA Plan is organized as follows:

- Section 1.0 provides this introduction, defines the format of the document, and provides definitions specific to terms used in the document.
- Section 2.0 defines personnel and organizations that will be involved with CQA and their roles.
- Section 3.0 provides information regarding various CQA-related meetings.
- Section 4.0 defines general CQA procedures, including items such as project reporting, data collection, record keeping, project filing, etc.

- Section 5.0 defines shear testing that will be performed to confirm shear strengths of composite liner materials.
- Section 6.0 defines CQA procedures for earthwork construction.
- Section 7.0 defines CQA procedures for geosynthetics manufacturing and installation.
- Section 8.0 defines CQA procedures for mechanical construction such as HDPE pipe installation.

1.3 Definitions

Whenever the terms listed below are used, the intent and meaning will be as indicated below:

AASHTO: American Association of State Highway and Transportation Officials

ASTM: American Society of Testing and Materials

Construction quality assurance (CQA): A planned and systematic pattern of procedures and documentation designed to provide confidence items of work or services meet the requirements of the contract documents (construction drawings and technical specifications). CQA includes verifying that the contractor is meeting construction CQC requirements and that MQC requirements are met as defined in the technical specifications.

CQA consultant (CQAC): The party, independent from owner and contractor, that is responsible for observing and documenting activities related to the quality of material manufacturing, material installation, and other construction activities related to the project. Also responsible for issuing the construction report sealed by a professional engineer (PE) registered in the state of Wyoming.

CQA laboratory: A laboratory capable of conducting the materials testing required by this CQA Plan.

CQA manager: Authorized representative of the CQAC responsible for managing the CQA program.

CQA monitor: Authorized representative of the CQAC that represent the CQA manager and is responsible for on-site implementation of CQA procedures and for observing and documenting CQA and CQC activities during construction.

CQA officer: Authorized representative of the CQAC and a PE registered in the state of Wyoming that is responsible for certifying that construction was performed in accordance with the intent of the construction drawings and technical specifications. The CQA officer and CQA manager may be the same individual within the CQAC organization.

Construction quality control (CQC): Those actions that provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents. The contractor will perform CQC.

Construction drawings: The official plans, profiles, typical cross-sections, elevations, and details, as well as their amendments and supplemental drawings, that show the locations, character, dimensions, and details of the work to be performed. Construction drawings may also be referred to as the “Plans.”

Contract documents: The official set of documents issued by the owner, which include bidding requirements, contract forms, contract conditions, technical specifications, construction drawings, addenda, and contract modifications.

Contractor: The person or persons, firm, partnership, corporation, or any combination, who as an independent contractor, has entered into a contract with the owner to perform construction defined in the contract documents.

Design engineer of record: The individual or firm responsible for the design and preparation of the project construction drawings and technical specifications. Also referred to as “designer” or “design engineer.”

Earthwork: A construction activity involving the use of soil materials as defined in the technical specifications and Section 6.0 of this Plan.

Geosynthetic clay liner (GCL): Geosynthetic clay liner is a product consisting of a layer of sodium bentonite encapsulated (top and bottom) between two layers of geotextile. The GCL may be un-reinforced or reinforced, with reinforcement provided as needed to increase internal shear strength of the GCL. The types of geotextile may vary based on site-specific design criteria.

Geosynthetics installer: Also referred to as the “liner installer.” The person or firm responsible for geosynthetic installation. This definition applies to any party installing geomembrane, geotextile, geocomposite, geonet, or other geosynthetic material.

Geosynthetics supplier: Also referred to as the “liner supplier.” The firm responsible for providing geosynthetic materials for construction. This definition applies to any party supplying geomembrane, geotextile, geocomposite, geonet, or other geosynthetic material.

GRI: Geosynthetic Research Institute.

High-density polyethylene (HDPE) geomembrane: HDPE geomembrane is a flexible membrane liner product manufactured from specially formulated HDPE resin.

Linear low-density polyethylene (LLDPE) geomembrane: LLDPE geomembrane is a flexible membrane liner manufactured from linear polymer (polyethylene), with significant numbers of short branches, commonly made by copolymerization of ethylene with longer-chain olefins.

Manufacturer quality control (MQC): Actions that provide a means to measure and regulate the manufactured characteristics of a material or product to comply with the requirements of the technical specifications. The material manufacturers will perform MQC.

Non-conformance: A deficiency, relative to the technical specifications and plans, that renders the quality of an item or activity unacceptable. Examples of non-conformance include, but are not limited to, physical defects, test failures, and inadequate documentation.

Non-woven geotextile: Non-woven geotextiles are manufactured from continuous or staple filament, polyester, or polypropylene oriented into a staple network that maintains its structure during handling, placement, and long-term service.

Owner: The City of Cheyenne, Wyoming (City).

Project manager: Authorized representative of the owner having overall responsibility for design and construction activities. Responsibilities include scheduling, cost control, engineering, procurement, and contracting functions with the support of the resident project representative.

Panel: A unit area of geosynthetic that will be seamed in the field.

Procedure: A written instruction that specifies or describes how an activity is to be performed.

Project documents: Also known as the project manual. The documents to be included in the project manual include, but are not limited to, contractor submittals, construction drawings, record drawings, technical specifications, contracts, the CQA Plan, health and safety plans, and project schedules.

Project communication records: This includes documents created and maintained throughout the project that record phone conversations, fax communications, or other ancillary contact between participants of the project.

Project surveyor: The independent surveying firm the owner appoints or the contractors retain to provide layout work, to perform surveys to measure installed quantities, to perform surveys to document as-built conditions, and to verify the construction conforms to the lines and grades in the Plans.

Polyvinyl chloride (PVC) geomembrane: PVC geomembrane is a synthetic thermoplastic flexible liner material made by polymerizing vinyl chloride.

Record drawings: Drawings recording the constructed dimensions, details, and coordinates of the project. Also referred to as “as-builts.”

Resident project representative: The resident project representative is the owner’s representative responsible for day-to-day construction contract administration, and coordination between parties in support of the project manager.

Technical specifications: The requirements for products, materials, and workmanship on which the contract is based.

Testing: Verification that an item meets specified requirements by subjecting that item to a set of physical, chemical, environmental, or operating conditions.

2.0 PERSONNEL AND ORGANIZATION RESPONSIBILITIES

This section of the CQA Plan describes personnel and organizations that will be assigned to this project and their roles.

2.1 Resident Project Representative (RPR)

The RPR is the owner’s representative responsible for construction contract administration, and coordination between parties, and provides overall support to the project manager. The RPR shall request assistance from the CQA manager, design engineer of record, CQA monitor, contractor, and geosynthetics installer to resolve construction, technical, or regulatory-related issues.

The RPR shall control construction documents, including technical specifications, construction drawings, and change orders. The RPR shall maintain one or more copies of the most current set of contract documents for use by the contractor and geosynthetics installer and CQAC. Upon issuance of new copies or revisions to any of these construction documents, it is the responsibility of the RPR to notify all parties involved in construction, provide revised contract documents, and then recall all copies of the contract documents that do not include the latest revisions.

2.2 Project Manager

The project manager is the owner’s on-site representative and is the primary person responsible for communicating with the RPR and the Wyoming Department of Environmental Quality (WDEQ). The project manager shall request assistance from the RPR, CQA manager, and design engineer of record to resolve technical or regulatory-related issues during construction.

2.3 Construction Quality Assurance Manager

The CQA manager is responsible for working directly with the RPR to manage CQA activities. The CQA manager is responsible for managing the CQA program, supervising the CQA monitor, conducting progress meetings, and preparing the construction report. The CQA manager shall obtain approval of the design engineer of record when an interpretation of the design is needed or a design change is being considered during construction.

The CQA manager shall maintain one master copy of the CQA Plan for reproduction and distribution.

2.4 Design Engineer of Record

The design engineer of record is responsible for the design as it exists at the time construction begins. The design engineer of record shall approve all design changes, CQA Plan changes, and provide clarifications to design questions raised during construction. The design engineer of record and CQA officer can be the same individual.

2.5 CQA Officer

The CQA officer is responsible for professionally certifying that construction was performed in accordance with the design intent, construction drawings, technical specifications, and any approved design changes or CQA procedural changes made during construction.

2.6 CQA Monitor

The CQA monitor represents the CQAC and owner by monitoring and testing the contractor's and geosynthetics installer's work in accordance with the CQA Plan. The CQA monitor reports to the CQA manager. The CQA monitor observes and documents the activities of the contractor and geosynthetics installer in sufficient detail and with sufficient continuity to provide a high level of confidence that the work product complies with the intent of the construction drawings and technical specifications. The CQA monitor also performs tests, when appropriate, to provide a high level of confidence that the characteristics of the work meet the requirements of the construction drawings and technical specifications.

Whenever the CQA monitor performs observations or performs tests, they are responsible for timely preparation and processing of all required documentation and reports. Accurate and concise documentation must be prepared for all monitoring activities and for each test performed on the day that the CQA activity occurs.

2.7 Contractors

The contractor and geosynthetics installer are responsible for coordinating amongst themselves, scheduling and performing the work within the timeframe and budget agreed to in the contract, and performing the work in accordance with the construction drawings and technical specifications. The contractor and geosynthetics installer are also responsible for implementing MQC and CQC procedures to document materials are manufactured and installed in accordance with the construction drawings and technical specifications. The contractor and geosynthetics installer are also expected to cooperate with the CQA monitor to achieve a quality product.

2.8 Surveyor

The surveyor shall work at the direction of the contractor or the owner to set construction control stakes, perform surveys to document as-built conditions and conformance with design lines and grades, and perform surveys to measure installed quantities of materials.

2.9 Geosynthetics Supplier

The geosynthetics supplier is responsible for manufacturing geosynthetic products.

3.0 PROJECT MEETINGS

In order to administer the construction contract, and to coordinate the contractor's and geosynthetics installer's activities with those of the CQAC, a variety of meetings will be held. They are discussed in the following paragraphs.

3.1 Pre-construction Meeting

A pre-construction meeting will be held at the site and be attended by the RPR, design engineer of record, project manager, CQA manager, contractor, geosynthetics installer, suppliers or subcontractors, CQA monitor, and others designated by the owner. The meeting will be facilitated by the RPR and assisted by the CQA manager and design engineer of record. A meeting report will be prepared to document the meeting and its attendees. The purpose of this meeting will be to:

- Present a proposed construction progress schedule and submittals register as required by the contract documents
- Discuss liquidated damages (if any)
- Discuss procedures for handling submittals
- Discuss the rules for project correspondence, and roles and responsibilities of the contractor, design engineer of record, RPR, CQA manager, and owner
- Establish reporting and documentation procedures for each party
- Schedule weekly progress meetings
- Present a summary of the laboratory materials testing and field testing that will be required to meet CQC, MQC, and CQA requirements
- Discuss applications for payment and progress payment procedures
- Discuss procedures for field orders, work change directives, and change orders
- Discuss owner's site regulations
- Review the construction drawings and technical specifications
- Review the CQA Plan
- Review work area security, safety procedures, and related issues
- Provide all parties with relevant contract documents
- Review testing equipment and procedures
- Establish testing protocols and procedures for correcting and documenting non-conforming work or materials
- Conduct a site inspection to discuss work area, stockpile areas, lay down areas, material storage areas, access roads, haul roads, and related items

The RPR or CQA manager shall record minutes of the meeting and provide copies to all parties present at the meeting.

3.2 Daily Progress Meetings

An informal progress meeting is recommended before the start of work daily. At a minimum, the CQA monitor and contractor's and geosynthetics installer's superintendents should conduct this meeting. A suggested typical agenda for this meeting may include the following:

- A discussion of the previous day's construction-related problems and how they will be resolved
- Review of relevant test data
- Discussing the contractor's and geosynthetics installer's personnel and equipment assignments for the day
- Identifying expected material and/or equipment deliveries and determining where they will be staged, stored, and inventoried
- Resolving any outstanding problems or disputes
- Discussing any site health and safety issues relevant to that day's scheduled work

3.3 Weekly Progress Meeting

Weekly scheduled progress meetings will be held. Typically, the RPR, project manager, CQA manager, contractor, geosynthetics installer, and CQA monitor shall be present. The RPR or CQA manager shall prepare the agenda for each meeting, facilitate the meeting, and prepare meeting minutes for distribution to all parties. An attendance sheet will be used to document the participants. At a minimum, the weekly progress meetings will address the following:

- Reviewing meeting minutes from previous progress meeting
- Discussing work in progress and key activities scheduled for the upcoming week
- Addressing any outstanding issues or conflicts that may or may not interfere with work progress
- Reviewing submittals register to identify any outstanding submittal issues
- Reviewing MQC, CQC, and CQA testing results and testing scheduled to take place that week
- Reviewing an updated schedule and quantities provided by the contractor
- Reviewing any health and safety issues for the site

At the beginning of each progress meeting all parties in attendance at the previous meeting must agree to the contents of the previous meeting minutes. Any changes to the meeting minutes must be marked on the file copy. The RPR shall keep a copy of all meeting minutes at that project site, and in a project file that can be accessed at any point during or after the project.

3.4 Other Meetings

As required, special meetings will be held to discuss problems or non-conforming work. Typically, the RPR, CQA manager, CQA monitor, and contractor and geosynthetics installer shall attend this meeting as necessary. If the problem requires a design modification and subsequent change order the design engineer of record and CQA manager shall also be present. The RPR shall document the meeting.

4.0 CQA DOCUMENTATION AND REPORTING

Success of the CQA program requires thorough performance of the required monitoring and testing activities, documentation of completed monitoring and testing activities, and frequent senior review of CQA documentation. Therefore, the CQA monitor and CQA manager shall ensure that all CQA procedures have been implemented, that results of the program are reviewed frequently, and corrections, if necessary, are implemented.

Procedures for completing, documenting, reviewing, and filing CQA and related activities are summarized in this section. The following paragraphs discuss each of the documentation and reporting requirements.

4.1 Daily Record of Construction Progress

A daily record of construction progress (daily progress report) will summarize each day's construction, CQA, CQC, and MQC activities, and any relevant discussions with the contractor or geosynthetics installer. The CQA monitor shall prepare a report on a daily basis. Each completed report will be submitted to the CQA manager no later than the following day. The CQA manager shall conduct a review to check for clarity, legibility, traceability, and completeness. At a minimum, the report will include the following:

- Date, project name, project number, and project location.
- A unique number for cross-referencing and document filing.
- A description of that day's weather.
- A description of ongoing construction activities in the area of the CQA monitor's responsibility.
- A summary of CQA, CQC, and MQC activities for that day.
- An inventory of equipment used by the contractor and an inventory of labor personnel used by the contractor.
- A summary of pertinent project-related discussions and names of parties involved in those discussions.
- A brief description of tests performed and identification as to whether or not the tests were passing or failing, and in the event of failure, a re-test with pass/fail results. A reference to attached test data can be used to meet this requirement.
- A description of any nonconforming work, and related corrective actions, if any.
- A summary of materials received and documentation of their quality, such as MQC data.
- Follow-up information on previously reported problems or deficiencies.
- The signature of the CQA monitor.

A copy of the daily report will be sent to the CQA manager, and a copy of the daily report signed by the CQA manager shall be kept on site.

4.2 Verifying Material Quality

4.2.1 Certificates of Compliance

Certificates of compliance may be used by the CQAC to establish the acceptability of materials. These certificates generally state that the material is in compliance with a particular code, standard, or specification. The certificates of compliance must directly reference the project and include the name of the product or source of the material. Submission of a certificate of compliance does not relieve the contractor of the responsibility of supplying and installing materials that meet the design requirements. Acceptance and proper review of submittals is the responsibility of the design engineer.

4.3 CQA Laboratory Test Reports

The CQA laboratory shall complete a test report whenever testing is performed. The laboratory performing the tests shall peer review the laboratory test reports, and the CQA manager shall review all field test reports. The CQA manager shall review laboratory and field test reports within 24 hours of completing the test. The review will include a determination regarding pass or fail relative to specified quality or installation requirements, a check for mathematical accuracy, conformance to test standards, conformance to the CQA Plan, and a check for clarity, legibility, traceability, and completeness.

Laboratory and field test reports must include the following information as is appropriate for the form being used:

- Date, project name, and project location
- A unique number for cross-referencing and document control
- Weather data
- A reduced-scale site plan showing sample and test locations
- Test equipment calibrations, if applicable
- A summary of test results identified as passing, failing, or, in the event of a failed test, a re-test
- Completed calculations, as applicable
- Signature of the CQA monitor or laboratory technician
- Signature of the laboratory peer reviewer

CQA test data will be summarized and presented in their respective forms in the construction report. Test data will be entered in the Summary Form following CQA manager review of the individual test reports. Sections 6.0 and 7.0 include summaries of required CQA testing.

4.4 MQC and CQC Test Reports

The contractor and geosynthetics installer have contractual responsibilities for performing MQC and CQC testing to determine the quality of materials manufactured for this project, and the quality of their installation. These requirements are presented in the technical specifications. The CQAC shall review MQC and CQC data to ensure manufactured materials and their installation meet specified requirements.

The CQA manager shall review MQC data for conformance with specified material quality requirements within three working days of receiving the data. If the MQC data does not verify material quality, the CQA manager shall immediately notify the contractor and the geosynthetics supplier, as appropriate.

4.5 Non-conforming Work

Whenever non-conforming work is found, the CQA monitor shall notify the contractor or geosynthetics installer supervising the work in question. The CQA monitor shall then document the non-conformance in writing on daily progress reports, test reports, or elsewhere, where appropriate, and that the contractor and/or geosynthetics installer was notified.

When a routine non-conformance is found as a result of testing, such as a failed field moisture–density test, corrective measures shall be determined by specification direction (e.g., re-compact until a passing test is achieved). If the routine non-conformance is determined by observation, such as a non-conforming grade tolerance, the CQA monitor, RPR, and contractor and/or geosynthetics installer shall discuss standard construction methods to correct the deficiency.

For a non-conformance that is considered serious or complex in nature, or which requires an engineering evaluation, such as accidental damage to an installed material, a non-conformance report will be initiated and issued to the design engineer of record, RPR, CQA manager, and contractor and/or geosynthetics installer. Whenever a non-conformance is discovered that requires technical input from the design engineer of record, the CQA monitor or CQA manager shall first determine the extent of the non-conforming work. This can be accomplished by performing additional sampling, testing, and observations, or taking photographic records. The design engineer of record shall determine corrective measures in cases when a non-conformance report is issued. A copy of the non-conformance report, with the design engineer of record's corrective measure determination, must be forwarded to the CQA monitor and contractor and/or geosynthetics installer for implementation of the corrective measure. The owner shall be notified of all serious non-conformances before corrective action is taken.

Upon notification to the CQA monitor by the contractor or geosynthetics installer that corrective measures are complete, the CQA monitor shall verify its completion. The verification must be documented by observations or re-testing and with photographs. The CQA monitor shall prepare written documentation of the corrective measures in daily reports, logs, and forms, and in the non-conformance report. The report will then become part of the project documentation and be filed as indicated in Section 4.13.

4.6 CQA Checklist

The CQA monitor is responsible for completing a checklist of CQA testing requirements. The purpose of the checklist is to list all required CQA testing, and then periodically review the checklist to ensure CQA testing and reporting is being completed as the pace of the project requires, and to ensure that all required testing is completed in a timely manner

4.7 Design Modifications/Clarifications

Design changes may be required during construction. Design changes can only be made by written agreement of the design engineer of record. A copy of the design changes will be provided to the CQAC for distribution among the CQA staff.

If questions arise regarding interpretation of the drawings and/or CQA requirements during construction, the design engineer of record and RPR shall be notified by the CQA monitor. Any clarification of drawings or CQA requirements shall be documented and distributed to the design engineer of record, RPR, CQA manager, and contractor and/or geosynthetics installer and a record shall be kept with the project files.

4.8 CQA Modifications

Changes to CQA procedures may be required during construction. CQA procedural changes can only be made by written agreement of the design engineer of record. These changes must be made in writing (technical memorandum or letter) by the design engineer of record and must identify the CQA procedural change and its justification. When CQA procedural changes are made, the design engineer of record shall distribute them to the CQAC. A copy of the CQA change will also be distributed to the CQAC for distribution among the CQA staff (officer, manager, and monitors). The design engineer of record shall be responsible for notifying the owner of major changes and WDEQ for any that may require regulatory approval.

4.9 As-built Records

The CQA monitor, the contractor and geosynthetics installer, and the project surveyor shall collect as-built information throughout the project as required by their contractual obligations. The CQA manager shall compile as-built information provided by the CQA monitor, contractor and geosynthetics installer, and the project surveyor into one set of “as-built” construction drawings and technical specifications, which will be maintained at the project site. These “as-built” construction drawings and technical specifications must be clearly marked as “project as-built drawings” and “project as-built technical specifications.” At the completion of the project, all as-built information will be provided to the CQA officer for use in preparing as-built drawings that must be included in the construction report.

4.10 Other Project Records

Other project records will be completed as needed. These may include records such as telephone records and meeting minutes that discuss issues related to the CQA of the project.

4.11 Photographic Documentation

The CQA monitor shall photograph construction activities. Photographs will include any significant problems encountered during the work, and corrective actions taken to correct the problem. Photographs will also be taken to document project progress. The photographs will be identified by number, location, time, date, subject, and photographer. Selected photographs may be used in the construction report.

4.12 Project Filing and Documentation

The CQA manager shall implement a project filing system that results in a complete and retrievable record of the project. A file will be kept on site and a duplicate file kept in the CQAC's office.

The files will contain the information listed in Table 4-1.

Table 4-1: File Contents

Item to be Filed	On-site CQA File	CQA Manager's Off-site File	Copy to Contractor
MQC Data	Yes	Yes	No
CQC Data	Yes	Yes	No
CQA Data	Yes	Yes	Upon request only
Submittals			
From Contractor and Geosynthetics Installer	Yes	Yes	No
Returned with comments etc.	Yes	Yes	Yes
Final approved submittals	Yes	Yes	Yes
Photographs	Yes	Yes	Upon request only
Progress reports	Yes	Yes	Upon request only
Communications, faxes, e-mails, etc.	Yes	Yes	Upon request only

4.13 Final Construction Report

At the completion of the project, the CQAC will prepare and submit a construction report. This report will document the construction and compliance with the construction drawings and technical specifications.

At a minimum, the report will contain the following:

- An introduction
- A summary of all parties responsible for completing the project
- A summary of all major landfill construction activities
- A summary of all MQC, CQC, and CQA tests
- A description of significant construction problems and their resolution

- A discussion of design changes and CQA procedural changes, and the justification for these changes, including references to any correspondence with the design engineer of record and regulatory agencies involved with the changes
- As-built record drawings (full-size) and tabloid-size (11" x 17") as-builts will be kept in the Operating Record
- Results of the Leak Detection Survey
- A statement that the work was completed in accordance with the construction drawings, technical specifications, and design intent, which is signed and stamped by a PE registered in the state of Wyoming

The as-built record drawings will accurately locate the as-constructed location of landfill components, including composite liner systems, leachate collection and removal system (LCRS), and secondary LCRS (SLCRS) piping, anchor trenches, etc. The project surveyor will perform all surveying required to develop record drawings. The CQA officer shall review and verify that as-builts are correct, before they are included in the construction report. Electronic copies of the as-builts will be provided to WDEQ. Daily and weekly summaries of CQA work will be kept in the Operating Record for a period of no less than five years.

4.14 Calibrating Test Equipment

Before on-site testing equipment is placed into service, the accuracy of each piece of equipment will be verified by calibration. Types of on-site equipment requiring calibration include nuclear gauges, tensiometers, and scales. The calibration procedures and frequencies will be completed as per the manufacturer’s instructions. The CQA manager shall maintain copies of current calibration certificates for equipment in the project file. Whenever the equipment is suspect or is producing questionable results, it will be removed from service and re-calibrated.

5.0 SHEAR TESTING

Prior to construction, the CQAC shall perform various laboratory tests to confirm composite liner system slope stability. These tests include interface shear strength of soil materials in contact with geosynthetic materials, and interface shear strength of geosynthetics in contact with other geosynthetics. All components of the liner or cover option to be constructed shall be tested according to ASTM D6243. The tests shall be performed with a hydrated moisture condition with a normal load as directed by the design engineer of record. These tests must be performed well in advance of construction using proposed soil, and using geosynthetic materials specifically designed and manufactured for this project. The design engineer of record or the CQA officer shall review all test results to confirm that shear strengths meet values indicated in the permit and the technical specifications.

Shear test data will not be summarized. Instead, full test reports from the laboratory will be provided as an appendix to the construction report.

6.0 EARTHWORK CONSTRUCTION QUALITY ASSURANCE

This section defines the earthworks CQA program for the bottom liner system and final cover system associated with the Phase 1 and Phase 2 cell construction and any associated infrastructure being constructed at the Landfill.

6.1 Scope of Earthwork Construction

The scope of earthwork construction for this project includes the following components:

- Excavation
- Soil stockpiling
- Trenching and backfilling
- Engineered fill placement
- Composite liner subgrade preparation
- Low-permeability soil liner placement and compaction (if option is selected by owner and design engineer)
- LCRS and SLCRS aggregate placement
- Operations layer placement

6.2 Soil Sampling

6.2.1 Sample Processing

The CQA monitor is responsible for ensuring the timely processing and testing of soil samples. This includes samples collected and tested by the contractor and samples collected and tested by the CQA monitor. The CQA manager shall determine which samples will be tested on site and which will be tested off site. This determination will be made based on available manpower, available equipment, complexity of test, and time available to determine results. Samples tested off site will be shipped as soon as practical.

As test data is obtained from the laboratories it will be summarized in tables in a format suitable for inclusion in the construction report.

6.2.2 Sample Numbering

The CQA monitor shall maintain a sample numbering system for all soil samples obtained for the project. These samples include those obtained prior to construction for conformance or shear testing, and samples obtained during construction such as samples obtained for engineering properties (Atterberg limits, grain-size distribution), moisture–density relationship (standard Proctor) testing, and permeability testing. Separate numbering systems may be used for samples collected and tested by the contractor.

Documentation of soil sampling will be recorded in a Soil Sample Log (Form S-1) and be maintained throughout the project. The log will include soil sample numbers that are unique to the type of sample being collect and will proceed sequentially. No sample number will be repeated, and re-tests of a sample that does not meet specified requirements will be given the original number with a letter suffix (e.g., re-tests for sample #0021 not meeting specified requirements would be 0021A, 0021B, etc.). Information contained in the Soil Sample Log must include the following:

- Sample number
- Test(s) being performed
- Date the sample was obtained
- Name of CQA monitor that obtained the sample
- Location that the sample was obtained, such as a stockpile, a fill, a borrow area, etc.
- Location testing will take place (on site vs. off site)
- Date sample sent off site

6.2.3 *Sample Tagging*

The CQA monitor shall maintain the identification of all samples obtained throughout the project from the time the sample is obtained to the time testing is completed. The CQA monitor shall place an identifying tag on the sample or mark the sample container with the sample number immediately upon sampling. The tag or identifying container will remain with the sample throughout processing, testing, and storage. The tag or container must have the following information:

- Sample number
- Soil material type
- Project name and project number
- Name of CQA monitor that obtained the sample
- The date the sample was obtained

6.3 Conformance and Construction Phase Testing

Tables 6-1, 6-2, 6-3, and 6-4 establish test frequencies for earthwork CQA testing. The tables include classification and conformance tests that will be performed prior to soil installation to ensure soil materials meet quality standards established in the technical specifications, and construction testing to ensure installed materials meet specified installation requirements.

The listed test frequencies establish a minimum number of required tests. Additional testing will be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. Any re-tests performed as a result of a failing test cannot contribute to the total number of tests performed in satisfying the minimum test frequency.

6.4 Field Moisture–Density Test Numbering

Each soil component that requires field moisture and density testing will have a unique set of test numbers. No test number will be repeated for a given soil component, and re-tests of failing tests must be given a letter suffix along with the original test number (e.g., re-tests for a failing Test #112 would be 112A, 112B, etc.). Test data will be recorded in a Field Density Test Form in a format suitable for the construction report.

6.5 Earthwork Observation and Testing Requirements

Earthwork components for the project are listed in Section 6.1. Each component has specific material quality and installation requirements that will be monitored and tested. The following paragraphs list monitoring and testing requirements for each type of earthwork. It is noted that Section 6.5.7 will be followed for placement of all operations layer material including that placed by the operator. All operations layers on slopes must be pushed up the slope and a CQA consultant shall prepare a construction report showing all the requirements for that layer have been met.

6.5.1 Excavation to Design Grades

During excavation the CQA monitor shall:

- Verify construction staking is performed prior to work
- Periodically verify slope requirements and grading tolerances are met
- Verify ditch excavations meet slope and cross-sectional requirements
- Verify lumped subsoil, boulders, and rock of the dimensions identified in the technical specifications are removed from the excavation if it is also a completed surface of the landfill cell subgrade
- Verify excavated materials not used as engineered fill or other earthwork components are stockpiled in designated areas

6.5.2 Soil Stockpiling

During soil stockpiling the CQA monitor shall:

- Verify soil is placed in the appropriate designated stockpile footprint
- Verify maximum and minimum slope requirements are met
- Verify access roads into the stockpiles are constructed to the minimum slope and width requirements

6.5.3 Utility Trench Backfilling

During utility trench backfilling the CQA monitor shall:

- Verify source of material is suitable for backfill by sampling backfill materials, log samples, and perform classification testing at required frequencies
- Obtain and maintain summarization of classification test results

- Verify lift thickness
- Test compaction and moisture content at required frequencies and record data
- Summarize nuclear moisture–density test data
- Verify completed grades meet finished grade and tolerance requirements

6.5.4 Engineered Fill Placement

During engineered fill placement the CQA monitor shall:

- Verify source of material is suitable for engineered fill by sampling proposed material and performing classification testing at required frequencies
- Summarize classification test results
- Verify lift thickness
- Test compaction and moisture content at required frequencies and record data
- Summarize nuclear moisture–density test data
- Verify CQA data is reviewed, summarized, and filed as required by this CQA Plan
- Verify final grading meets grade and tolerance requirements

6.5.5 Composite Liner Subgrade Preparation

During composite liner subgrade preparation the CQA monitor shall:

- Obtain five-gallon bucket of highest plasticity material observed in the entire subgrade area, ship it to the off-site laboratory for interface shear testing, and record the sample.
- Verify source of material is suitable for composite liner subgrade by obtaining representative soil sample, logging the sample, and performing classification testing at required frequencies.
- Summarize classification and interface test results.
- Test compaction and moisture content at required frequencies and record data.
- Summarize nuclear gauge moisture–density test data.
- Verify final grading has been completed to tolerances indicated in the technical specifications.
- Verify no soil particles greater than that specified in the technical specifications are exposed on the finished surface. If the GCL option is selected by the owner and design engineer, verify that there are no protrusions greater than 0.5 inches, and there are no angular or sharp rocks or other debris that could damage GCL that will be installed on the subgrade surface.
- Verify grade control stakes are removed at the completion of subgrade preparation.
- Verify that an as-built survey of subgrade is performed.
- Verify that the subgrade as-built survey establishes horizontal and vertical location of subgrade at grid required in the technical specifications for all areas that will be covered with composite liner materials, and that the grading tolerances have been met.

6.5.6 Low-permeability Soil Liner

For the low-permeability soil liner the CQA monitor shall:

- Verify source of material is suitable for low-permeability soil liner by obtaining representative soil sample, logging the sample, and performing classification testing at required frequencies
- Verify roots, rocks, rubbish, soil not meeting the CQA Plan and technical specification requirements, or other deleterious materials are removed from the liner material
- Verify low-permeability soil liner material is spread adequately to obtain complete coverage and the specified loose/compacted lift thickness
- Verify oversize clods in the low-permeability soil liner material are reduced in size
- Verify water is adequately spread and enough time is allowed (typically 24 to 48 hours) to obtain full penetration through the soil and uniform distribution of the specified water content
- Verify soil moisture content is adjusted appropriately in the event of a significant prolonged rain or drought during construction
- Verify significant water loss and desiccation cracking before and after compaction is prevented through the use of water application, covering, rolling with smooth-drum, or other methods
- Document the compaction equipment type, configuration, and weight, and verify as necessary to meet design requirements in the CQA Plan and technical specifications
- Document the compaction equipment’s coverage area, especially at fill edges
- Document the soil density, water content, and permeability throughout each completed lift and verify that technical specification requirements are achieved
- Document permeability values for undisturbed low-permeability soil liner samples and verify that technical specification requirements are achieved
- Document penetrations or holes resulting from the collection of undisturbed soil samples or the use of density or moisture probes are repaired using the same or other suitable materials and methods as approved by the design engineer
- Document compacted lifts are tied together by scarifying the top of each lift with a roller with feet or other applicable means prior to applying the following lift
- Document minimum specified density of material is achieved in accordance with the technical specifications
- Document that geomembrane is placed in a timely manner where necessary to prevent desiccation of the low-permeability soil liner
- Document that equipment traffic is routed and controlled such that accidental damage of installed portions of the low-permeability soil liner is prevented

6.5.7 LCRS and Operations Layer Aggregates

For the LCRS and operations layer aggregates the CQA monitor shall:

- Verify sources of aggregate materials are suitable for LCRS by obtaining material submittals from contractor, logging the samples, and performing classification testing at required frequencies

- Perform gradation and permeability testing of LCRS aggregate prior to installation at the frequencies established in this CQA Plan to verify material quality, and record test data
- Verify CQA data is reviewed, summarized, and filed as indicated in this CQA Plan
- Establish stockpile location, if required
- Verify that LCRS aggregate placement does not damage geosynthetics being covered
- Verify underlying geosynthetics and piping installations are complete prior to material installation
- Verify grade control is established to control thickness of material placed
- During placement of material over geosynthetics, verify required minimum material thickness is maintained below equipment that is spreading the material
- Verify equipment that is spreading material has a ground pressure equal to or less than the maximum ground pressure specified in the technical specifications
- Identify geosynthetics damaged during material installation, and verify that the damage is repaired
- Monitor temporary haul road thickness over geomembrane and verify equipment hauling and placing material over geomembrane meets technical specifications
- Monitor placement of material over piping, and verify pipe is not damaged by occasionally uncovering and inspecting piping

7.0 GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

This section describes the geosynthetics CQA program. Objectives of the geosynthetics CQA program are to:

- Ensure geosynthetic materials manufactured for the project meet interface shear requirements and associated slope stability requirements
- Ensure geosynthetic materials manufactured for the project meet quality standards defined in the technical specifications
- Ensure construction techniques and procedures used during installation of geosynthetics are in compliance with the construction documents.
- Identify and define problems that may occur during construction and then verify these problems are corrected before construction is complete

The manufacturers shall be qualified and approved by the engineer. In addition to the qualifications required by submittals in the specifications, the manufacturer will provide information on corporate background, manufacturing capabilities, and information on plant size, equipment, number of shifts per day, and capacity per shift. To ensure compliance, the CQA program will include a review of any conformance testing and MQC testing, documentation of CQC testing, and visual observation of the installations. Geosynthetics MQC testing will take place before geosynthetics installation to verify material quality. Construction testing includes activities that occur during geosynthetics installation to verify installation quality.

The following types of geosynthetics may be installed:

- GCL as a component of the composite and secondary composite liner systems
- HDPE geomembrane as a component of the composite and secondary composite liner systems
- LLDPE or PVC geomembrane as a component of the final cover system
- Geocomposite drain layer as part of the leachate collection system or as a drainage layer on final cover
- Non-woven geotextile as a cushion on top of the geomembrane, if required
- Non-woven geotextile to separate LCRS aggregate from the operations layer soil, if required

7.1 GCL Quality Assurance

7.1.1 Pre-construction Submittal Review

Prior to scheduled manufacturing of the product, the geosynthetics manufacturer shall submit the items required by the technical specifications to the CQAC for review and testing for conformance to the requirements in the technical specifications.

If properties outlined in the technical specifications differ from the manufacturer's standard cut sheet, the manufacturer shall provide a written statement certifying to the properties in the technical specifications, or provide an alternative material.

Prior to shipment of the GCL, the CQAC and design engineer of record shall review the GCL submittals for conformance to the technical specifications.

Prior to scheduled installation of the product, the liner supplier or geosynthetics installer shall provide the items required by the technical specifications to the CQAC for review and testing for conformance to the technical specifications. All submittals received by the CQAC must be recorded in the Submittal Log (Form A-4), provided to the design engineer of record for review and approval, and then placed in the project files for review by the CQA monitor.

7.1.2 Delivery

During delivery of GCL, the CQA monitor shall:

- Verify equipment used to unload the materials does not damage the GCL
- Verify rolls are wrapped in impermeable and opaque protective covers
- Verify appropriate care is used to unload the rolls so as to not cause damage
- Verify all MQC and submittal documentation required by the technical specifications has been received, reviewed, and filed
- Verify each roll is marked or tagged with manufacturer's name, project identification, lot number, roll number, roll dimensions, and that this information is documented in a GCL Inventory Log
- Verify materials are stored in a location that will protect the rolls from exposure to precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions

Damaged rolls will be rejected. If rejected, verify rejected material is removed from the site or stored at a location separate from accepted rolls. GCL rolls that do not have proper manufacturer's documentation will be stored at a separate location, until all documentation has been received and approved.

7.1.3 Subgrade Acceptance

Prior to GCL deployment, the surface on which the GCL will be installed will be prepared in accordance with the technical specifications. Before GCL installation, the CQA monitor and geosynthetics installer shall inspect the surface. The CQA monitor shall verify the following:

- The soil subgrade underlying the GCL has been prepared in accordance with the subgrade preparation technical specifications.
- No sharp objects or other materials that could puncture the GCL are present on the soil subgrade surface.

- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- There are no excessively soft areas.
- All construction stakes have been removed.
- The geosynthetics installer has certified in writing, in a form acceptable to the CQA manager, that the surface on which the GCL will be installed is acceptable. The contractor shall also sign this form.
- This Subgrade Acceptance Form will be prepared on a daily basis whenever GCL is being deployed.

7.1.4 Deployment and Seaming

During GCL deployment and seaming operations, the CQA monitor shall:

- Observe the GCL as it is deployed and identify all defects and defect corrective actions (panel rejected, patch installed, etc.), verify corrective actions are performed in accordance with the technical specifications, and record these corrective actions in the daily reports
- Verify equipment used to install GCL does not damage it during handling, deployment, or due to leakage of hydrocarbons or other means
- Verify crews working on the GCL do not smoke, wear shoes that could damage the GCL, or engage in activities that could damage the GCL
- Verify the GCL is securely anchored to prevent movement by the wind
- Verify adjacent panels are overlapped and seamed in accordance with the technical specifications and that the proper amount of bentonite is applied to the seam overlap, if required
- Verify the GCL is not exposed to precipitation
- Verify no more panels are deployed than can be covered with geomembrane on that same day
- Examine the GCL after installation to ensure no potentially harmful foreign objects are present that could damage the overlying geomembrane
- Verify minimum overlap of GCL panels in accordance with the technical specifications

The CQA monitor shall inform both the CQA manager and geosynthetics installer if the above conditions are not met.

7.1.5 Construction Testing

During installation, the CQA monitor shall obtain samples of the deployed GCL, record the samples, and perform testing as required by the specifications. Test results will be summarized for inclusion in the construction report.

7.1.6 Repairs

Where repairs are necessary the CQA monitor shall verify the following methods are used:

- Patching: used to repair large holes, tears, and small defective areas
- Removal: used to replace large defective areas where the preceding method is not appropriate or to replace GCL that has a moisture content greater than that allowed in the technical specifications

7.2 HDPE and LLDPE Geomembrane Quality Assurance

7.2.1 Pre-construction Submittal Review

Prior to scheduled manufacturing of the product, the geosynthetics manufacturer shall submit the items required by the technical specifications to the CQAC for review and testing for conformance to the technical specifications.

If properties outlined in the technical specifications differ from the manufacturer's standard cut sheet, the manufacturer shall provide a written statement certifying to the properties in the technical specifications, or provide an alternative material.

Prior to shipment of the geomembrane, the CQAC or design engineer of record shall review geomembrane submittals for conformance to the technical specifications.

Prior to installation of the geomembrane, the CQAC shall review personnel qualification submittals and shop drawings for conformance to the technical specifications.

All submittals received by the CQAC must be recorded in the Submittal Register and then placed in the project files for review by the CQA monitor.

7.2.2 Delivery

Upon delivery of geomembrane, the CQA monitor shall:

- Inspect geomembrane rolls for damage potentially occurring during shipping and/or handling, then identify damaged materials and verify damaged materials are set aside and not installed
- Verify the geomembrane is stored in accordance with the technical specifications and manufacturer's recommendations and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage
- Verify each roll is marked or tagged with manufacturer's name, project identification, lot number, roll number, roll dimensions, and that this information is documented in a Geomembrane Inventory Log
- Verify all MQC and submittal documentation required by the technical specifications has been received, reviewed, and filed, and that this information is recorded
- Verify a Geomembrane Inventory Log is completed for all geomembrane materials received

Damaged geomembrane will be rejected. If rejected, the CQA monitor shall verify material is removed from the site or stored at a location separate from accepted geomembrane. Geomembrane that does not have proper manufacturer's documentation will be stored at a separate location, until all documentation has been received, reviewed, and accepted.

7.2.3 Review of Geosynthetics Installer’s Geomembrane Panel Drawings

Before installing any geomembrane, the geosynthetics installer shall submit shop drawings in accordance with the technical specifications. The shop drawings will show the proposed layout of the panels, field seams, and any other details that are needed to describe the proposed installation. The CQA monitor shall review these shop drawings prior to geomembrane installation, and record the submittal in the Submittal Register.

7.2.4 Subsurface Preparation

Before geomembrane installation, the CQA monitor shall:

- Verify all lines and grades have been met by the contractor
- Verify low-permeability soil liner or GCL surface has been prepared in accordance with the technical specifications

7.2.5 Subgrade Acceptance

Prior to geomembrane deployment, the low-permeability soil liner or GCL surface on which the geomembrane will be installed must be prepared in accordance with the technical specifications. Before geomembrane installation, the CQA monitor and geosynthetics installer shall inspect the low-permeability soil liner or GCL surface. The CQA monitor shall verify the following:

- The low-permeability soil liner or GCL surface underlying the geomembrane has been prepared in accordance with the technical specifications.
- No sharp objects or other materials that could puncture the geomembrane are present on the low-permeability soil liner or GCL surface.
- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- There are no excessively soft areas.
- All construction stakes have been removed.
- The geosynthetics installer has certified in writing, in a form acceptable to the CQA manager, that the surface on which the geomembrane will be installed is acceptable. The contractor shall also sign this form when the GCL is placed over low-permeability soil liner.
- This Subgrade Acceptance Form must be prepared on a daily basis whenever geomembrane is being deployed.

7.2.6 Panel Layout As-built

During installation, the CQA monitor shall maintain an up-to-date panel layout drawing that shows the following as-built information:

- Orientation and size of each geomembrane panel
- Roll numbers associated with each panel
- Assigned panel numbers
- Assigned seam numbers
- Destructive test locations
- Repair locations

The project surveyor shall survey the installed perimeter of geomembrane prior to it being covered, and then prepare a final as-built drawing showing the following information:

- The location of the installed primary geomembrane
- The location of the installed secondary geomembrane (if necessary)

7.2.7 Panel Placement Documentation

During panel placement operations, the CQA monitor shall:

- Record panel numbers and dimensions in a Geomembrane Panel Deployment Log
- Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (panel rejected, patch installed, etc.) in the Geomembrane Repair Log
- Verify where required that corrective actions and repairs are made in accordance with the technical specifications
- Verify equipment used during deployment operations does not damage the geomembrane
- Verify equipment used on the geomembrane does not leak hydrocarbons (e.g., fuels, oils, etc.) onto the geomembrane and that preventative measures are taken to prevent leakage
- Verify the surface beneath the geomembrane has not deteriorated since previous acceptance
- Verify no stones, construction debris, or other items that could damage the geomembrane are present
- Verify a slip sheet is used to deploy geomembrane over GCL to prevent damage to GCL
- Verify the geomembrane is not dragged across a potentially damaging surface
- If the geomembrane is dragged across a surface that could damage the geomembrane, the geomembrane will be inspected for scratches and repaired or rejected, if necessary
- Verify the geomembrane is not deployed in the presence of excess moisture (fog, dew, mist, etc.)
- Verify the geomembrane is not placed when the ambient air temperature does not meet the requirements of the technical specifications

- Verify crews working on the geomembrane do not smoke, wear shoes that could damage the geomembrane, or engage in activities that could damage the geomembrane
- Verify methods used to deploy the geomembrane minimize wrinkles, and that panels are anchored and ballast is placed by the geosynthetics installer to prevent movement by the wind
- Verify installer corrects any damaged geomembrane resulting from movement by wind
- Verify no more panels are deployed than can be seamed on the same day

The CQA monitor shall inform both the geosynthetics installer and the CQA manager if any of the above conditions are not met. The CQA monitor shall mark any observed damage to geomembrane and determine if material can be repaired. If it can be repaired, the repair must be performed in accordance with this CQA Plan and the technical specifications. All repairs will be documented. Material that cannot be repaired will be rejected, removed from the installation area, and moved away from the construction area so that it is not re-installed.

7.2.8 Trial Welding and Production Welding Documentation

Before the start of geomembrane production welding and during welding operations, each welder and welding apparatus will be tested in accordance with the technical specifications to verify that they are functioning properly.

The CQA monitor shall observe all trial welding operations and verify that the installer quantitatively tests each trial weld for peel adhesion and bonded seam strength (ASTM D6392). Peel adhesion tests will be referred to as “peel” and bonded seam strength tests will be referred to as “shear” in this CQA Plan. Results of trial weld peel and shear tests will be recorded in a Geomembrane Trial Welds Form. Trial welds must be completed under conditions similar to those under which production seams will be welded. Trial welds must meet specified requirements in the technical specifications for peel and shear, and the failure must be ductile, or a film tearing bond (FTB). If at any time the CQA monitor believes that a welding apparatus is not functioning properly or there are wide variations in environmental conditions (temperature, wind speed, humidity), a trial weld must be performed. The trial weld must be allowed to cool to ambient temperature before it is tested.

During geomembrane welding operations, the CQA monitor shall:

- Verify the installer has the number of welding apparatuses and spare parts necessary to continuously perform the work
- Verify equipment used for welding will not damage the geomembrane
- Verify extrusion welders are purged before beginning a weld so that all heat-degraded extrudate is removed from the nozzle of the welder
- Verify seam grinding is completed an adequate time (per the technical specifications) before seam welding, and the upper sheet is beveled (extrusion welding only)

- Verify and document that the ambient temperature measured six inches above the geomembrane surface meets the technical specifications
- Verify ends of extrusion welds that are more than five minutes old are ground to expose new material before restarting a weld
- Verify contact surfaces of the panels are clean and free of dust, grease, dirt, debris, and moisture before welding
- Verify welds are free of dust, rocks, and other debris
- Verify cross seams are ground to a smooth incline before welding (fusion welding only)
- Verify all seams are overlapped in accordance with the technical specifications
- Verify solvents or adhesives are not present in the seam area
- Verify procedures used to temporarily hold the panels together do not damage the panels and do not preclude CQA testing
- Verify panels are being welded in accordance with the construction drawings and technical specifications
- Verify there is no free moisture in the weld area
- Document seaming operations and weather conditions in a Geomembrane Seam Welding Log
- For extrusion-welded seams, the extrudate or bead must conform to the requirements presented in the technical specifications

7.2.9 Non-destructive Seam Testing

The purpose of non-destructive geomembrane seam testing is to detect discontinuities or holes in the seams. Non-destructive geomembrane tests include vacuum and air pressure testing. Non-destructive testing must be performed over the entire length of the welded seam.

It is the installer's responsibility to perform all non-destructive testing as part of the CQC program, record the results, and report the results to the CQA monitor. The CQA monitor's responsibility is to observe and independently document in a Geomembrane Non-destructive Test Summary Form that the installer's QC testing is in compliance with the technical specifications, and to independently document seam defects and panel defects that the installer detects in a Geomembrane Repair Log. The non-destructive testing procedures are described below:

For welds tested by vacuum method the weld is placed under suction using a vacuum box constructed with rigid sides, a transparent top for viewing the seams, a neoprene rubber gasket attached to the bottom of the rigid sides, a vacuum gauge on the inside, and a valve assembly attached to a vacuum hose connection. Procedures outlined in ASTM D5641 will be used to perform this test. The vacuum box is placed over a seam section that has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom of the box must fit snugly against the soaped seam section of the panel to ensure a leak-tight seal. A vacuum pump is energized and a vacuum of approximately five pounds per square inch (psi) is applied to the geomembrane seam covered by the vacuum box. Any pinholes or other seam defects are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time for the applied vacuum will not be less than 10 seconds.

Air pressure testing is used to test the double wedge-welded seams that have an enclosed air space (channel) between the wedge welds. Procedures outlined in ASTM D5820 will be used for this test procedure. Both ends of the air channel will be sealed. A pressure feed device, usually a needle equipped with a pressure gauge, will be inserted into one end of the channel. Air will then be pumped into the channel to a minimum specified pressure according to the technical specifications. A five-minute relaxing period is allowed for the pressure to stabilize. The air chamber must sustain the pressure as specified in the technical specifications. Following a passed pressure test, and while the air pressure is sustained, the end of the air channel opposite of the needle and gauge will be punctured to release air in the channel. The pressure gauge will return to zero; if not, a blockage is likely in the seam channel. When a blockage is detected it will be located and the seam re-tested on both sides of the blockage. The penetration holes must be repaired after testing.

During non-destructive testing, the CQA monitor shall:

- Review the technical specifications and associated ASTM test standards regarding test procedures, and verify all testing is completed in accordance with the technical specifications and standards
- Verify equipment operators are fully trained and qualified to perform their work
- Verify test equipment meets requirements indicated in the technical specifications and test standards
- Verify the entire length of each seam is tested
- Observe all testing and independently record test results in a Geomembrane Non-destructive Test Summary Form and the Geomembrane Seam Welding Log
- Identify any failed areas detected by the geosynthetics installer by marking the area with a waterproof marker, verify the geosynthetics installer is aware of the required repair, and record completion of the repair in the Geomembrane Repair Log

7.2.10 CQC Destructive Seam Sampling and CQC Field Testing

The purpose of destructive seam sampling and CQC testing is to ensure seam quality before completing destructive seam sampling and CQA testing.

Destructive seam testing will be conducted along completed seams at intervals outlined in the technical specifications. The geosynthetics installer shall remove samples from the completed seam at locations the CQA monitor selects. The samples will be cut into one-inch-wide specimens as described in the technical specifications. Five specimens will be tested for peel and five for shear with the results meeting the requirements of the technical specifications. However, additional specimens may be taken if the CQA monitor suspects that a seam does not meet specification requirements. Reasons for taking additional samples may include, but are not limited to:

- Wrinkling in seam area
- Crystallinity in the seam area
- Suspect seaming equipment or techniques
- Weld contamination
- Insufficient overlap
- Adverse weather conditions
- Failing tests

The geosynthetics installer shall remove specimens the CQA monitor identifies, and then test the specimens for peel and shear using the same procedures used for trial welds as presented in Section 7.2.8 of this CQA Plan. During sampling the CQA monitor shall:

- Observe sample cutting
- Mark each specimen with an identifying number and record the seam number, welder, weld date, and weld time relative to the specimen number
- Record specimen locations in the panel layout drawing
- Record the specimen locations in the Geomembrane Repair Log
- Record the geosynthetics installer's test results in the Summary of Destructive Tests Form

The geosynthetics installer shall test seam specimens at the project site using a tensiometer capable of quantitatively measuring shear and peel strengths in accordance with ASTM D6392. For double wedge welding, both sides of the air channel will be tested for peel strength. The CQA monitor shall observe the tests. A specimen passes when the break is a ductile FTB. An FTB means the test specimen breaks at the edge or the outside of the seam, but not in the seam. In addition, the seam strength must meet the values specified in the technical specifications.

If any of the specimens fail to meet specified seam quality, the geosynthetics installer can, at his discretion, reconstruct the entire seam, or take 2 additional test samples 10 feet in either direction from the point of the failed specimen. At that point the geosynthetics installer can repeat the field peel and shear tests. If subsequent specimens fail to meet specified seam quality, this procedure will be repeated until the length of poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly, and appropriate corrective action will be taken immediately.

If a peel test on a butt seam fails, the entire butt seam must be capped.

7.2.11 CQA Destructive Seam Testing

The purpose of CQA destructive seam testing is to verify CQC destructive seam sampling and field testing. Additional CQA tests may be taken if the CQA monitor suspects that a seam does not meet the specification requirements.

These CQA specimens will be tested for peel and shear by the CQAC using procedures with ASTM D6392 and outlined for CQC testing. This testing can be performed on site in an environment and using equipment that complies with ASTM D6392, or off site in a qualified laboratory.

During sampling and testing the CQA monitor shall include the following:

- Observe sample cutting
- Mark each specimen with an identifying number and record the seam number, welder, weld date, and weld time relative to the specimen number
- Record specimen locations in the panel layout drawing
- Record the specimen locations in the Geomembrane Repair Log
- Record the CQA laboratory test results in the Summary of Destructive Tests Form

If any of the CQA test specimens fail to meet specified seam quality, the geosynthetics installer can, at his discretion, reconstruct the entire seam, or take 2 additional test samples 10 feet in either direction from the point of the failed specimen. At that point the installer can repeat the CQA sampling and testing. If subsequent specimens fail to meet specified seam quality, this procedure will be repeated until the length of poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly, and appropriate corrective action will be taken immediately.

If a peel test on a butt seam fails, the entire butt seam will be capped.

7.2.12 Repairs

Repairs are required where geomembrane panels, and/or seams contain a flaw, where a destructive test sample has been taken, and where a “T” intersection exists at corners of welded panels. All of these repairs must be made in accordance with the technical specifications. The CQA monitor shall locate required repairs and record completion of repair work in a Geomembrane Repair Log. Acceptable repair techniques include the following:

- Patching: used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, destructive sample locations, and “T” locations in panel welds.
- Extrusion: used to repair small defects in the panels and seams. In general, this procedure must be used for defects less than ½-inch in the largest dimension

- Capping: used to repair failed welds or to cover seams where welds cannot be non-destructively tested.
- Removal: used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal will be patched or capped

7.2.13 Wrinkles

During placement of soil materials over geomembrane, temperature changes may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over will be repaired either by cutting out excess material or, if possible, by allowing the geomembrane to contract by temperature reduction. In no case will material be placed over the geomembrane that could result in the geomembrane folding. The CQA monitor shall monitor geomembrane for wrinkles and notify the geosynthetics installer if wrinkles are being covered by soil. The CQA monitor is then responsible for documenting corrective action to remove the wrinkles in the Daily Progress Report Form.

7.2.14 Anchor Trench

The geomembrane anchor trench will be excavated to the lines, grades, and width shown in the construction drawings, prior to geosynthetic placement, and left open until seaming is completed. The CQA monitor shall verify that the anchor trench has been constructed according to the construction drawings. Expansion and contraction of the geomembrane will be accounted for in the liner placement. Geosynthetic materials will be extended into the anchor trench as shown in the construction drawings. The geosynthetic materials will be seamed, bonded, or attached along the entire length of the anchor trench. The anchor trench will be backfilled in accordance with the technical specifications. Anchor trench backfill material will be moisture conditioned and compacted to the satisfaction of the CQA monitor. Backfilling will take place in the morning when temperatures are coolest to reduce potential bridging of the geomembrane.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetic materials. At no time will construction equipment come into direct contact with the geosynthetic materials. The contractor shall repair any damage that occurs prior to completion of the backfilling at no cost to the owner.

7.2.15 Soil-covered Geoelectrical Liner Integrity Survey

The CQAC shall perform a soil-covered geoelectrical liner integrity survey on the primary geomembrane following placement of the soil operations layer and/or LCRS layer. To ensure the best possible boundary conditions for a successful survey, the CQAC shall be responsible for performing the following verification procedures during subgrade preparation, GCL installation/soil liner placement, geomembrane installation, and soil operations layer and/or LCRS layer placement operations:

- Monitor subgrade moisture content: Obtain subgrade soil samples and perform field moisture content testing to verify the subgrade soils contain a minimum of 5% moisture by weight. Samples should be obtained from the top three inches of the soil profile on a daily basis during GCL/geomembrane deployment. Daily sample locations should correspond with that day's deployment area so that corrective measures can be performed, if necessary, prior to GCL deployment. Corrective measures shall include the application of water to the subgrade surface by the earthworks contractor. Care should be taken to avoid over-saturating the subgrade soils to the point where deployment equipment will cause rutting or displacement.

- Monitor GCL moisture content: It is generally recognized that GCL must contain a minimum of 12% to 14% moisture content to reliably conduct electricity. To verify the moisture content of the GCL, the CQA monitor shall obtain a sample of the GCL on a daily basis during deployment. The sample will be obtained from rolls identified for that day's deployment and field-tested prior to the beginning of deployment operations so that corrective measures can be taken. Corrective measures will include the application of moisture to the subgrade surface immediately in advance of GCL deployment. Care should be taken to avoid over-saturating the subgrade soils to the point where deployment equipment will cause rutting or displacement.
- Monitor low-permeability soil liner moisture content: Obtain liner soil samples and perform field moisture content testing to verify the soil liner material contains a minimum of between 3% and 5% moisture by weight. Daily sample locations should correspond with that day's deployment area so that corrective measures can be performed, if necessary, prior to geomembrane deployment. If the low-permeability soil liner is not sufficient, the contractor shall add sufficient water to the low-permeability soil liner as required.
- Perimeter isolation: During the placement of LCRS layer and/or operations layer soils, the CQA monitor shall verify that soil placement ends a minimum of 12 inches from the geomembrane limits to provide an electrical isolation between cover soils and the perimeter subgrade soils.
- Cover soil moisture content: Cover soils in direct contact with the primary liner system should contain a minimum moisture content of 3% to 5% by weight. The CQA monitor shall obtain soil samples each day during cover soil placement and perform field moisture content testing to verify the minimum quantity of moisture is present in the soils placed that day. In the event, the cover soil does not contain the minimum quantity of moisture corrective measures shall be taken by the earthworks contractor to increase the moisture content by the direct application of water to the soil stockpile and/or the cover soil surface prior to the placement of subsequent layers.

The CQAC shall perform a geoelectrical liner integrity survey on the completed primary geomembrane installation after placement of the overlying soil operations layer and/or LCRS layer using standard practices specified in ASTM D7007: Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials. This method, on a soil covered geomembrane liner, applies a voltage across the liner and locates points where electrical current flows through discontinuities (leaks) in the geomembrane. Voltage is applied to an electrode in the soil layer covering the geomembrane, and to another electrode in the conductive subgrade and GCL/low-permeability soil liner under the geomembrane liner. Because the geomembrane is an electrical insulating material, the applied voltage produces a uniform electrical potential distribution in the soil layer above the liner when no leaks are present. If a leak is present in the liner, the electrical current will flow through the leak, which produces high current density and a localized abnormality of the potential distribution in the soil layer covering the geomembrane. Electrical measurements are made every 3 feet along 20-foot spacings in the soil layer covering the geomembrane using a dipole survey probe. A compact monitoring meter produces an audio signal that increases in intensity when approaching a leak, and then immediately becomes silent when the leak is passed. Two arrows on the meter will then indicate whether the leak is in front or behind the probe, and their intensity indicates the direction of the leak. Leaks are zeroed in on as the probe and meter approaches, pinpointing the leaks in real time. Leaks detected will be isolated so no electrical current flows through the leak, will be repaired by extrusion welding procedures, and will be re-tested using the dipole survey probe.

7.2.16 Acceptance

Geomembrane installation is accepted when the following conditions are met:

- The installation is finished in accordance with the construction drawings and technical specifications as determined by the CQA manager;
- All seams have been inspected and tested and all required tests have been completed, the tests pass, and test data have been reviewed and approved by the CQA manager;
- All required installer- and manufacturer-supplied documentation has been received, reviewed, approved, and filed by the CQA manager;
- All as-built record drawings have been completed and verified by the CQA manager to show the true panel dimensions, the locations of all seams, trenches, pipes, appurtenances, and repairs; and
- The Leak Location Survey has been completed and all detected leaks have been repaired.

7.3 Polyvinyl Chloride (PVC) Geomembrane Quality Assurance

7.3.1 Pre-construction Submittal Review

Prior to scheduled manufacturing of the product, the geosynthetics manufacturer shall submit the items required by the technical specifications to the CQAC for review and testing for conformance to the requirements in the technical specifications. If properties outlined in the technical specifications differ from the manufacturer’s standard cut sheet, the manufacturer shall provide a written statement certifying to the properties in the technical specifications, or provide an alternative material. Prior to shipment of the geomembrane, the CQAC or design engineer of record shall review geomembrane submittals for conformance to the technical specifications. Prior to installation of the geomembrane, the CQAC shall review personnel qualification submittals and shop drawings for conformance to the technical specifications. All submittals received by the CQAC must be recorded in the Submittal Register and then placed in the project files for review by the CQA monitor.

7.3.2 Geomembrane Fabrication

Individual calendared widths of PVC are factory-fabricated into large panels to minimize seaming during installation. Factory-fabricated seams shall be a minimum one inch wide and extend to the edge of the sheet. Factory seams are produced using either chemical, dielectric, or thermal methods.

Factory fabrication production records identify each panel by panel number, size, date of fabrications, material lot number, and seam station identification. Each panel is prominently marked with the panel number and panel size to coincide with production records. Visual and non-destructive inspection is performed on 100% of factory-fabricated seams. In addition, the geosynthetic supplier shall perform destructive testing on factory-fabricated seams in order to verify compliance.

Samples of factory seams are taken at the beginning and at the end of each production shift. All seams are tested for compliance and the results shall be made available to the CQAC.

All factory seams shall meet or exceed the requirements of the technical specifications.

7.3.3 Packaging, Handling, and Delivery

After factory fabrication, the PVC panels are double-accordion-folded and placed on a pallet or rolled on a cardboard core. Shipping cartons are shrink wrapped using a water and UV-resistant polymer sheeting and packaged to minimize handling at the site and damage to the contents. All cartons are labeled by the fabricator and shall have the manufacturer’s name, material thickness, and panel identification and dimensions. PVC panels delivered to the job site are to be unloaded on level ground and stored in their original, unopened containers in a secure, dry area, and protected from weathering. Whenever possible, a six-inch minimum air space between the cartons should be maintained, especially when the PVC panels are to be stored over an extended period of time. Pallets must not be stacked.

Transportation of the PVC will be through an independent trucking firm, and will be shipped via a closed or flat-bed trailer. Adequate tarps are recommended during transport via flat-bed truck.

The manufacturer shall be responsible for repairing or replacing any material damaged during shipment at no cost to the owner; however, the CQA monitor is responsible for noting and recording any damage at the time of delivery and immediately reporting the same to the shipper and geosynthetics supplier.

Upon delivery the CQA monitor shall:

- Verify equipment used to unload the materials does not damage the geomembrane
- Inspect geomembrane pallets or rolls for damage potentially occurring during shipping and/or handling, then identify damaged materials and verify damaged materials are set aside and not installed
- Verify the geomembrane is stored in accordance with the technical specifications and manufacturer’s recommendations, and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage
- Verify each pallet or roll is marked or tagged with manufacturer’s name, project identification, lot number, roll number, and roll dimensions, and that this information is documented in a Geomembrane Inventory Log

- Verify all MQC and submittal documentation required by the technical specifications has been received, reviewed, and filed, and that this information is recorded
- Verify a Geomembrane Inventory Log is completed for all geomembrane materials received

Damaged geomembrane will be rejected. If rejected, the CQA monitor shall verify material is removed from the site or stored at a location, separate from accepted geomembrane. Geomembrane that does not have proper manufacturer's documentation will be stored at a separate location, until all documentation has been received, reviewed, and accepted.

7.3.4 Review of Geosynthetics Installer's Geomembrane Panel Drawings

Before installing any geomembrane, the geosynthetics installer shall submit shop drawings in accordance with the technical specifications. The shop drawings will show the proposed layout of the panels, field seams, and any other details that are needed to describe the proposed installation. The CQA monitor shall review these shop drawings prior to geomembrane installation, and record the submittal in the Submittal Register.

7.3.5 Subsurface Preparation

Before geomembrane installation, the CQA monitor shall:

- Verify all lines and grades have been met by the contractor
- Verify soil foundation layer surface has been prepared in accordance with the technical specifications
- Subgrade preparation is signed by contractor and geosynthetics installer

Any necessary repairs will be made by the contractor. It is the responsibility of the contractor to maintain the integrity of the foundation soil prior to, and during, the PVC cover geomembrane installation.

If an herbicide is required, it must be suitable for use with geomembranes and shall be applied as per the manufacturer's recommendations. The herbicide manufacturer shall confirm suitability for use with the geomembrane.

7.3.6 Subgrade Acceptance

Prior to geomembrane deployment, the soil foundation layer surface on which the geomembrane will be installed must be prepared in accordance with the technical specifications. Before geomembrane installation, the CQA monitor and geosynthetics installer shall inspect the soil foundation layer surface. The CQA monitor shall verify the following:

- The soil foundation layer surface underlying the geomembrane has been prepared in accordance with the technical specifications
- No sharp objects or other materials that could puncture the geomembrane are present on the surface

- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones
- There are no excessively soft areas
- The geosynthetics installer has certified in writing, in a form acceptable to the CQA manager, that the surface on which the geomembrane will be installed is acceptable
- This Subgrade Acceptance Form must be prepared on a daily basis whenever geomembrane is being deployed

7.3.7 Panel Layout As-built

During installation, the CQA monitor shall maintain an up to date panel layout drawing that shows the following as-built information:

- Orientation and size of each geomembrane panel
- Roll numbers associated with each panel
- Assigned panel numbers
- Assigned seam numbers
- Destructive test locations
- Repair locations

The project surveyor shall survey the installed perimeter of geomembrane prior to it being covered, and then prepare a final as-built drawing showing the location of the installed PVC geomembrane.

7.3.8 Panel Placement Documentation

During panel placement operations, the CQA monitor shall:

- Record panel numbers and dimensions in a Geomembrane Panel Deployment Log.
- Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (panel rejected, patch installed, etc.) in the Geomembrane Defect and Repair Logs.
- Verify that corrective actions and repairs are made in accordance with the technical specifications where required.
- Verify that equipment used during deployment operations does not damage the geomembrane. Tools used in the installation process shall be properly stored and carried. Knives and other sharp objects shall be secured when not in use and carried in protective sheaths.
- Verify equipment used on the geomembrane does not leak hydrocarbons (e.g., fuels, oils, etc.) onto the geomembrane and that preventative measures are taken to prevent leakage.
- Verify that high traffic areas have adequate temporary wear surfaces, such as geotextile, additional PVC rubsheets, clean fill, etc.
- Verify that vehicles do not travel on the PVC unless approved by the CQA manager. Vehicle ground pressure shall not exceed the requirements of the technical specifications.

- Verify the surface beneath the geomembrane has not deteriorated since previous acceptance.
- Verify no stones, construction debris, or other items that could damage the geomembrane are present.
- Verify the method used to unfold the PVC panels does not cause damage to the PVC.
- Verify the geomembrane is not dragged across a potentially damaging surface.
- If the geomembrane is dragged across a surface that could damage the geomembrane, the geomembrane will be inspected for scratches and repaired or rejected, if necessary.
- Verify the geomembrane is not deployed in the presence of excess moisture (fog, dew, mist, etc.).
- Verify the geomembrane is placed in accordance with ambient temperature requirements in the technical specifications. Verify crews working on the geomembrane do not smoke, wear shoes that could damage the geomembrane, or engage in activities that could damage the geomembrane.
- Verify methods used to deploy the geomembrane minimize wrinkles and that the geosynthetics installer anchors panels and places ballast to prevent movement by the wind.
- Verify installer corrects any damaged geomembrane resulting from movement by wind.
- Verify that PVC panels are deployed with a minimum overlap and as oriented in the technical specifications.
- Verify no more panels are deployed than can be seamed on the same day.

The CQA monitor shall inform both the geosynthetics installer and the CQA manager if any of the above conditions are not met. The CQA monitor shall mark any observed damage to geomembrane and determine if material can be repaired. If it can be repaired the repair must be performed in accordance with this CQA Plan and the technical specifications. All repairs will be documented. Material that cannot be repaired will be rejected, removed from the installation area, and moved away from the construction area so that it is not re-installed.

7.3.9 Trial Welding and Production Welding Documentation

The two acceptable panel seaming methods are hot wedge single-track and hot wedge dual-track. Patching, details, and pipe boots may be performed by hot air (hand-held leister), chemical bonding, or equivalent methods.

Before the start of geomembrane production welding, and during welding operations, each welder and welding apparatus will be tested in accordance with the technical specifications to verify that they are functioning properly. One trial weld will be performed before the start of work and one at mid-shift. Additional trial welds will be required if a machine is down (i.e., not in operation) longer than one hour.

The CQA monitor shall observe all trial welding operations and verify that the installer quantitatively tests each trial weld for peel adhesion and bonded seam strength (ASTM D7408). Peel adhesion tests will be referred to as “peel” and bonded seam strength tests will be referred to as “shear” in this CQA Plan. The purpose of peel and shear tests is to evaluate seam strength. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel adhesion measures the strength of the bond created by the welding process. Results of trial weld peel and shear tests will be recorded in a Geomembrane Trial Welds Form. Trial welds must be completed under conditions similar to those under which production seams will be welded. Trial welds must meet specified requirements in the technical specifications for peel and shear. If at any time the CQA monitor believes that a welding apparatus is not functioning properly, a trial weld must be performed. If there are wide changes in environmental conditions (temperature, humidity, or wind speed), another trial weld must be performed. The trial weld must be allowed to cool to ambient temperature before it is tested.

During geomembrane welding operations, the CQA monitor shall:

- Verify the installer has the number of welding apparatuses and spare parts necessary to continuously perform the work.
- Verify equipment used for welding will not damage the geomembrane.
- Verify and document that the ambient temperature measured six inches above the geomembrane surface meets technical specifications.
- Verify that cold weather procedures as provided in the technical specifications are followed, if applicable.
- Verify contact surfaces of the panels are clean, and free of dust, grease, dirt, debris, and moisture before welding.
- Verify welds are free of dust, rocks, and other debris.
- Verify that seaming boards, platforms, or rub sheets are used in cases where seaming must be conducted over a rough substrate.
- Verify all seams are overlapped in accordance with the technical specifications.
- Verify seam widths are a minimum as provided in the technical specifications.
- Verify that pressure “squeeze-out” along seam edge is kept to a minimum.
- Verify solvents and adhesives, such as chemical fusion seaming agents, fuels, or chemical cleaning agents are stored separately away from PVC panels and not present in the seam area. Spill-resistant containers shall be used while working directly on the PVC and shall be stored on a sacrificial material such as scrap PVC or heavy cardboard.
- Verify procedures used to temporarily hold the panels together do not damage the panels and do not preclude CQA testing.
- Verify panels are being welded in accordance with the construction drawings and technical specifications.
- Verify there is no free moisture in the weld area.
- Document seaming operations and weather conditions in a Geomembrane Seam Welding Log.
- Verify that seaming equipment is capable of producing sufficient heat and pressure to the seam overlap contact zone to create a continuous thermal weld.

7.3.10 Non-destructive Seam Testing

The purpose of non-destructive geomembrane seam testing is to detect discontinuities or holes in the seams. Non-destructive geomembrane tests include air lance and air channel testing. Non-destructive testing must be performed over the entire length of all welded seams.

It is the installer's responsibility to perform all non-destructive testing as part of the CQC program, record the results, and report the results to the CQA monitor. The CQA monitor's responsibility is to observe and independently document in a Geomembrane Non-destructive Test Summary Form that the installer's QC testing is in compliance with the technical specifications, and to independently document seam defects and panel defects that the installer detects in a Geomembrane Defect Log. The non-destructive testing procedures are described below.

Air lance testing is used to test single-track seams created by hot wedge fusion, hot-air, or chemical bonding methods of seaming. Procedures outlined in ASTM D4437 will be used for this test procedure. The air lance shall be capable of supplying a minimum of 50 psi air supply through a 3/16-inch-diameter nozzle. The air stream shall be directed at the edge of the seam no more than two inches from the seam edge.

Air pressure testing is used to test the double wedge-welded seams that have an enclosed air space (channel) between the wedge welds. Procedures outlined in ASTM D7177/7177M will be used for this test procedure. The air chamber must sustain the pressure as provided in the technical specifications.

Following a passed pressure test, and while the air pressure is sustained, the end of the air channel opposite of the needle and gauge will be punctured to release air in the channel. The pressure gauge will return to zero; if not, a blockage is likely in the seam channel. When a blockage is detected it will be located and the seam re-tested on both sides of the blockage. The penetration holes must be repaired after testing.

During non-destructive testing, the CQA monitor shall:

- Review technical specifications and associated ASTM test standards regarding test procedures, and verify all testing is completed in accordance with the technical specifications and standards
- Verify equipment operators are fully trained and qualified to perform their work
- Verify test equipment meets requirements indicted in the technical specifications and test standards
- Verify the entire length of each seam is tested
- Observe all testing and independently record test results in a Geomembrane Non-destructive Test Summary Form and the Geomembrane Seam Welding Log

- Identify any failed areas that the geosynthetics installer detects by marking the area with a waterproof marker, verify the geosynthetics installer is aware of the required repair, and record completion of the repair and retest in the Geomembrane Repair Log

7.3.11 Destructive Seam Sampling and CQC Field Testing

The purpose of destructive seam sampling and CQC testing is to ensure seam quality before completing destructive seam sampling and CQA testing.

Destructive seam testing will be conducted along completed seams at intervals provided in the technical specifications by each welding apparatus. As per Fabricated Geomembrane Institute (FGI) Field Seam-Test Frequency for Fabricated Geomembrane Panels Specifications (FGI 2016), no destructive testing will be required when air channel testing is performed and deemed passing on double-track hot wedge fusion welds. The geosynthetics installer shall remove samples from the completed seam at locations the CQA monitor selects. Five specimens will be tested for peel and five for shear with the results meeting the requirements of the technical specifications. However, additional specimens may be taken if the CQA monitor suspects that a seam does not meet the technical specification requirements. Reasons for taking additional samples may include, but are not limited to:

- Wrinkling in seam area
- Crystallinity in the seam area
- Suspect seaming equipment or techniques
- Weld contamination
- Insufficient overlap
- Adverse weather conditions
- Failing tests

The geosynthetics installer shall remove specimens the CQA monitor identifies, and then test the specimens for peel and shear using the same procedures used for trial welds as presented in the technical specifications. During sampling the CQA monitor shall:

- Observe sample cutting
- Mark each specimen with an identifying number and record the seam number, welder, weld date, and weld time relative to the specimen number
- Record specimen locations in the panel layout drawing
- Record the specimen locations in the Geomembrane Repair Log
- Record the geosynthetics installer’s test results in the Summary of Destructive Tests Form

The geosynthetics installer shall test seam specimens at the project site using a tensiometer capable of quantitatively measuring shear and peel strengths in accordance with ASTM D7408 for thermal fusion and by ASTM D4437 for chemical seams. The CQA monitor shall observe the tests. The seam strength must meet the values specified in the technical specifications.

If any of the specimens fail to meet specified seam quality, the geosynthetics installer can, at his discretion, reconstruct the entire seam, or take two additional test samples 10 feet in either direction from the point of the failed specimen. At that point the geosynthetics installer can repeat the field peel and shear tests. If subsequent specimens fail to meet specified seam quality, this procedure will be repeated until the length of poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly, and appropriate corrective action will be taken immediately.

If a peel test on a butt seam fails, the entire butt seam must be capped.

7.3.12 CQA Destructive Seam Testing

The purpose of CQA destructive seam testing is to verify CQC destructive seam sampling and field testing. Additional CQA tests may be taken if the CQA monitor suspects that a seam does not meet the specification requirements.

These CQA specimens will be tested for peel and shear by the CQAC using procedures with ASTM D7408 and outlined for CQC testing. This testing can be performed on site in an environment and using equipment that complies with ASTM D7408, or off site in a qualified laboratory.

During sampling and testing the CQA monitor shall include the following:

- Observe sample cutting
- Mark each specimen with an identifying number and record the seam number, welder, weld date, and weld time relative to the specimen number
- Record specimen locations in the panel layout drawing
- Record the specimen locations in the Geomembrane Repair Log
- Record the CQA laboratory test results in the Summary of Destructive Tests Form

If any of the CQA test specimens fail to meet specified seam quality, the geosynthetics installer can, at their discretion, reconstruct the entire seam, or take 2 additional test samples 10 feet in either direction from the point of the failed specimen. At that point the installer can repeat the CQA sampling and testing. If subsequent specimens fail to meet specified seam quality, this procedure will be repeated until the length of poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly, and appropriate corrective action will be taken immediately.

If a peel test on a butt seam fails, the entire butt seam will be capped.

7.3.13 Repairs

Repairs are required where geomembrane panels, and/or seams contain a flaw, where a destructive test sample has been taken, and where a “T” intersection exists at corners of welded panels. All of these repairs must be made in accordance with the technical specifications. The CQA monitor shall locate required repairs and record completion of repair work in a Geomembrane Repair Log. Acceptable repair techniques include the following:

- Patching: used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, destructive sample locations, “fishmouths,” and “T” locations in panel welds.
- Capping: used to repair failed welds or to cover seams where welds cannot be non-destructively tested.
- Removal: used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal will be patched or capped.

During geomembrane repair operations, the CQA monitor shall:

- Verify that patches extend the minimum distance beyond the repair area as per the technical specifications in all directions
- Verify that seams have the minimum width specified in the technical specifications along the entire perimeter of patches
- Identify all repairs requiring a patch or cap on an as-built panel drawing
- Verify each repair has undergone and passed non-destructive testing
- Verify that any repair that does not pass non-destructive testing are reconstructed and retested until a passing result is obtained

7.3.14 Wrinkles

During placement of soil materials over geomembrane, temperature changes may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over will be repaired either by cutting out excess material or, if possible, by allowing the geomembrane to contract by temperature reduction. In no case will material be placed over the geomembrane that could result in the geomembrane folding. The CQA monitor shall monitor geomembrane for wrinkles and notify the geosynthetics installer if wrinkles are being covered by soil. The CQA monitor is then responsible for documenting corrective action to remove the wrinkles in the Daily Progress Report Form.

7.3.15 Pipe Penetrations

Pipe penetrations through the PVC geomembrane shall be sealed via the use of factory-fabricated pipe seals whenever possible.

During pipe boot installation the CQA monitor shall:

- Verify pipe seals are constructed of the same material and thickness as the specified PVC geomembrane
- Verify that pipe seals are ponded to the PVC using an approved seaming
- Verify that chemically bonded seams have a minimum width of two inches, if applicable
- Verify each pipe seal has undergone and passed non-destructive testing

7.3.16 Soil-covered Geoelectrical Liner Integrity Survey

The CQAC shall perform a soil-covered geoelectrical liner integrity survey on the primary geomembrane following placement of the drainage layer. To ensure the best possible boundary conditions for a successful survey, the CQAC shall be responsible for performing the following verification procedures during foundation soil layer preparation, geomembrane installation, and drainage layer placement operations:

- Monitor foundation layer soil moisture content: Obtain foundation layer soil samples and perform field moisture content testing to verify the soils contain a minimum of 5% moisture by weight. Samples should be obtained from the top three inches of the soil profile on a daily basis during geomembrane deployment. Daily sample locations should correspond with that day's deployment area so that corrective measures can be performed, if necessary, prior to geomembrane deployment. Corrective measures shall include the application of water to the foundation layer surface by the contractor. Care should be taken to avoid over-saturating the subgrade soils to the point where deployment equipment will cause rutting or displacement.
- Perimeter isolation: During the placement of the drainage layer soils, the CQA monitor shall verify that soil placement ends a minimum of 12 inches from the geomembrane limits to provide an electrical isolation between cover soils and the perimeter subgrade soils.
- Drainage layer soil moisture content: Cover soils in direct contact with the primary liner system should contain a minimum moisture content of 3% to 5% by weight. The CQA monitor shall obtain soil samples each day during cover soil placement and perform field moisture content testing to verify the minimum quantity of moisture is present in the soils placed that day. In the event the drainage layer soil does not contain the minimum quantity of moisture, corrective measures shall be taken by the contractor to increase the moisture content by the direct application of water to the soil stockpile and/or the cover soil surface prior to the placement of subsequent layers.

The CQAC shall perform a geoelectrical liner integrity survey on the completed primary geomembrane installation after placement of the overlying soil drainage layer using standard practices specified in ASTM D7007: Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials. Electrical measurements are made every 3 feet along 20-foot spacings in the soil layer covering the geomembrane using a dipole survey probe. Leaks detected will be isolated so no electrical current flows through the leak, will be repaired by repair procedures, and will be re-tested using the dipole survey probe.

7.3.17 Acceptance

Geomembrane installation is accepted when the following conditions are met:

- The installation is finished in accordance with the construction drawings and technical specifications as determined by the CQA manager
- All seams have been inspected and tested and all required tests have been completed, the tests pass, and test data has been reviewed and approved by the CQA manager
- All required installer- and manufacturer-supplied documentation has been received, reviewed, approved, and filed by the CQA manager
- All as-built record drawings have been completed and verified by the CQA manager to show the true panel dimensions, and the locations of all seams, trenches, pipes, appurtenances, and repairs
- The geoelectrical liner integrity has been completed and all detected leaks have been repaired

7.4 Geotextile Construction Quality Assurance

7.4.1 Pre-construction Submittal Review

Prior to scheduled manufacturing of the product, the geosynthetics manufacturer shall submit the items required by the technical specifications to the CQAC for review and testing. If properties outlined in the technical specifications differ from the manufacturer’s standard cut sheet, the liner supplier shall provide an alternative product. Prior to shipment of the geotextiles, the CQAC shall review the geotextile submittals for conformance to the technical specifications. All submittals received by the CQAC shall be recorded in the Submittal Register and then placed in the project files for review by the CQA monitor.

7.4.2 Delivery

During delivery of geotextiles the CQA monitor shall:

- Verify equipment used to unload the rolls will not damage the geotextile
- Verify rolls are wrapped in impermeable and opaque protective covers
- Verify care is used to unload the rolls
- Verify all MQC and submittal documentation required by the technical specifications has been received, reviewed, and filed
- Verify each roll is marked or tagged with manufacturer’s name, project identification, lot number, roll number, roll dimensions, and that this information is documented in a Geotextile Inventory Log
- Verify materials are stored in a location that are protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions

Damaged rolls will be rejected. If rejected, the CQA monitor shall verify rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls that do not have proper manufacturer's documentation will also be stored at a separate location, until all documentation has been received and approved.

7.4.3 Subsurface Preparation

Before geotextile installation, the CQA monitor shall:

- Verify installation of underlying layer is complete and its thickness has been verified if placed on earthen materials
- Verify geomembrane installation is complete and CQC and CQA documentation verifies its installation meets specified requirements if placed on geomembrane
- Verify underlying layer surface does not contain stones or other protruding objects that could damage the geotextile
- Verify all construction stakes have been removed

7.4.4 Placement and Seaming

During geotextile placement and seaming operations, the CQA monitor shall:

- Observe the geotextiles as they are deployed and identify all defects and defect corrective actions (panel rejected, patch installed, etc.). Verify corrective actions are performed in accordance with the technical specifications, and record these corrective actions in the daily progress reports.
- Verify equipment used to install geotextile does not damage it during deployment.
- Verify crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Verify the geotextile is securely anchored to prevent movement by the wind.
- Verify adjacent panels are overlapped and seamed in accordance with the technical specifications.
- Verify the geotextile was not exposed to direct sunlight for more than the number of days recommended by the manufacturer.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.

The CQA monitor shall inform both the CQA manager and geosynthetics installer and/or contractor, as appropriate, if the above conditions are not met.

7.4.5 Repairs

Where repairs are necessary the CQA monitor shall verify the following methods are used:

- Patching: used to repair large holes, tears, and small defective areas.
- Removal and replacement: used to replace large defective areas where the preceding method is not appropriate.

7.5 Geocomposite Quality Assurance

7.5.1 Pre-construction Submittal Review

Prior to scheduled manufacturing of the product, the geosynthetics manufacturer shall submit the items required by the technical specifications to the CQAC for review and testing. If properties outlined in the technical specifications differ from the manufacturer’s standard cut sheet, the manufacturer shall provide a written statement certifying to the properties in the specifications, or provide an alternative product. Prior to shipment of the geocomposites, the CQAC shall review the geocomposite submittals for conformance to the technical specifications. All submittals received by the CQAC must be recorded in the Submittal Register and then placed in the project files for review by the CQA monitor.

7.5.2 Delivery

During delivery of geocomposites the CQA monitor shall:

- Verify equipment used to unload the rolls does not damage the material
- Verify rolls are wrapped in impermeable and opaque protective covers
- Verify care is used to unload the rolls
- Verify all MQC and submittal documentation required by the technical specifications has been received, reviewed and filed
- Verify each roll is marked or tagged with manufacturer’s name, project identification, lot number, roll number, roll dimensions, and that this information is documented in a Geocomposite Inventory Log
- Verify materials are stored in a location that will protect the rolls from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions

Damaged rolls will be rejected. If rejected, the CQA monitor shall verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geocomposite rolls that do not have proper manufacturer’s documentation will also be stored at a separate location, until all documentation has been received and approved.

7.5.3 Subsurface Preparation

Before geocomposite installation, the CQA monitor shall:

- Verify the geomembrane installations are complete and all CQC and CQA documentation verifies the installations meet specified requirements

7.5.4 Deployment and Seaming

During deployment and seaming operations, the CQA monitor shall:

- Observe the geocomposite as it is deployed and identify all defects and defect corrective actions (panel rejected, patch installed, etc.), verify corrective actions are performed in accordance with the technical specifications, and record these corrective actions in the daily progress reports
- Verify equipment used to install geocomposite does not damage it during deployment
- Verify crews working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite
- Verify the geocomposite is securely anchored to prevent movement by the wind
- Verify adjacent panels are overlapped and connected in accordance with the technical specifications
- Verify the geotextile component is not exposed to direct sunlight for more than the number of days recommended by the manufacturer

The CQA monitor shall inform both the CQA manager and contractor if the above conditions are not met.

7.5.5 Repairs

Where repairs are necessary the CQA monitor shall verify the following methods are used:

- Patching: used to repair large holes, tears, and small defective areas.
- Removal and replacement: used to replace large defective areas where the preceding method is not appropriate.

8.0 MECHANICAL CONSTRUCTION QUALITY ASSURANCE

8.1 Polyethylene Pipe Conformance and Construction Testing

This section describes CQA procedures for polyethylene pipe installations. Perforated and solid-wall HDPE pipe will be used to construct the LCRS and leachate force main. Installation requirements are specified in the technical specifications.

8.1.1 Pre-construction Submittal Review

Prior to shipment of the product, the geosynthetics installer or contractor shall provide the submittals to the CQAC for review and testing as required by the technical specifications.

All submittals received by the CQAC will be recorded in the Submittal Register, and then placed in the project files for review by the CQA monitor.

8.1.2 Delivery

During delivery of HDPE pipe the CQA monitor shall:

- Verify equipment used to unload the pipe does not damage the material
- Verify care is used to unload the pipe
- Verify all documentation required by the technical specifications has been received
- Verify materials are stored in a location that will protect the pipe from puncture, cutting, or any other damaging or deleterious conditions
- Verify materials are not stacked higher than specified in the technical specifications or as recommended by the manufacturer
- Verify that materials have the required markings described in the technical specifications

Damaged pipe will be rejected. If rejected, verify rejected material will be removed from the site or stored at a location separate from accepted materials. Pipe that does not have proper manufacturer’s documentation will also be stored at a separate location until all documentation has been received and approved.

8.1.3 LCRS Construction Monitoring

Before pipe fusion welding and installation operations begin, the CQA monitor shall verify that qualified fusion welding technicians are performing the work.

During pipe fusion welding operations the CQA monitor shall verify the following:

- Qualifications and certifications of HDPE pipe fusion weld operators.
- Hot plate temperatures are maintained within the range specified in the technical specifications.
- Pipe ends are squarely faced and cuttings are removed before fusion welding occurs.

- Joining, holding, and cooling time for fusion welding varies with pipe size and wall thickness. The complete process will require approximately 30 to 90 seconds per inch of pipe diameter and the welding bead should be cool to the touch.
- Pressure testing, pulling, or installation of pipe should not take place for a minimum time as defined in the technical specifications.
- Cooling time of the fusion-welded pipe shall be allowed as defined in the technical specifications before release from the weld machine.
- Fusion weld roll-back (melted HDPE) thickness after the pipe ends are jointed meets the requirements of the technical specifications
- LCRS pipes are properly aligned in the LCRS gravel and are at the design grade.
- Force main pipes are properly aligned in the trench and are at the design grade.
- Backfilling operations are conducted in accordance with the technical specifications.
- Documentation of the above work must be provided in the daily progress reports.

TABLES

Table 6-1: CQA Testing Frequency of Engineered Fill

Testing	Frequency$^{(1, 2, 3)}$
Pre-construction Testing	
Standard Proctor Curve (as appropriate) (ASTM D698)	One per material type
Construction Testing	
Standard Proctor Curve (as appropriate) (ASTM D698)	One per 10,000 cy
Density/Moisture–Nuclear Gauge (ASTM D6938)	One per 500 cy
Nuclear Gauge Calibration Block (ASTM D6938)	One per day check on Nuclear Density Gauge
Oven Moisture Content (ASTM D2216)	One per 20 Nuclear Gauge Density–Moisture Tests

Notes:
1). Test frequencies are per cubic yard of placed and compacted material.
2). At a minimum, nuclear gauge density–moisture tests should be performed once per day for each day that material is placed.
3). When options are allowed in the testing frequency, the option that will result in a greater frequency will apply.

Table 6-2: CQA Testing Frequency of Composite Liner Subgrade Preparations

TESTING	Frequency$^{(1, 2, 3, 4)}$
Pre-construction Testing	
Sampling for Interface Testing (ASTM D5321)	One per project
Standard Proctor Curve (as appropriate) (ASTM D698)	One per material type
Construction Testing	
Standard Proctor Curve (as appropriate) (ASTM D698)	One per 50,000 sf
Density–Moisture – Nuclear Gauge (ASTM D6938)	One per 25,000 sf
Nuclear Gauge Calibration Block (ASTM D6938)	One per day
Oven Moisture Content (ASTM D 2216)	One per 20 Nuclear Gauge Density–Moisture Tests

Notes:
1). Test frequencies are per square feet of placed and compacted material.
2). As a minimum, nuclear gauge density–moisture tests should be performed once per day for each day that material is placed:
3). When options are allowed in the testing frequency, the option that will result in a greater frequency will apply.
4). Applies to six inches of structural fill under GCL or low-permeability soil layer.

Table 6-3: CQA Testing Frequency of Low-permeability Soil Liner

TESTING	**Frequency$^{(1)}$**
Pre-Construction Testing	
Atterberg Limits (ASTM D4318)	One per material type or one per 20,000 cy
Sieve – Grain Size (ASTM C136/D422)	One per material type or one per 20,000 cy
Oven Moisture Content (ASTM D2216)	One per material type or one per 20,000 cy
Standard Proctor Curve (as appropriate) (ASTM D698)	One per material type or one per 20,000 cy
Permeability (ASTM D2434)	One per material type or one per 20,000 cy
Construction Testing	
Atterberg Limits (ASTM D4318)	One per material type or one per 5,000 cy
Sieve – Grain Size (ASTM C136/D422)	One per material type or one per 5,000 cy
Oven Moisture Content (ASTM D2216)	One per material type or one per 5,000 cy
Standard Proctor Curve (as appropriate) (ASTM D698)	One per material type or one per 10,000 cy
Density–Moisture – Nuclear Gauge (ASTM D6938)	One per 300 cy with minimum of one per day
Nuclear Gauge Calibration Block (ASTM D6938)	One per day
Permeability – Shelby Tube of Compacted Liner (ASTM D5084)	One per material type or one per 10,000 cy

Notes:

1). Test frequencies are per cubic yard of placed and compacted material.

2). As a minimum, the following tests should be performed once per day for each day that material is placed:
  a). Nuclear moisture–density test
  b). Oven-dried moisture content

3). All holes made in the cover or liner barrier layers for the purposes of these tests should be backfilled with hydrated bentonite powder or with hand-compacted clay.

4). When options are allowed in testing frequency, the option that will result in a greater frequency will apply.

Table 6-4: CQA Testing Frequency of Granular LCRS (Operations Layer) and LCRS Gravel

TESTING	Frequency$^{(1)}$
Granular LCRS Pre-Construction Testing	
Sieve – Grain Size (ASTM C136/D422)	One per source
Permeability (ASTM D2434)	One per source
Granular LCRS Construction Testing	
Sieve – Grain Size (ASTM C136/D422)	One per material type or one per 2,500 cy
Permeability (ASTM D2434)	One per material type or one per 5,000 cy
LCRS Gravel Pre-Construction Testing	
Sieve – Grain Size (ASTM C136/D422)	One per source
Permeability (ASTM D2434)	One per source
Carbonate Content (ASTM D3042)	One per source
LCRS Gravel Construction Testing	
Sieve – Grain Size (ASTM C136/D422)	One per material type or one per 2,500 cy
Permeability (ASTM D2434)	One per material type or one per 5,000 cy
Carbonate Content (ASTM D3042)	One per material type

Notes:
1). Test frequencies are per cubic yard of placed and compacted material.